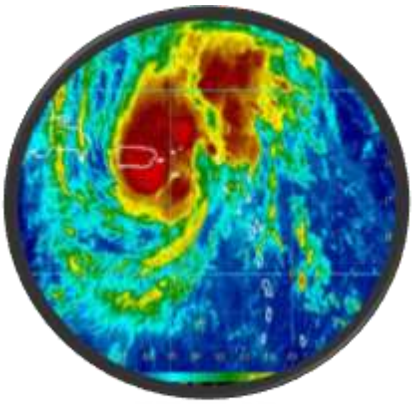
MUNICIPIO DE SAN SEBASTIÁN
PUERTO RICO

HAZARD MITIGATION PLAN

UPDATED (V4)



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TETRA TECH

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Municipality of San Sebastián
Puerto Rico

Hazard Mitigation Plan
Municipality of San Sebastián, Puerto Rico
(Updated May 2018, V4)

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1.0 INTRODUCTION

This section provides a general introduction to the Municipality of San Sebastián Hazard Mitigation Plan Revision for 2018. This introduction is presented in the following four subsections:

- Background
- Purpose
- Authority
- Organization of the Plan

1.1 BACKGROUND

Natural hazards, such as hurricanes, fires, mudslides, floods and earthquakes are a part of the world around us. Their occurrence is natural and inevitable, and there is little we can do to control their force and intensity. It is when these naturally occurring events intersect with our built environment—where we live, work and play—that these hazards have the potential to become disasters.

In response to the requirements of the Disaster Mitigation Act of 2000 (DMA 2000), the Municipality of San Sebastián, Puerto Rico has developed this All-Hazard Mitigation Plan (HMP or Plan). The original HMP for the Municipality of San Sebastián was approved on April 5, 2006. The most recent update was adopted on March 29, 2012. The current update corresponding to year 2018 edition will be adopted by the local government when approved (Prelaminar Ordenanza Municipal Número 26, Serie 2017-18), see **Appendix A**.

DMA 2000 amends the Stafford Act and is designed to improve planning for, response to, and recovery from, disasters by requiring state and local entities to implement pre-disaster mitigation planning and develop HMPs. The Federal Emergency Management Agency (FEMA) has issued guidelines for HMPs. The Puerto Rico Office of Emergency Management (PREMA) also supports plan development for jurisdictions in the Island.

Hazard Mitigation

is any sustained action taken to reduce or eliminate the long-term risk and effects that can result from specific hazards.

FEMA defines a **Hazard Mitigation Plan** as the documentation of a state or local government evaluation of natural hazards and the strategies to mitigate such hazards.

Specifically, DMA 2000 requires that local governments with support from local and State agencies develop HMPs to prepare for and reduce the potential impacts of natural hazards. DMA 2000 is intended to facilitate cooperation between state and local authorities, prompting them to work together. This enhanced planning will better enable local and state governments to articulate accurate needs for mitigation, resulting in faster allocation of funding and more effective risk reduction projects.

FEMA's goal, based on the provisions of Code of Federal Regulations (CFR) 44 through part 201, is that state and local governments develop comprehensive and integrated plans that are coordinated through state, local and regional agencies, with the participation of non-governmental groups. In addition, to the extent possible, FEMA seeks to unify the planning requirements for different FEMA mitigation programs. This ensures that the municipal plan meets the minimum requirements for different FEMA mitigation programs. The plan must integrate information from documents and other plans, including emergency management. In the early 1990s a new federal policy regarding disasters began to evolve. Rather than simply reacting whenever disasters strike communities, the federal government would encourage communities to first assess their vulnerability to various disasters and then take actions to reduce or eliminate potential risks. The logic is simply that a disaster-resistant community can rebound from a natural disaster with less loss of property or human injury, at much lower cost, and, consequently, more quickly. Moreover, other costs associated with disasters, such as the time lost from productive activity by business and industries, are minimized.

DMA 2000 provides an opportunity for States, tribes and local governments to take a new and revitalized approach to mitigation planning. DMA 2000 amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act by repealing the previous mitigation planning provisions (Section 409) and replacing them with a new set of requirements (Section 322). This section sets forth the requirements that communities evaluate natural hazards within their respective jurisdictions and develop an appropriate plan of action to mitigate those hazards, while emphasizing the need for State, tribal and local governments to closely coordinate mitigation planning and implementation efforts.

The ***Federal Emergency Management Agency*** (FEMA) estimates that for every dollar spent on damage prevention (mitigation), twice that amount is saved through avoided post-disaster damage repair.

Responsibility for fulfilling the requirements of Section 322 of the Stafford Act and administering the FEMA Hazard Mitigation Program has been delegated to the Commonwealth of Puerto Rico, specifically to the Puerto Rico Emergency Management Agency (PREMA or AEMEAD for its acronym in Spanish). FEMA also provides support through guidance, resources, and plan reviews. Copies of the applicable Federal regulations are found in **Appendix B**.

The amended Stafford Act requires that each local jurisdiction identify potential natural hazards to the health, safety and wellbeing of its residents and identify and prioritize actions that can be taken by the community to mitigate those hazards—before disaster strikes. For communities to remain eligible for hazard mitigation assistance from the federal government, they must first prepare an HMP (this Plan).

This document captures the development of the Mitigation Plan adopted by the Municipality of San Sebastián in 2012 and the five-year update. The Plan includes the update process undertaken by the Municipal Mitigation Committee, with technical collaboration of the advisory group Tetra Tech, Inc. It also includes the changes and recommendations incorporated in the light of the signs and expressions made by the public. Mitigation techniques include both structural measures, such as strengthening or protecting buildings and infrastructure from the forces of hazards, and non-structural measures, such as the adoption of land use policies or the creation of public awareness programs. A comprehensive mitigation approach addresses hazard vulnerabilities that exist today and in the foreseeable future.

The HMP (version 2012), suggested to evaluate projected patterns of future development regarding how that growth will increase or decrease its overall vulnerability to hazards because of the development pressures facing San Sebastián. This version (2018) included the expansion development areas approved in the Municipal Land Comprehensive Plan (Plan de Ordenamiento Territorial) in the vulnerability assessment.

This plan is presented to proper authorities for their revision and approval to establish mitigation projects that will help the citizens and government of San Sebastián mitigate or eliminate natural hazards that may cause loss of life and property. This Plan makes references to previous or updated information along the document.

1.2 PURPOSE

This Plan is designed to meet both the requirements of DMA 2000 and the applicable rules of the Puerto Rico State Emergency Management Agency (PRSEMA). The scope of this Hazard Mitigation Plan Update is to review and revise the current plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities according with the mitigation planning regulation at 44 CFR § 201.6(d)(3). The planning process followed for the Municipality of San Sebastián was intended to:

- Protect life, safety and property by reducing the potential for future damages and economic losses that result from natural hazards.

- Speed recovery and redevelopment following future disaster events.
- Demonstrate a firm local commitment to hazard mitigation principles; and
- Comply with both central government and federal legislative requirements for local hazard mitigation plans.

1.3 AUTHORITY

This Plan has been adopted and certified by the Municipality of San Sebastián under the authority defined under Autonomous Municipalities Act (Ley de Municipios Autónomos), Law No. 81 of 1991. The law was enacted to empower local municipalities. It established a framework for a more democratic and participatory form of government. This Plan was adopted and certified by the Mayor and the Municipal Assembly, a local representative group of residences, which per the Law 81, is given broad legislative powers to approve ordinances, resolutions and regulations on matters of municipal jurisdiction.

This Plan has been prepared in accordance with the following regulations and guidance. The Plan shall be routinely monitored and updated to remain in compliance with the following enabling legislation and regulatory guidance:

- The Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended by the Disaster Mitigation Act of 2000 (Public Law 106-390 – October 30, 2000).
- 44 Code of Federal Regulation (CFR) 44 Section 201.
- FEMA. 2008. "Local Multi-Hazard Mitigation Planning Guidance".
- FEMA. 2004. "How-To Guide for Using HAZUS-MH for Risk Assessment." FEMA Document No. 433.
- FEMA Mitigation Planning How-to Series (FEMA 386-1 to 4, 2002).

1.4 ORGANIZATION OF THE PLAN

The following sections of the Plan present detailed information to support the purposes of the Plan, they are:

- Section One, introduces the Plan.
- Section Two, provides a background of the municipality.
- Section Three, describes the development of a Hazard Mitigation Committee and local community planning activities that were conducted for the development of this Plan.
- Section Four, summarizes the results of the hazard identification and risk assessment, which estimates potential losses associated with identified hazards.
- Section Five, describes goals and objectives of the Plan, along with a broad range of mitigation actions.
- Section Six, presents the strategy for implementing the prioritized mitigations presented in Section Five. It outlines requirements for monitoring and updating the Plan following its adoption.
- Section Seven, a bibliography.

Table 1-1 summarizes the requirements outlined in the DMA 2000 and where each of these requirements is addressed in this Plan.

Table 1-1
FEMA Local Mitigation Plan Review Crosswalk

Plan Criteria	Primary Location in Plan
Pre-requisites	
Adoption by the Local Governing Body: §201.6(c)(5)	Sections 1.1, 1.3, Appendix A
Planning Process	
Documentation of the Planning Process: §201.6(b) and §201.6(c)(1)	Section 3.0
Risk Assessment	
Identifying Hazards: §201.6(c)(2)(i)	Section 4.3
Profiling Hazards: §201.6(c)(2)(i)	Section 4.4
Assessing Vulnerability: Overview: §201.6(c)(2)(ii)	Section 4.6
Assessing Vulnerability: Identifying Structures: §201.6(c)(2)(ii)(A)	Section 4.5
Assessing Vulnerability: Estimating Potential Losses: §201.6(c)(2)(ii)(B)	Sections 4.6, 4.7
Assessing Vulnerability: Analyzing Development Trends: §201.6(c)(2)(ii)(C)	Section 4.8
Mitigation Strategy	
Local Hazard Mitigation Goals: §201.6(c)(3)(i)	Section 5.2.1
Identification and Analysis of Mitigation Actions: §201.6(c)(3)(ii)	Sections 5.3, 5.4
Implementation of Mitigation Actions: §201.6(c)(3)(iii)	Section 5.5, 5.6
Plan Maintenance Process	
Monitoring, Evaluating, and Updating the Plan: §201.6(c)(4)(i)	Sections 6.3, 6.4
Incorporation into Existing Planning Mechanisms: §201.6(c)(4)(ii)	Section 6.5
Continued Public Involvement: §201.6(c)(4)(iii)	Section 6.6

1.5 PLAN ADOPTION

The Municipal Legislature of San Sebastián adopted the original HMP updated version per Ordinance Number 26, Series: 2017-18 dated May 17, 2018. The document is included in Appendix A of this Plan. The review process coincided with the Puerto Rico Recovery, Reconstruction, and Resiliency Project and the reorganization of FEMA to address the recovery efforts after the path of Hurricane María in the Island.

The Municipality received the comments to the HMP filed in the original GAR Office per a letter sent by *ARCADIS* (Reviewer Consultant) to the State Hazard Mitigation Officer (SHMO) dated March 15, 2019. The four (4) comments were addressed and filed to the SHMO through *ARCADIS* on April 30, 2019. The Municipality edited the HMP to include the responses of the comments in the corresponding sections of the main document after obtain the approval from the SHMO.

Response to question number one (1) was inserted in new Sections 3.6.1 to 3.6.3 and the original section 3.6.1 was renumbered as Section 3.6.4. The response to question number two (2) was inserted in the "National Flood Insurance Program" Section 4.6. Response number three (3) was introduced in Section number 6.5 while response to question number four (4) was inserted in Sections 4.8.1 and 4.8.2.

This Section 1.5 is also new to document the changes occurred after the GAR/SHMP review process. The Municipality agree with the reviewer recommendation and proposes the use of the Approval Pending Adoption (APA) process by filing the final draft Local Mitigation Plan for a review by FEMA prior to the final adoption by the Municipality of San Sebastián Legislature.

However, if FEMA's reviewer determines that the HMP is approvable, we also respectfully propose to send an e-mail to the Coordinator of the HMP Committee, Ms. Maritza Ruiz, Director of Federal Programs for the Municipality of San Sebastián (federalesmss@gmail.com) to provide the new adoption Resolution ASAP and complete the process at once.

FEMA Region 2 received the HMP for review on June 28, 2019. The plan was reviewed by September 18, 2019 by FEMA and comments were sent to the State Hazard Mitigation Officer with a letter dated September 23, 2019. The Municipality of San Sebastián addressed the comment to four (4) elements included in the Regulation Checklist. The answers are provided in the document titled "Response to Comments Issued by FEMA p/c ARCADIS (Consultant to the SHMO) dated September 23, 2019, Filed by the Municipality of San Sebastián to the SHMO p/c ARCADIS, December 2019" and included in the HMP main document.

2.0 COMMUNITY PROFILE

This section provides a brief overview of the Municipality of San Sebastián presented in the following five subsections:

- 2.1 Administrative Divisions
- 2.2 Environment
- 2.3 Population and Demographics
- 2.4 Economy, Employment and Industry
- 2.5 Housing

The Municipality of San Sebastián is in the Northwest Central region of Puerto Rico (**Figure 2-1**). The Municipality is bordered to the North by municipality of Isabela, Quebradillas and Camuy; South by municipality of Las Marias; East, by the municipality of Lares; West to the municipality of Moca and Añasco. The geographic coverage of San Sebastián is approximately 114 square miles (184 square kilometers) and has a population of 42,430 as per PRPB, 2018[1]. The most populated ward is Culebrinas (3,787), followed by Hoya Mala (3,594), and Pozas (3,515). The less populated ward is Magos (232).

The town of San Sebastián Del Pepino was founded by Don Luigi Lebrón in 1751. Acquires the name of the famous Gherkin (Pepinos) devotion of Don Luigi by the Cuban sandwiches with extra pickles. Don Luigi was a farmer and owner of the first Vaqueria Switzerland in Puerto Rico. Aibonito, Alto Sano, Bahomamey, Calabazas, Cibao, Cidral, Culebrinas, Eneas, Guacio, Gajataca, Guatemala, Hato Arriba, Hoya Mala, Juncal, Magos, Mirabales, Perchas Uno, Perchas Dos, Piedras Blancas, Pozas, Robles, Saltos, San Sebastián Pueblo and Sonador are 24 Wards of San Sebastián (**Figure 2-2**). The Municipality of San Sebastián is located in an area that is vulnerable to a wide range of natural hazards, including flooding, fires, earthquakes and hurricanes.

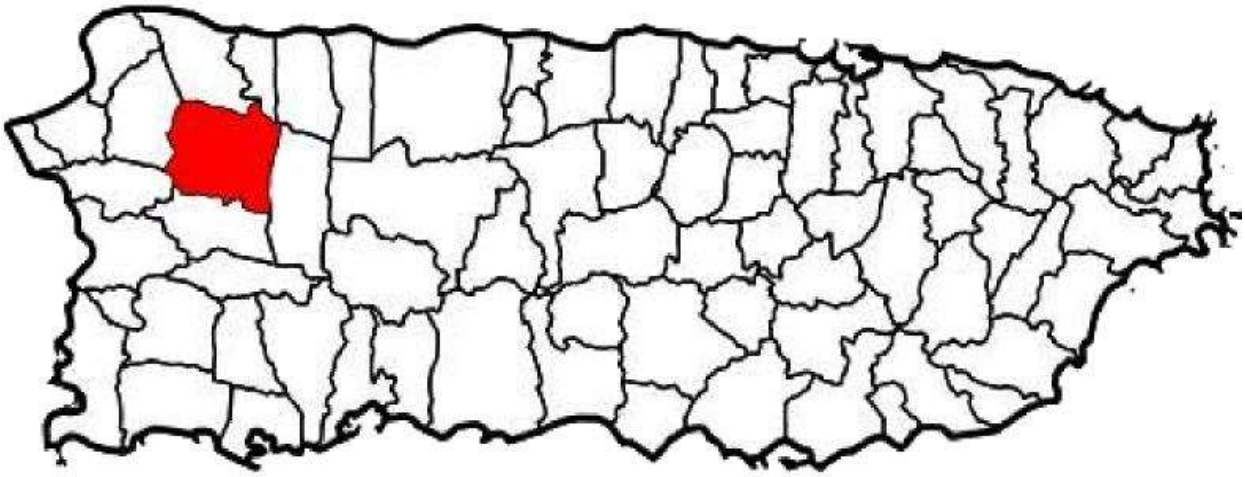


Figure 2-1 Location of the Municipality of San Sebastián in Puerto Rico

[1] Puerto Rico Planning Board, 2018.

2.1 ADMINISTRATIVE DIVISIONS

Like others municipalities throughout Puerto Rico, San Sebastián recognizes wards "barrios" as territorial or district "areas" divisions within the jurisdictional area of San Sebastián. "Barrio Pueblo" represents the local government seat on each municipality in the Island.

Figure 2-2 Administrative Boundaries (barrios), Municipality of San Sebastián

2.2 ENVIRONMENT

2.2.1 Geology and Soils

San Sebastián is located within the Karts Region of Puerto Rico. Although the Municipality lacks the notable landforms of haystack hills (mogotes) and massive cave systems found further to the east, the rock formations throughout San Sebastián are limestone. The limestone rock formations have been exposed to a long process of chemical weathering. The lack of significant slope constraints and the nature of the limestone bedrock limit the susceptibility of the Municipality to landslide and flood hazards. Road cuts in limestone are often made close to vertical with high probability of triggering landslide events.

2.2.2 Topography and Hydrology

Eighty five percent of the territory is within the mountainous. San Sebastián is the central mountainous interior. In general, relief is not very high but has many small hills so hummocks. It is watered by the Rio Grande de Añasco, Río Culebrinas, Río Guajataca, several tributaries and the reservoir known as Lake Guajataca. The mayor river system within the Municipality is Río Culebrinas, which born in the Municipality of Lares. This river crosses the town of San Sebastián from east to west, passing near of the down town. Another important rivers Guatemala, this river born in Aibonito ward and flows into the Río Culebrinas. The Río Culebrinas basin has a drainage area of 104 square miles (267 square kilometers). The lower portion of the Río Culebrinas delineates the boundaries between Aguadilla and Aguada.

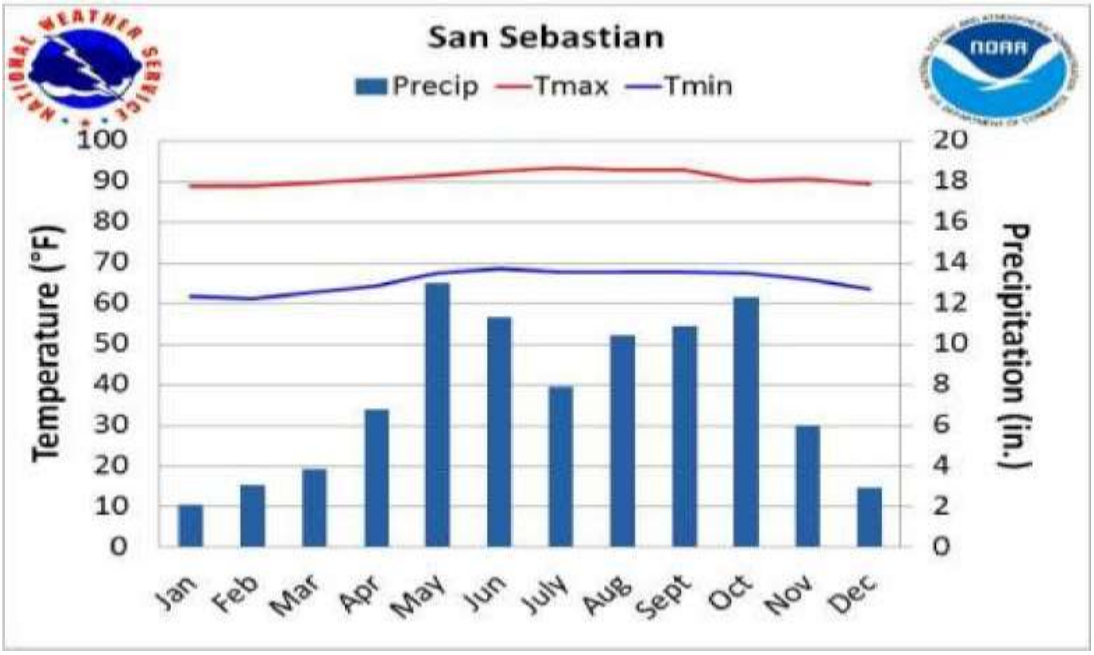
2.2.3 Ecological Zones

The entire Municipality of San Sebastián falls within the Subtropical Moist Forest zone. This zone receives an average annualized rainfall between 39—81 inches and is optimal for agricultural activities. Much of the original forests have been lost to develop home construction. In the past, the Municipality had a Sugar Cane Central, the territory produced tons of sugar cane. Remnants of forested land can be found along stream valleys and undeveloped tracts of land throughout the Municipality.

2.2.4 Climate

The climate of San Sebastián is characterized as warm and humid (tropical-marine), with frequent showers occurring throughout the year. Throughout the entire year, for tropical areas like Puerto Rico, the same quantity of energy is lost during the night as is received during the day. The result is uniform temperatures throughout the year, according with NOAA and National Weather Service (

Figure 2-3). An average of approximately 7.5 inches of rain falls annually, although there may be considerable variations from year to year (NCDC 1981 – 2010).



NCDC 1981-2010	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average High (F)	88.9	88.9	89.7	90.7	91.6	92.6	93.3	92.8	92.9	92.0	90.7	89.3	91.1
Average Low (F)	61.7	61.3	62.9	64.5	67.5	68.5	67.7	67.9	67.7	67.4	65.9	63.5	65.6
Average Rain (in)	2.12	3.07	3.83	6.81	13	11.3	7.89	10.4	10.9	12.3	6	2.96	90.45

Figure 2-3 Average Rainfalls and Temperature for Municipality of San Sebastián (1981-2010)

2.3 POPULATION AND DEMOGRAPHICS

Metropolitan/Urban Area

The U.S. Census Bureau defines an urban area as all territory with its population and housing units located within an urbanized area (UA) or an urban cluster (UC) (**Figure 2-4**). It delineates UA and UC boundaries to encompass densely populated areas. For Census 2010, the Census Bureau identifies two types of urban areas: Urbanized Areas (UAs) of 50,000 or more people; Urban Clusters (UCs) of at least 2,500 and less than 50,000 people. According to the 2000 and 2010 Census data, the Municipality of San Sebastián experienced a 4.01 % decrease in total population, from 44,204 in 2000 to 42,430 in 2010. The 2000 population density was cited in Census 2000 at 624 people per square mile. However, based on the Census 2010, this value has decreased to 599 people per square mile (U.S. Census, 2010, Oficina del Contralor - Indicadores Socioeconómicos, revised. July 31, 2017). This trend reflects non-favorable conditions for business, industry and employment in the Municipality. **Table 2-1** shows the latest demographic data for San Sebastián per gender and age range. **Table 2-2** shows population in the Municipality of San Sebastián per ward.

Figure 2-4 Metropolitan and Micropolitan Statistical Areas in Puerto Rico, July, 2015.

Source: U.S. Census Bureau, Geography Division, Cartographic Products Branch
Created: June 8, 2011, Last Revised: March 6, 2017

Table 2-1
Municipality of San Sebastián, Population Data

Subject	Number	Percent (%)
TOTAL	42,430	100.0
Male	20,705	48.7
Female	21,725	51.2
Under 18 years	10,091	23.78
18 years and over	32,339	76.22
20 to 24 years	2,554	6.0
25 to 34 years	5,236	12.3
35 to 49 years	7,979	18.8
50 to 64 years	8,422	19.8
65 years and over	6,971	16.4

Note: PRPB 2018. Datos del Censo. Accessed April 17, 2018 < http://jp.pr.gov/Economía/Censo>.
Percent of under 18 years updated from 2.5 to 23.78% and for 18 years and over from 7.5 to 76.22%

Table 2-2
Population and Demographics[2]

Wards	Population 2010	Percent 2010 (%)
Aibonito	1,972	4.6
Alto Sano	920	2.2
Bahomamey	2,218	5.2
Calabazas	2,768	6.5
Cibao	1,224	2.9
Cidral	415	1.0
Culebrinas	3,787	8.9
Eneas	996	2.3
Guacio	640	1.5
Guajataca	603	1.4
Guatemala	2,512	5.9
Hato Arriba	1,980	4.7
Hoya Mala	3,594	8.5
Juncal	1,926	4.5
Magos	232	0.5
Mirabales	672	1.6
Perchas 1	902	2.1
Perchas 2	988	2.3
Piedras Blancas	2,563	6.0
Pozas	3,515	8.3
Robles	1,697	4.0
Salto	3,069	7.2
San Sebastián	1,424	3.4
Sonador	1,813	4.3
Total	42,430	100.0

Source: Programa Graduado de Demografía UPR-Ciencias Médicas, Retrieved April 17, 2018
http://demografia.rcm.upr.edu/index.php/series-historicas-datos-censales-2/poblacion-por-barrios
Note: Data for Perchas 1 and 2 was inverted and percentages fixed.

The Census Flows Mapper[3] reports the following movers' statistics for the Municipality of San Sebastián during years 2011-2017.

Statistics	2010-2014	2011-2015	2012-2016	2013-2017
Population (1 yr and over)	40,910	40,279	39,583	38,784
Movers from a different state	452	290	252	165
Movers to a different state	657	958	872	1,066
Movers from a different county, same state	628	609	494	409
Movers to a different county, same state	594	790	847	783

[2] US Census data 2010.

[3] Total Net Migration Flows for San Sebastián, PR. Source: U.S. Census Bureau, 2011-2015 5-year American Community Survey. https://flowsmapper.geo.census.gov/map.html.

2.4 ECONOMY, EMPLOYMENT AND INDUSTRY

Economically, the Municipality of San Sebastián has historically been a city with a thriving and independently economy, primarily for its agricultural land. In addition, it has two hotels and many tourist attractions. Two festivals held annually**: "Festival de la Novilla and Festival de la Hamaca.** These activities are comparable to other municipalities in the region. The median family **households'** income for San Sebastián was $12,115 in 2010 and $16,343 in 2012 (**Table 2-3**).

The municipality has ongoing commercial activities, have established branches of large chain stores, pharmacies and supermarkets. The banking industry is composed by banks, finance companies and credit unions, especially those in the area of greatest commercial activity.

Table 2-3
Municipality of San Sebastián, Comparative Household Income Levels[4]

Income in 2008-2012	San Sebastián 2010	Percent 2010 (%)	San Sebastián 2012	Percent 2012 (%)
Households	12,668	100.0	8,890	100.0
Less than $10,000	5,390	42.5	2,775	31.2
$10,000 to $14,999	2,024	16.0	1,360	15.3
$15,000 to $24,999	2,144	16.9	1,910	21.5
$25,000 to $34,999	1,191	9.4	1,053	11.8
$35,000 to $49,999	1,113	8.8	1,056	11.9
$50,000 to $74,999	573	4.5	604	6.8
$75,000 to $99,999	136	1.1	80	0.9
$100,000 to $149,999	97	0.8	52	0.6
$150,000 to $199,999	0	0.0	0	0.0
$200,000 or more	0	0.0	0	0.0
Median HH Income	12,115	-	16,343	-
Per Capita Income	7,705	-	6,627	-

Note: PRPB 2018. Municipios 2008-2012 Encuesta de la Comunidad. Accessed April 17, 2018 <http://jp.pr.gov/Economía/Censo>.
Percentages for 2010 were revised and columns for 2012 added.

[4] US Census Bureau data, 2006 - 2010 American community survey 5 year estimates

2.5 HOUSING

The U.S. Census 2010 indicates that there are 18,695 housing units in the Municipality of San Sebastián. Of the total housing units, 16,047 are classified as occupied. The predominant housing type is a single-family detached dwelling. It accounts for much of housing types throughout the Municipality. Census 2010 indicates that 72.5 percent of the municipality's housing stock is owner-occupied, while renters occupy approximately 27.5 percent of households (**Table 2-4**). Many factors influence tenure patterns including age and household income.

Table 2-4
Tenure of Housing, Municipality of San Sebastián[5]

Tenure	2010	Percent (%)
Owner-occupied housing units	11,638	72.5
Renter-occupied housing units	4,409	27.5
Total	16,047	100.0

Note: PRPB 2018. Datos del Censo. Accessed April 17, 2018 < http://jp.pr.gov/Economía/Censo>.

[5] Based on US Census data 2010.

3.0 PLANNING PROCESS

This section includes a description of the hazard mitigation planning approach utilized for the development of the 2018 San Sebastián Mitigation Plan update. It also describes the organization of community resources (i.e., formation of the Hazard Mitigation Planning Committee), outcomes of public informational meetings, comparisons from prior 2006 mitigation plan presented previously with the submitted projects, the corresponding status, and important documents/legislation reviewed during the development of the Plan. The Planning Committee added Federal laws and programs, local laws, regulations, Governor Executive Orders, municipal ordinances, plans, permits, and tools in this HMP 2018 updated version.

The following official meetings were hold during the updating process (**Appendix C**):

- March 1, 2018 – First HMP Planning Committee Meeting
- March 20, 2018 – Second HMP Planning Committee Meeting
- April 20, 2018 – HMP Planning Committee Meeting
- May 2, 2018 – HMP Planning Committee Meeting
- May 17, 2018 – Plan Adoption by Local Government – Ordinary Meeting Open to Community

The section is organized in the following seven subsections:

- 3.1 Requirements for Planning Process
- 3.2 Description of the Hazard Mitigation Planning Process
- 3.3 Formation of a Hazard Mitigation Committee
- 3.4 Public Involvement and Outreach
- 3.5 Public Participation and Community Workshops
- 3.6 Public Review of the Draft Plan
- 3.7 Review of Existing Legislation, Plans and Reports

3.1 REQUIREMENTS FOR PLANNING PROCESS

44 CFR Requirement **§201.6(b)**: states that "[I]n order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:

- An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval.
- An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academic and other private and non-profit interests to be involved in the planning process.
- Review and incorporation, if appropriate, of existing plans, studies, reports and technical information.

Plan Documentation as per Requirement §201.6(c) (1): [The plan shall document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.

3.2 DESCRIPTION OF THE HAZARD MITIGATION PLANNING PROCESS

The planning process began with the first Hazard Mitigation Planning Committee meeting held on March 1, 2018. The Municipality of San Sebastián was represented by the following staff:

- Maritza Ruiz, Federal Programs Director and Coordinator of the HMP Update Planning Committee
- Félix Avilés, OMME Director
- Félix Irizarry, Finance Director
- Camilo Ortiz, Legislature Vice-President
- Guillermo Nieves, Public Works Director
- Emily Ramos, Vice-Mayor
- Luis Albaladejo, Engineering Office Director
- Alexis Crespo, IT

The abovementioned municipal officers were appointed as the Hazard Mitigation Committee by the Municipality Major, Hon. Javier Jiménez Pérez. Mrs. Ruiz along with project consultant Tetra Tech, led the development of the Plan over a three-month timeframe that included the steps listed below:

- Background research and field assessment;
- Community-based planning process;
- Hazard identification and risk assessment;
- Previous plan status and outcomes;
- Community-based mitigation strategy; and
- Strategy for plan implementation and maintenance.

The text on the 2012 HMP version was reviewed for clarity, accuracy, tone, and relevance, resulting in various adjustments made to the wording. Historical background of the DMA 2000 was included in Section One. Figures regarding the location of the municipality were moved to Section 4 (Municipality Profile). Additional changes are mentioned along the document as they occurred. The new findings of the background research conducted by the study contractor are found in Section Two, titled *Community Profile* (there are no major changes in community profile however, the information was confirmed or updated with the most recent data from Census and other sources). Section Two describes the makeup of the community, including the prevalent environmental, demographic and economic characteristics. During this phase, an analysis of the community's built environment and critical facilities was conducted. This baseline information, which provides a snapshot of the community's exposure (i.e., economic assets), is located in the *Hazard Identification and Risk Assessment* (Section Four) and is essential to the vulnerability analysis conducted for the municipality.

The Hazard Mitigation Planning Committee provided oversight to the plan development process and worked to engage the public through multiple public informational workshops. A fundamental component of this planning process involves public participation and input. Also, in this phase of the planning process, the study contractor conducted a review of applicable plans, legislation, regulations, policies, and reports relevant to San Sebastián and the topic of hazard mitigation.

The next important phase of the planning process involved the *Hazard Identification and Risk Assessment* (Section Four) An analysis was conducted to identify and describe the type of hazards that can affect the Municipality and evaluate which risks had been mitigated or which projects are currently in progress. This analysis includes a hazard profile that present a description of the location and extent of each identified hazard (delineate areas at risk), describes previous occurrences of hazard events (history), and provides an understanding of the frequency (probability) of each hazard event. To be consistent with DMA 2000, further analysis was conducted that assesses vulnerability to hazards by providing a summary of the overall impact to community assets (types and numbers of buildings, infrastructure and critical facilities), and projects future vulnerability (potential losses) in San Sebastián so that mitigation options can be reasonably assessed. This updated version of the HMP includes a list of all disaster declarations for Puerto Rico since 1956 to 2018. The only declarations issued during years 2012-2018 were for Hurricane Irma (EM-3384 and DR-4336) and Hurricane María (EM-3391, and DR-4339). These declarations were issued on September 2017. The Planning Committee identified 46 critical facilities including the Municipal City Hall, Finance and Municipal Legislature, OMME, medical facilities, fire house, communication facilities, elderly facilities, and schools, among others. The figure showing these facilities (new element of this version), is included on Section 4.6. This 2018 update HMP also includes, as a new element, the HAZUS maps with the critical facilities for each hazard analyzed and tables indicating the level of hazard area where the critical facilities are located. Similar maps and tables are included for the potential new development areas integrating the information provided in the Land Use Plan of the Municipality of San Sebastián.

Based on citizen input gathered from community workshop, an assessment of the baseline information and the findings of the *Hazard Identification and Risk Assessment*, the community formulated a comprehensive *Mitigation Strategy* (Section Five). This involved the development of broad mitigation goals and objectives and the identification and prioritization of mitigation measures or actions. Following the completion of its *Mitigation Strategy*, the Municipality concentrated on designing measures to ensure the Plan's ultimate implementation, presented in *Plan Implementation* (Section Six). In this section, an implementation framework is provided to ensure that mitigation actions, outlined in the Plan, are implemented, evaluated and routinely updated.

3.3 FORMATION OF A HAZARD MITIGATION COMMITTEE

The planning process was initiated with the Hazard Mitigation Planning Committee meeting on March 1, 2018. The purpose of this initial planning meeting was to provide the Directors an overview of the planning process, identify general concerns of all participants, and to discuss the creation of the Hazard Mitigation Planning Committee. The consultant, Tetra Tech, oriented the Committee regarding the following topics.

- HMP Survey
- What is Mitigation?

- Why to update the HMP?
- Municipality of San Sebastian HMP 2012
- HMP Update Process
- HMP Update Planning Committee
- Information Needed
- Public Participation - Strategy

The HMP Planning Committee was formally established as follow:

- Maritza Ruiz, Federal Programs Director and Coordinator of the HMP Update Planning Committee
- Félix Avilés, OMME Director
- Félix Irizarry, Finance Director
- Camilo Ortiz, Legislature Vice-President
- Guillermo Nieves, Public Works Director
- Emily Ramos, Vice-Mayor
- Luis Albaladejo, Engineering Office Director
- Alexis Crespo, IT

3.4 PUBLIC INVOLVEMENT AND OUTREACH

As citizens become more involved in decisions that affect their safety, they are more likely to gain a greater appreciation of the natural hazards present in their community and take personal steps to reduce their potential impact. Public awareness is the "key" to making a home, neighborhood, school, business or city safer from the potential effects of natural hazards.

One community workshop was held on March 20, 2018. The presentation to the Municipal Legislature was open to the public on May 17, 2018. Community Leaders, Municipal Department Directors, and government representatives were invited to the meeting. The following Community members were invited to be part of the Hazard Mitigation Committee and/or participate in the Community Meetings:

- Community Leaders from each ward
- Municipal Legislature
- Representatives from each Municipal Agency were invited to all community meetings

Thirty-two persons participated in the workshop. They identify 28 facilities and vulnerable areas that were converted into mitigation actions. **Appendix C** includes a list of invitees, attendance sheets, and minutes for each meeting in the development of the Plan.

3.5 PUBLIC PARTICIPATION AND COMMUNITY WORKSHOPS

This subsection explains how the public was involved during the development of the plan. Public participation in the Plan development has been encouraged through a Community Workshop.

3.5.1 Hazard Mitigation Planning Committee and Community Workshop

The Community Workshop was held on March 20, 2018 at 1:30 p.m. at the Municipal Legislature facility in San Sebastián. The HMP Planning Committee coordinator, Mrs. Ruiz, with the assistance of the Municipal Legislature Vice-President, Hon. Camilo Ortiz, called community leaders, representatives from a wide range of community associations and organizations from all 24 municipal wards.

The project consultant used a PowerPoint presentation to outline the proposed hazard mitigation planning process, explain federal requirements, and discuss the timeframe and schedule for project completion. Participants filled out an informal survey regarding mitigation general knowledge. The workshop facilitator emphasized the importance of engaging the public, private and non-profit sectors in the Plan development. Community Leaders actively identified areas in printed aerial photos and asked questions. Additional efforts by the Hazard Mitigation Committee would be needed to target specific stakeholders and personally invite them to subsequent public informational meetings. This targeted approach proved much more successful. A short Community Workshop report is provided in the appendix section.

The Municipality identified a preliminary list of hazards of concern specifically for the Municipality of San Sebastián. **Table 3-1** summarizes this hazard identification and shows hazards of interest carried forward for further study based on group discussion.

Table 3-1
Identification of Hazards

Identified	Hazard
✓	Riverine Flooding
✓	Wildfire
✓	Earthquake (Ground Shaking)
✓	Earthquake (Liquefaction)
✓	Earthquake-Induced Landslide
✓	Rainfall-Induced Landslide
✓	High Wind (includes hurricane and tropical storm)

Seven (7) hazards were selected as hazards of interest for the Hazard Mitigation Plan. These seven hazards include *earthquake (ground shaking, liquefaction, earthquake-induced landslide), flooding (riverine, rainfall-induced landslide), high wind (includes hurricanes and tropical storms), and Wildfire.* Once hazards were identified, a descriptive and historical event discussion technique was used to identify citizen concerns about natural hazards. The summarized results of this strategic planning exercise, including output from previous and 2018 workshops, are summarized below:

Flooding

General concerns noted about flooding hazards throughout the Municipality include:

- Debris removal and cleaning—Debris disrupts natural flow of rivers and streams. This is due to increased run-off and sedimentation. Also, garbage discarded in stream beds is a problem.
- Bridge and culvert maintenance—Related to the above, debris blockages beneath bridges and culverts cause problems at river, stream and some road intersections.
- There are certain conditions that may aggravate the effect of flooding, like:
    - Impermeable surfaces
    - Terrain slopes high inclination, accumulation of filling near the floodplain that will obstruct the flow of water
    - Building product obstructions that block the flow current
    - Residual contaminants including dirt, animal waste, oils and other contaminants
    - Ground saturation limits drainage
    - The flow velocity of water that causes erosion

Specific concerns and locations of flooding hazards:

- A couple of bridges are literally in the air because when flooding occurs the flow of the rivers has undermined the bridges' foundations. Low-lying areas of residential in the Cibao, Hoya Mala PR-119, Alto Sano Ward PR-109 and Sonador Ward PR-109.
- Perchas 1 Ward is the most affected area because to reach the community, need to cross 3 bridges. In the flood events, the river passing over the bridges leaving the community un-communication. Repetitive flooding along the portion of road happened in road PR-4435 Sector "Quebrada Las Canas".
- Periodic flooding of the El Culebrina River in San Sebastián affects residential, commercial and infrastructure. The most vulnerable area is San Sebastián Pueblo along road PR-111
- With heavy rain, the area of PR-119 Hoya Mala, when the area it flooded, preventing the traffic. Also, it affects many properties surrounding the wide area which is flooded in the event of heavy rain.
- The greatest exposure is concentrated in the urban center of town and adjacent areas, which incidentally is the most densely populated area and residential and commercial structures, many of them located on the sides of the river Culebrinas.
- The flooded area in PR-448 (Guajataca ward) is very extensive (almost 100 meters) when heavy rain occurs. This happen because the culverts have not the capacity to absorb the water that falls in the area.
- Several community representatives commented that many publicly maintained roads did not have adequate storm drainage parallel to the road and undersized culverts at key road intersections

High Wind

The major concerns identified by the community about the high wind hazard include:

- General concern about poorly constructed homes and/or abandoned buildings, wood homes and very old construction.
- Concerns about potential high wind damages to existing and future homes perched upon the steep, hilly terrain surrounding the urban center.
- No two hurricanes affect the municipality in the same manner based on the hurricane track, highest wind gusts, forward motion, and amounts of precipitation upon land fall. The entire Municipality of San Sebastián is vulnerable to receive a Hurricane hit.
- There are general concerns about power and telephone poles breaking
- during high wind events. It was mentioned that lines are often inadequately secured and there can be long restoration periods following high wind events

Earthquake–Related Hazards

The major concerns identified by the community about earthquake hazards include:

- General community concerns are latent about this matter because they just had seen the lately experience from Haiti, Chile and Japan which suffered major earthquakes in 2010 and 2011.
- There are general concerns about the earthquake hazard/risk, especially the identification of earthquake hazard areas to determine suitable areas for development.
- If the soil is saturated by water, a condition that often exists when the soil is below the ground water table or sea level, then water fills the gaps between soil grains ('pore spaces'). In response to the soil compressing, this water increases in pressure and attempts to flow out from the soil to zones of low pressure (usually upward towards the ground surface).

Landslides

The major concerns identified by the community about landslide hazard include:

- Given the limited topographic relief and limestone bedrock present in the Municipality, there were few concerns mentioned about the likelihood of landslides associated with rainfall events.
- In Guacio ward recurring landslides and affected both sides of the road, from top to bottom and bottom to bottom. Constant landslide has affected the foundations of the community center, which is at the top of the hill.

Rainfalls

- Periodic rain causes landslides and obstruction of the local street in Guacio, Hato Arriba, Robles, Alto Sano and Sonador. The situation of this issue is that this road may use for evacuation in case major disasters. Some roads are the unique way to reach the communities. The obstruction impedes the evacuation of the communities around it in case of heavy rain.

- Puerto Rico's varying topography over a small area in the Caribbean Sea leads to stark land, sea and air interactions. Easterly trade winds in the tropics prevail over Puerto Rico during much of the year. During the summer, which lies on a northern coastal plain, experiences a wind from the east, northeast, or southeast about sixty percent of the time.
- Monthly rainfall climatology is an important first step toward quantitative precipitation forecasting (QPF) in the tropics. Rainfall in Puerto Rico is primarily a function of local effects, passing easterly waves, and tropical cyclones. Monthly climatology reveals how these effects act to vary rainfall throughout the year.

Wildfire

The major concerns identified by the community about wildfires are:

- Expansion of development into forested areas has created a situation where wildfires can adversely affect lives and property, as can the flooding and landslides that occur in the aftermath of the fires.
- Post-fire landslide hazards include fast-moving, highly destructive debris flows that can occur in the years immediately after wildfires in response to high intensity rainfall events, and those flows that are generated over longer time periods accompanied by root decay and loss of soil strength.
- Post-fire debris flows are particularly hazardous because they can occur with little warning, can exert great impulsive loads on objects in their paths, can strip vegetation, block drainage ways, damage structures, and endanger human life.
- Wildfires could potentially result in the destabilization of pre-existing deep-seated landslides over long time periods.
- Urban Fires in San Sebastián may involve buildings, residences, warehouses and industries with potential for spread to adjoining structures.
- Although the statistics show a decline in fire casualty rates in recent years as acknowledged by the Puerto Rico Fire Department.
- The urban fire hazard in San Sebastián may involve areas where single family homes, multi-family occupancies and/or business facilities are clustered close together, increasing the possibility of rapid spread to another structure.
- Other areas are characterized by adjoining buildings. Adjoining buildings are found in the downtown region of the city or include other closely spaced wood frame structures.

Government Coordination

The major government concerns identified by the community include:

- Municipal officials are aware of the need to improve coordination between municipal government and the central government, specifically with the Department of Natural Resources (i.e., stream cleaning programs).

Education

The major education concerns identified by the community include:

- Community members pointed out that hazard mitigation should be part of everyday life for the people who live and work on an island.
- The Municipality was encouraged to pursue outreach programs through community institutions such as churches, libraries, and government offices.
- Community leaders understand that there should be more information available to the public, how to react to a natural disaster and what to do.

The efforts as part of the 2018 workshop resulted in 32 participants identifying 28 facilities and vulnerable areas that were included as a project in the mitigation actions list of this updated version. **Figure 3-1** shows all the 28 facilities and vulnerable areas identified by the community on each ward aerial photo provided. All the sites identified by the community were included as a mitigation action in the updated 2018 HMP version.

	Mitigation Action (GPS coordinates)
1	landslide – fault in Salto ward (18°22'59.33"N; 67°00'45.92"W)
2	landslide in Salto ward (18°22'27.42"N; 67°02'01.14"W)
3	flood in Salto ward (18°22'18.49"N; 67°00'15.53"W)
4	landslide in Salto ward (18°21'41.22"N; 67°00'06.69"W)
5	Landslide in Robles ward (18°22'59.94"N; 66°58'51.89"W)
6	flood – bridge in Robles ward (18°22'17.39"N; 66°59'31.64"W)
7	flood – bridge in Aibonito ward (18°22'06.31"N; 66°57'11.44"W)
8	Landslide in Guatemala ward (18°21'32.54"N; 67°00'01.01"W)
9	landslide - collapsed road in Guatemala ward (18°21'35.63"N; 66°59'38.36"W)
10	landslide in Guatemala ward (18°21'21.65"N; 66°59'47.52"W)
11	flood in Guatemala ward (18°20'45.14"N; 67°00'37.95W)
12	flood in Guatemala ward (18°20'51.60"N; 67°00'58.60"W)
13	flood - bridge in Guatemala ward (18°21'18.18"N; 67°00'47.96"W)
14	flood - collapsed road in Ciabo ward (18°19'49.42"N; 67°54'57.10"W)
15	Landslide in Pozas ward (18°20'10.76"N; 67°01'56.54"W)
16	Flood in Pozas ward (18°20'42.27"N; 67°01'30.14"W)
17	Landslide in Pozas ward (18°20'23.25"N; 67°00'44.39"W)
18	Flood in Pozas ward (18°19'59.06"N; 66°59'59.95"W)
19	Flood in Pozas ward (18°19'29.91"N; 67°01'18.89"W)
20	Flood in San Sebastián ward (18°20'08.24"N; 66°59'13.69"W)
21	landslide – fault in Piedras Blancas ward (18°20'07.46"N; 66°58'19.40"W)
22	Landslide in Piedras Blancas ward (18°19'56.40"N; 67°56'57.13"W)
23	Flood in Culebrinas ward (18°19'52.63"N; 66°59'22.56"W)
24	landslide – bridge in Culebrinas ward (18°19'42.62"N; 67°59'53.79"W)
25	landslide – bridge in Alto Sano ward (18°17'37.98"N; 67°02'28.33"W)
26	Landslide in Guacio ward (18°17'37.48"N; 67°00'54.02"W)
27	Flood in Guacio ward (18°16'34.50"N; 66°58'45.16"W)
28	Landslide in Mirabales ward (18°17'08.56"N; 67°57'23.01"W)

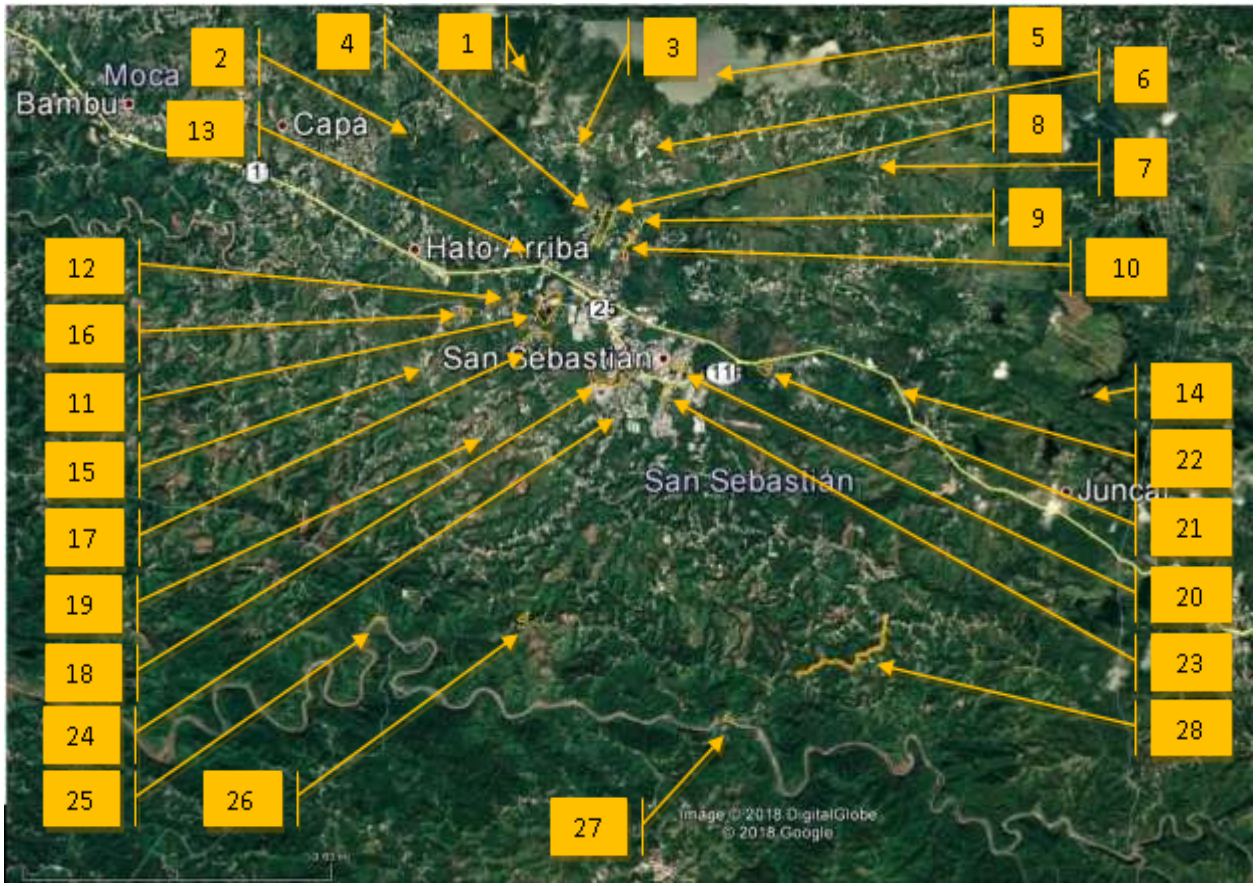


Figure 3-1 Hazardous areas identified by the community

3.5.2 Hazard Mitigation Planning Committee: Developing Mitigation Strategy

The Hazard Mitigation Planning Committee explained the strategies that are intended to support, correspond and define a path to attain the desired timeframe goals. The committee determined to keep all goals and objectives as established, after review and discuss about them.

Goal #1 Reduce the impact of natural disasters on residents and property

- Objective 1.1 Protect existing development from future disaster events
- Objective 1.2 Reduce the vulnerability of future development

Goal #2 Strengthen the capabilities of municipal agencies to implement and maintain hazard mitigation programs and evaluate prior plans

- Objective 2.1 Identify and develop policies, regulations, and specialized training necessary to support an effective hazard mitigation program in the Municipality.

Goal #3 Increase the awareness and understanding of those living and working in San Sebastián to natural hazards and to the principles of hazard mitigation

- Objective 3.1 Develop outreach programs focused on increasing public awareness of hazards and their associated risks
- Objective 3.2 Support local businesses and industries in becoming more disaster resistant

Goal #4 Improve local ability to restore critical facilities, essential infrastructure, and ensure the continuity of municipal operations following natural disasters

- Objective 4.1 Enhance municipal capabilities to support emergency response and recovery operations
- Objective 4.2 Undertake planning to maximize governmental coordination and communication between municipality, central government and federal agencies
- Objective 4.3 Reduce the vulnerability of critical facilities, infrastructure and essential municipal facilities

3.5.3 Hazard Mitigation Planning Committee: Preparing an Implementation Strategy

The study contractor led a strategic planning process at the planning committee meeting to identify, evaluate and prioritize a series of mitigation actions designed to achieve the goals and objectives. The 2012 HMP version included a total of 25 mitigation actions. The outcome of the 2018 HMP review process was the removal of those projects included in the 2012 HMP that were completed, and the addition of the projects identified by the community and the municipal government for a new prioritized list of 93 mitigation actions**.** For each action, specific implementation requirements were defined. These requirements included the identification of the lead department/agency designated for action implementation, an estimation of project costs (approximation until actual final dollar amounts can be determined), determination of funding method, determination of a project implementation timeframe; and a prioritization of each action.

3.6 PUBLIC PARTICIPATION IN THE PLAN DEVELOPMENT, REVIEW AND COMMENTS OF THE PLAN

The subsection below clearly indicates how the public was involved in the development of the Plan, contributed to its development by providing specific content, and was given the opportunity to provide comments prior to Plan finalization. The Municipality harvested public input throughout the entire planning process. Specifically, these efforts included:

- Engaging public stakeholders through community meetings. Public concerns were documented and incorporated into draft and final version.
- Public input was obtained through workshop.
- Public input was obtained through personal interviews about hazards and associated impacts
- The San Sebastián Hazard Mitigation Planning Committee was formed on March 1, 2018 and meetings were held on March 20, 2018 and May 17, 2018.
- Public input was sought during the first community meeting, held March 20, 2018. The public, along with the Hazard Mitigation Committee, prioritized series of Mitigation Strategies and actions for incorporation into the Plan.
- Supporting documentation is provided in **Appendix C**.

3.6.1 How Neighboring Communities Were Involved

Section 3.5 of the HMP, describes how the neighboring communities were involved. Community Public Meeting was held on March 20, 2018 at 1:30 p.m. at the Municipal Legislature facility in San Sebastián. The HMP Planning Committee Coordinator, Mrs. Ruiz, with the assistance of the Municipal Legislature Vice-President, Hon. Camilo Ortiz, called community leaders, representatives from a wide range of community associations and organizations from all 24 municipal wards.

Section 3.4, Public Involvement and Outreach, of the HMP describes that at least 32 persons participated in the workshop held on March 20, 2018. Appendix C (pages 35 to 34) of the HMP includes a copy of the attendance sheet for the Public Meeting. Participants included:

- Municipal Legislators
- Municipal Directors
- Community Members (Urb. Pepino, Robles Ward, Aibonito Ward, Cibao Ward, Saltos Ward, Villa Rita Ext.)
- Community and Faith Base Initiatives
- PESAC Executive Director (Non-Profit)

Participants filled out an informal survey regarding mitigation general knowledge. The survey does not pretend to be scientific but to provide general information to the HMP Updating Committee. Briefly, of the participants of the survey (n=21), 81% were residents of the Municipality of San Sebastián, all have lived in the municipality for more than 10 years. 29% of the respondents indicated that they reside in the Pueblo Ward. There were no representatives from the Naranjo, Plata, Rocha and Voladora wards. 52% of the respondents were employees of the Municipality of San Sebastián. When asked about the communication media, at least 80% of the respondents indicated having access to the internet, television

(island-wide reach) and the written press (also with island-wide reach). However, at the time to indicate what was the preferred media to be used to obtain information during a natural event, the island-wide and local radio were the favored ones. Those people who use social networks, prefer the use of Facebook, WhatsApp and Google. The radio was favored over the other media, including social networks. Concerned about natural hazards goes from hurricanes and storms, followed by landslides induced by rain, and the floods related to the rivers. 65% of respondents indicated that they knew if their properties are located in a flood susceptible area. 18% from those that known the information reported that their properties are located in areas susceptible to flooding. Finally, 95% of the respondents know what a Hazard Mitigation Plan is and 80% of them, were participating for the first time in the updating process. Appendix C (page 20) of the HMP shows a copy of the survey while Figures 3 to 14 of the report in Appendix C show the graphic results of each survey question.

The workshop facilitator emphasized the importance of engaging the public, private and non-profit sectors in the Plan development. Community Leaders actively identified areas in 24 printed aerial photos (one per ward) and asked questions. Presentation provided during the Community Public Meeting is provided in Appendix C (pages 37 to 42) of the HMP. The efforts of the 2018 Public Meeting resulted in at least 32 participants identifying 28 facilities and vulnerable areas listed in **Table 3-2**. All these sites were included as a project in the mitigation actions list of this HMP updated version. **Figure 3-2** shows all the 28 facilities and vulnerable areas identified by the community on each ward aerial photo provided.

Table 3-2 List of the 28 vulnerable sites identified by participants in the Public Meeting held on March 20, 2018

No.	Mitigation Action (GPS coordinates)
1	landslide – fault in Salto ward (18°22'59.33"N; 67°00'45.92"W)
2	landslide in Salto ward (18°22'27.42"N; 67°02'01.14"W)
3	flood in Salto ward (18°22'18.49"N; 67°00'15.53"W)
4	landslide in Salto ward (18°21'41.22"N; 67°00'06.69"W)
5	landslide in Robles ward (18°22'59.94"N; 66°58'51.89"W)
6	flood – bridge in Robles ward (18°22'17.39"N; 66°59'31.64"W)
7	flood – bridge in Aibonito ward (18°22'06.31"N; 66°57'11.44"W)
8	landslide in Guatemala ward (18°21'32.54"N; 67°00'01.01"W)
9	landslide - collapsed road in Guatemala ward (18°21'35.63"N; 66°59'38.36"W)
10	landslide in Guatemala ward (18°21'21.65"N; 66°59'47.52"W)
11	flood in Guatemala ward (18°20'45.14"N; 67°00'37.95W)
12	flood in Guatemala ward (18°20'51.60"N; 67°00'58.60"W)
13	flood - bridge in Guatemala ward (18°21'18.18"N; 67°00'47.96"W)
14	flood - collapsed road in Ciabo ward (18°19'49.42"N; 67°54'57.10"W)
15	landslide in Pozas ward (18°20'10.76"N; 67°01'56.54"W)
16	flood in Pozas ward (18°20'42.27"N; 67°01'30.14"W)
17	landslide in Pozas ward (18°20'23.25"N; 67°00'44.39"W)
18	flood in Pozas ward (18°19'59.06"N; 66°59'59.95"W)
19	flood in Pozas ward (18°19'29.91"N; 67°01'18.89"W)
20	flood in San Sebastián ward (18°20'08.24"N; 66°59'13.69"W)
21	landslide – fault in Piedras Blancas ward (18°20'07.46"N; 66°58'19.40"W)
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23	flood in Culebrinas ward (18°19'52.63"N; 66°59'22.56"W)
24	landslide – bridge in Culebrinas ward (18°19'42.62"N; 67°59'53.79"W)
25	landslide – bridge in Alto Sano ward (18°17'37.98"N; 67°02'28.33"W)

No.	Mitigation Action (GPS coordinates)
26	landslide in Guacio ward (18°17'37.48"N; 67°00'54.02"W)
27	flood in Guacio ward (18°16'34.50"N; 66°58'45.16"W)
28	landslide in Mirabales ward (18°17'08.56"N; 67°57'23.01"W)

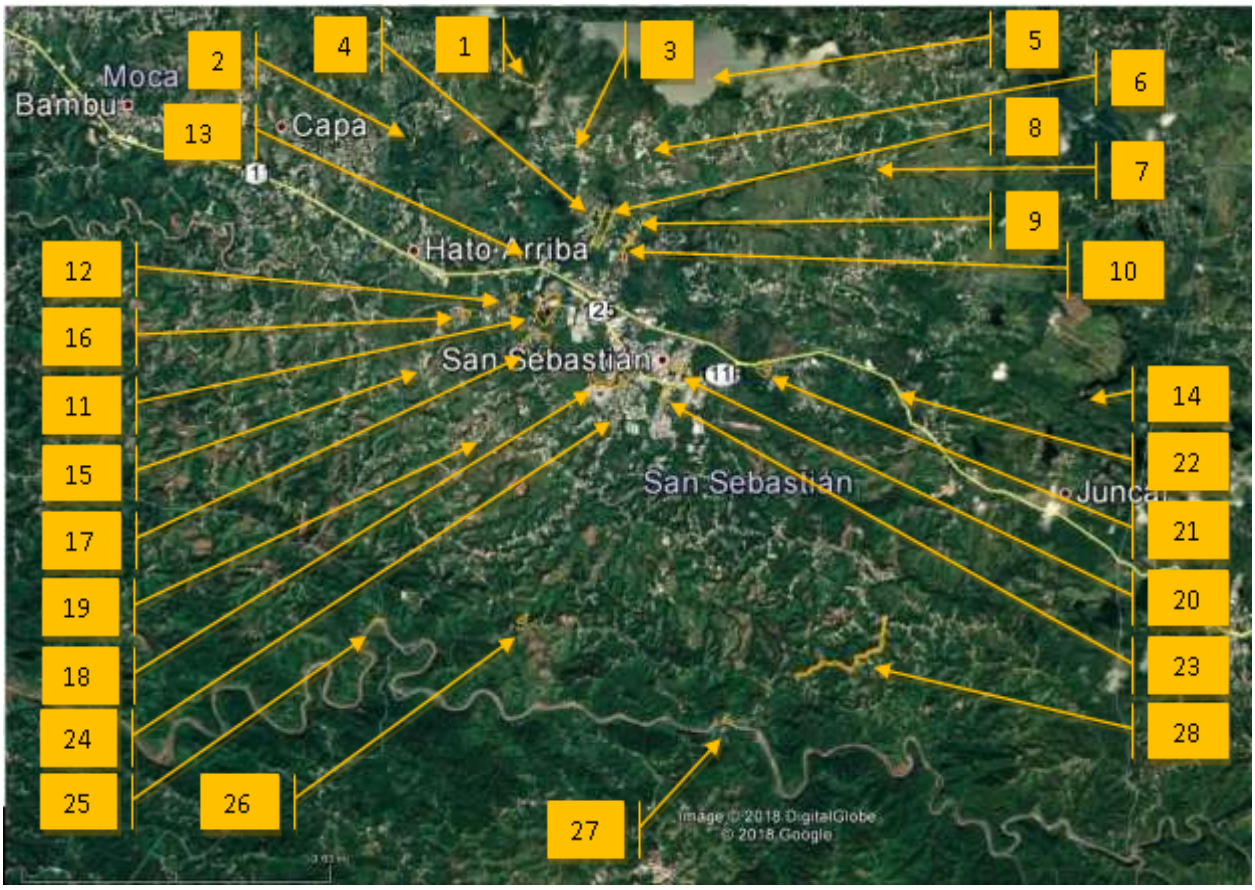

Figure 3-2 Hazardous areas identified by the community during the Public Meeting, March 20, 2018.

3.6.2 How Neighboring communities were given the opportunity to be involved in the planning process

The Community Public Meeting was held on March 20, 2018.

- Community leaders, Municipal Legislators, Municipal Department Directors, and State Government Representatives were invited to the meeting.
    - Please refer to Appendix C (page 33-34), of the HMP showing the invitation log for Municipal Officers, State Agencies, Cultural and other non-profit organizations, local high education institution, and commercial representatives dated March 16, 2018 including, but limited to:
        - Municipal Secretariat and other municipal dependencies
        - CRIM
        - Puerto Rico Police Department
        - Puerto Rico Fire Department
        - Cultural organization (Casa Pepiniana de la Cultura)
        - Community and Faith Base Initiatives
        - EDP University College
        - Oronoz Hnos., Inc. (commercial representative)
        - Comercial Felo, Inc. (commercial representative)

Section 3.6, Public Participation in the Plan Development, Review and Comments of the Plan, (page 3-12), indicates how the public was involved in the development of the Plan, contributed to its development by providing specific content, and was given the opportunity to provide comments prior to Plan finalization. The Municipality harvested public input throughout the entire planning process. Specifically, these efforts included:

- Engaging public stakeholders through community meeting. Public concerns were documented and incorporated into draft and final version.
- Public input was obtained through workshop.
- Public input was obtained through personal interviews about hazards and associated impacts.
- The San Sebastián Hazard Mitigation Planning Committee was formed on March 1, 2018 and open community meetings were held on March 20, 2018 and May 17, 2018.
- Public input was sought during the first community meeting, held March 20, 2018. The public, along with the Hazard Mitigation Committee, prioritized series of Mitigation Strategies and actions for incorporation into the Plan.

Section 3.6.4 (page 3-18), explain that the HMP Draft was made available to the public on May 1, 2018, through May 25, 2018, as announced in the public meeting. The Municipality of San Sebastián chose to place copies of the document at the Office of Federal Programs for Public review and comment. There were no comments or suggestions by the public to the Mitigation Plan. All the questions were answered during the community meetings.

3.6.3 Documentation of Invitation to Neighboring Communities, e.g. Adjacent Municipalities and Municipalities with Similar Hazards

Please refer to the following screen images showing the invitation letter sent to the neighboring municipalities (**Figure 3-3**) and the image if the e-mails report (**Figure 3-4**) as evidence of the invitation to the neighboring municipalities:

GOBIERNO DE PUERTO RICO
MUNICIPIO AUTÓNOMO DE SAN SEBASTIÁN
DEPARTAMENTO DE PROGRAMAS FEDERALES

FECHA: 5 de marzo de 2018

A: *Oficiales Electos del Municipio de San Sebastián*
Representante del Sector Comercial
Oficial de Agencia Regional, Estatal y/o Federal
Representante de Instituciones Culturales
Representante de Colegio / Universidad
Representante de Organización sin Fines de Lucro
Representantes de la Comunidad
Público en General

DE: Comité de Planificación

ASUNTO: **Invitación a Reunión Pública sobre Actualización Plan de Mitigación de Riesgos del Municipio de San Sebastián**

El Comité de Planificación del Plan de Mitigación de Riesgos del Municipio de San Sebastián, en conjunto con los Directores de varias dependencias municipales, estamos trabajando para actualizar el Plan de Mitigación de Riesgos por Desastres Naturales de nuestro Municipio. Hemos contratado a la firma de consultores Tetra Tech, Inc. para que nos brinde apoyo técnico durante este proceso. El proceso de revisión y actualización del plan actual ha comenzado, es por ello que deseamos invitar a los diferentes grupos de interés para que participen desde la etapa inicial en que nos encontramos.

El plan provee una guía para los proyectos que se planifiquen realizar durante los próximos cinco (5) años con el fin de reducir o eliminar los riesgos y efectos de los desastres naturales a los ciudadanos de nuestra jurisdicción municipal. Sin embargo, es vital obtener la información que los grupos de interés y el público en general puedan aportar al proceso de actualización. Al completar la actualización del plan y contar con la aprobación de la ***Agencia Federal para el Manejo de Emergencias (FEMA).*** *el Municipio de San Sebastián podrá ser elegible para recibir fondos federales* que nos permitan completar los proyectos de mitigación que se identifiquen.

Nuestra primera reunión abierta al público se llevará a cabo el próximo martes, 20 de marzo de 2018 en las facilidades de la Legislatura Municipal de 1:30 P.M. a 4:30 PM.

Es de suma importancia su asistencia a esta reunión, le esperamos.

PO BOX 1603, CALLE RUIZ BELVIS NUM.275, SAN SEBASTIAN, PR 00685-1603 • TELEFONO 787-896-7110 • FAX 787-280-2165 • E-Mail federalesmss@gmail.com

Figure 3-3 Screen image of the invitation letter sent to neighboring municipalities to participate in the Public Meeting regarding the HMP Update process for the Municipality of San Sebastián, dated March 5, 2019

Gmail nilda Sosa <nildafederales@gmail.com>

Invitación a Reunión Pública sobre Actualización Plan de Mitigacion de Riesgos del Municipio de San Sebastián

2 mensajes

nilda Sosa <nildafederales@gmail.com> 16 de marzo de 2018, 11:23
Para: manejodeemergencias@quebradillaspr.com

Saludos cordials: Adjunto envio invitación a Reunión Pública sobre Actualizacion de Plan de Mitigación y riesgos del Municipio de San Sebastian.

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Gmail nilda Sosa <nildafederales@gmail.com>

Invitación a Reunión Pública sobre Actualización Plan de Mitigación de Riesgos del Municipio de San Sebastián

2 mensajes

nilda Sosa <nildafederales@gmail.com> 16 de marzo de 2018, 11:42
Para: edwinsotolasmarias@gmail.com

Saludos Cordiales:

Sr. Luis Muñiz Rivera,Director Interino , envio invitación a Reunión Pública sobre Actualización Plan de Mitigación de Riesgos del Municipio de San Sebastian.Cualquier duda comunicarse al (787) 896-7110

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447K

Gmail nilda Sosa <nildafederales@gmail.com>

Invitación a Reunión de Planificación sobre Actualización Plan de Mitigación de Riesgos del Municipio de San Sebastian.

1 mensaje

nilda Sosa <nildafederales@gmail.com> 16 de marzo de 2018, 11:11
Para: omemoca@yahoo.com

Saludos:
Adjunto envio carta para Reunión Pública sobre Actualización Plan de Mitigación del Municipio de San Sebastián. Cualquier duda comunicarse al (787) 896-7110

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Figure 3-4 Screen Images of e-mails sent to the Municipalities of Quebradillas, Las Marías, and Moca respectively, with the invitation letter (Figure 3-3), to participate in the Public Meeting as part of the HMP Update process for the Municipality of San Sebastián as neighboring communities.

3.6.4 Plan Availability, Public Review of the Draft Plan

Plan availability would be given through personal communication with community leaders of all 24 municipal wards. A Draft Plan was made available to the public May 1, 2018, through May 25, 2018. The Municipality of San Sebastián chose to place copies of the document at the Office of Federal Programs for Public review and comment. There were no comments or suggestions by the public to the Mitigation Plan. All the questions were answered during the community meetings.

3.7 REVIEW OF EXISTING LEGISLATION, PLANS AND REPORTS

The review of existing plans, studies, reports, and ordinances was an important aspect of the planning process. The review focused on important studies and legislation that would have an impact on the Municipality's ability to implement and manage a hazard mitigation initiative. The subsection below provides a summary of major documents/legislation were reviewed during the development of the Plan. Several key issues from the following legislation and plan were incorporated into the Plan document. The citation of local regulations has been reviewed for clarity an accuracy during 2018 update process. The Committee also added information regarding Federal and State laws, Governor Executive Orders, and Integrated Hazard Assessment for the Island of Puerto Rico, among others.

3.7.1 Federal Acts, Plans, Guidance

The Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 USC 5121) and its rules (44 CFR 206)

This Act establish the politic to the mitigation process of natural disasters. The USA Congress recognize that a natural disaster cause the loss of lives, human suffering, income loss, property lose and damage, dislocate the government and community normal function, adversely affect families and individuals. The purpose of the Stafford Act is to provide assistance from Federal government to states and local governments so they could relief suffering and damage caused by natural danger. The implementation of this Act relies on FEMA. Section 409 of the Act requires each state to prepare a mitigation plan as a condition to receive Federal funds if a disaster occurs. Programs should be identified and adopted to reduce hazards from natural disasters. The Municipality of San Sebastián is responsible to prepare and adopt a HMP to be eligible to receive such funds.

3.7.2 Puerto Ric Laws

Law 81 from August 30, 1991

Law 81 from August 30, 1991, known as Autonomous Municipal Act. Section 13.011 (Compatibility with Land Use and Zone Plans), establishes the preeminence of the Planning Regulation No. 13 and prohibit the adoption of any substitute regulation for the control of development in flood zones.

Law No. 20 of April 10, 2017, known as the Law of the Department of Public Security of Puerto Rico. This law was developed to establish the Department of Public Security of Puerto Rico; for the purpose of creating a new system composed of all the components that administer public security in Puerto Rico; allow you to share staff and administrative expenses; create the Puerto Rico Police Bureau; create the Puerto Rico Fire Department Bureau; create the Puerto Rico Forensic Sciences Bureau; create the 9-1-1 Emergency Systems Bureau; create the Bureau for Emergency Management and Disaster Management; create the Bureau of Medical Emergency Corps of Puerto Rico; create the Puerto Rico Special Investigations Bureau; repeal Act 211-1999, as amended, known as the "State Agency for Emergency Management and Disaster Management Act of Puerto Rico, among other purposes.

3.7.3 Puerto Rico Regulations

A review of state regulations provided an understanding of the established norms and procedures for land use and development in Puerto Rico. An understanding of each of these is useful for future planning focused on reducing the impacts of natural hazards.

Puerto Rico Codes 2018 – Regulation No. 9049, November 15, 2018

Puerto Rico Codes 2018 repeals the Regulation No. 8222 of June 20, 2012, known as the "Puerto Rico Building Code". This regulation arises from the adoption of ten (10) of the International Codes Council (ICC) family with its amendments to conform to the requirements of laws and regulations of construction and occupancies in Puerto Rico. This rule was enacted in order to update building codes in Puerto Rico so as to contemplate the minimum regulations necessary for the design, construction and execution of a project, regulate by code the requirements of planning, design, construction, inspection and maintenance of all types of buildings and structures, establish the minimum requirements and construction standards to safeguard life and safety, with the intention of having the best and most up-to-date design and construction practices within the jurisdiction of Puerto Rico. Since the HMP is updated every five (5) years, on normal circumstances, and to avoid code editions discrepancies, the Municipality of San Sebastián will refer to the document as the "Puerto Rico Codes" or "Puerto Rico Codes in effect".

Commonwealth of Puerto Rico Regulation No. 12

This regulation established the "certification process" in ARPE. This process was implemented to streamline development review procedures. It allows the engineering and architectural community to certify that a construction or development project is in conformance with all regulations.

Commonwealth of Puerto Rico Regulation No. 13 - Flood Zone Regulations (Reglamento Sobre Zonas Susceptibles a Inundaciones)

Adopted in 1971 to restrict development in flood zones, this regulation was adopted under the protection of Law No. 3 of September 27, 1961, which is known as the (Law to Control Construction in Flood Zones). Ley para el Control de Edificaciones en Zonas Susceptibles a Inundaciones Regulation No. 13 was amended in 1978, when the Central Government joined the National Flood Insurance Program (NFIP). These amendments were necessary to conform to federal legislation regulating construction in the Special Flood Hazard Areas (SFHAs) as identified in the Flood Insurance Rate Maps (FIRMs). FEMA published the FIRMs for Puerto Rico in August 1978 and subsequently amended over time by more thorough and updated flood studies have been completed, primarily in the metropolitan San Juan region.

Commonwealth of Puerto Rico Regulation 8486, Karst Zone Special Planning Area, June 16, 2014

The purpose of this Special Regulation is to implement the public policy established in Article 2 of the Law of the Karst Physiography, to protect, conserve and manage for the benefit of this and future generations the Karst Physiography of Puerto Rico; by prohibiting the destruction of its formations and natural materials, such as flora, fauna, soils, rocks and minerals; limiting the extraction of earth's crust and avoiding the transportation and sale of natural materials without the corresponding permission; and regulating the imposition of penalties for violation of its provisions.

3.7.4 Integrated Hazard Assessment for the Island of Puerto Rico, 2002

This is the baseline document for hazardous maps used for this plan. It also explains, in details, the method used during its preparation.

3.7.5 Four-Year Investment Program (PICA) 2018-2019 to 2021-2022

The current Four-Year Investment Program (Programa de Inversiones de Cuatro Años, PICA, for its acronym in Spanish) includes the periods from 2018-2019 to 2021-2022. The PICA is prepared in compliance with the provisions of the Organic Law of the Puerto Rico Planning Board, Law Number 75 of June 24, 1975, as amended. The document integrates the investments that the Government of Puerto Rico will make through its different organizations and responds to the need to allocate and distribute the funds effectively, directing them to the areas of highest priority. It constitutes a short and medium term planning instrument aligned with the goals of the Government of Puerto Rico and contributes to a healthy and effective public administration. The Puerto Rico Planning Board uses the following criteria in the analysis of priorities during the Puerto Rico investment programming:

- Projects that address emergencies, risks or needs of the population.
- Projects that respond to an order of the Federal Court, applicable legislation or regulations.
- Projects that require assignments to honor credit lines and / or authorizations to incur obligations.
- Projects whose construction phase is scheduled to end during the fiscal year or that requires an assignment to complete its accounting settlement.
- Projects under construction and that require additional funds to continue their development.
- Projects that constitute a programmatic commitment.
- Projects needed to make other projects viable.
- Greater rehabilitation or repair that prolongs the life of the infrastructure or improves its efficiency.
- Projects to replace obsolete facilities that are part of the infrastructure.
- Projects with significant federal contribution.
- Fixed equipment for finished projects

The municipality of San Sebastián is aware of the projects included in the PICA for the municipality. The following table provides all the projects included in the current PICA for the Municipality of San Sebastián. The proposed project of the Solid Waste Authority (ADS, for its acronym in Spanish), is the last project in the agency priority list, sharing the position with the Mini Transfer Station Project in San Germán.

Table 3-3 Potential Projects for a Four-Year Investment Program 2017-2018 to 2020-2021

Name and Description of Projects	2017-2018	2018-2019	2019-2020	2020-2021	TOTAL 2017-2018 to 2020-2021
	(in thousands of dollars)				
Proposed Investment to PICA 2017-2018 to 2020-2021, All Agencies					
Puerto Rico Solid Waste Authority San Sebastián Mini Transfer Station: Construction of improvements to the San Sebastián Mini Transfer Station.	72	78	0	0	150
Puerto Rico Aqueduct and Sewer Authority 75 km Distribution System (San Sebastian) Phase II b	5,737	2,834	548	-	9,119
List of Projects Under Consideration of the Department of Transportation and Public Works These projects do not respond to cases with federal assignments, special assignments or by joint resolution or to an order of the Federal Court, applicable legislation or regulations.					
3048 - Scarification, Resurfacing and Marking of Pavement from km 5.0 (Int. PR-110) to 17.2 (Int. PR-111, San Sebastián	-	-	-	-	1,300

Name and Description of Projects	2017-2018	2018-2019	2019-2020	2020-2021	TOTAL 2017-2018 to 2020-2021
	(in thousands of dollars)				
3014 - (Correcting Detachment) Sinking in the Juncal sector. It was evaluated by contracted firm. ACT worked preliminary design to correct underground drainage	-	-	-	-	0
3015 - (Correct Detachment) Correct Detachment	-	-	-	-	40
3062 - (Asphalt and / or scarification)	-	-	-	-	1,800
3063 - (Asphalt and / or scarification)	-	-	-	-	800
3064 - (Asphalt and / or scarification)	-	-	-	-	800
3065 - (Asphalt and / or scarification)	-	-	-	-	450
3066 – Resurfacing and Marking	-	-	-	-	470
Total					14,929

Source: Proyectos Potenciales para un Programa de Inversiones de Cuatro Años (PICA) 2017-2018 a 2020-2021 (Junta de Planificación, 2017).

3.7.6 Municipal Ordinances, Plans, and Tools

Ordinances

- Ordinance No. 13, Series: 2001-02 to create the Municipal Office for Emergency and Disaster Management; to authorize the Mayor to appoint a director for said office, to derogate all ordinances, resolutions and regulations concerning the Municipal Office of Civil Defense; and for other purposes.
- Ordinance No. 128, Series: 2012-13 to authorize the Municipality of San Sebastián to acquire two residences located on road PR-423 Km 0.3, Hato Arriba Ward, San Sebastián, to demolish them and create an open land for perpetuity due the nature and land condition after land instability. (Investment: $379,256.00; Funds from FEMA-4017-DR-PR.Proyecto 0031).
- Ordinance No. 62, Series: 2014-15. Resolution of the Municipal Legislature of San Sebastian, to request the Department of Transportation and Public Works of Puerto Rico to take immediate action in the interruption of the use of State road PR-446 due to the road collapse in Robles Ward and for the advanced state of deterioration of the intersection with PR-4446 Km 6.5 of the same road in our municipality; and for other purposes.

Plans / Permits

- **Comprehensive Plan: Land Use and Zoning -** The Municipality of San Sebastián competed the following stages: Objectives, Memorial, Advance, and Program. This document outlined goals and strategies based on a complete analysis of the Municipality's population, its potential for growth, and the general needs that may arise from this growth. It also described the public policies that would guide the implementation of recommendations outlined in the Plan.
- **Municipality of San Sebastián Hazard Mitigation Plan** – Most recent updated plan adopted in year 2012.

- **San Sebastián Municipal Stormwater Program NPDES Permit -** The Municipality of San Sebastián submitted a complete Notice of Intent document to be covered under the National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (Small MS4 GP) in urbanized areas (PRR040000) in Puerto Rico (October 3, 2016). The coverage date of the municipality NPDES Small MS4 General Permit started on February 21, 2017 (Permit Number: PRR040072).

Tools and data

- **HAZUS** – This is an application prepared by FEMA to establish a method to calculate damage caused by natural danger. HAZUS was used to prepare the method for damage assessment for this plan.
- **Local Data -** The HMP Planning Committee and the contract consultant reviewed and incorporated existing data and plans to support the Mitigation Plan. Many electronic and hard copy documents were made available to support the planning process including:
    - Local and regional Geographic Information System (GIS) data
    - Documentation of past mitigation actions and grant applications
- **Federal and State Data -** Federal and State data was collected and used throughout the mitigation process including:
    - US Census data
    - HAZUS-MH provided data
    - FEMA "How To" Series (386-1 to 386-4, and 386-7)

  A complete list of the existing data and plans used to support this HMP is included in the references section of this document. By incorporating data from existing programs into this Plan, the Municipality of San Sebastián also could identify the relevance of mitigation planning to these existing programs.

3.7.7 Capability Assessment and Incorporation of Plans and Technical Information

While a capability assessment is not required part of the DMA 2000 planning requirements, the Project Consultant team reviewed current plans and legislation mentioned above (see Section 5.2.2). These plans provided important background information on the demographic profile of the municipality, proposed capital improvement projects and land use, as well as the administrative capabilities. This information was used to assess the **municipality's** capability to the implementation of hazard mitigation policies and programs.

This analysis provided invaluable information for developing an effective and practical Hazard Mitigation Strategy. Specifically, it allowed the project consultant team to determine what actions are practical, or is likely to be implemented over time given the administrative, technical, fiscal, legal and political makeup of the municipality.

An additional part of the evaluation involves the assessment of existing policies, **programs and projects currently in place that impact the Municipality's** vulnerability to natural hazards. For example, future vulnerability may be reduced as hazard maps are used to in the permit and development review process. Hazard maps can be used to make decisions on where to place public infrastructure.

The assessment of local plans and legislation policies is reflected throughout this document, more specifically, in Section 5, which outlines hazard mitigation actions that reflect local realities, and therefore, are more likely to be implemented.

3.7.8 Continued Public Involvement

The Municipality of San Sebastián is committed to the continued involvement of the public. Therefore, copies of the Plan are available for review at the Municipality of San Sebastián in the Major's Office: Calle Padre Feliciano Núm.3, San Sebastián, P.R. 00685.

After completion of the Plan, implementation and ongoing maintenance will become a function of the HMP Planning Committee. The HMP Planning Committee will meet every six months to evaluate the progress of the proposed actions. The HMP Planning Committee will review the Plan and accept public comment as part of the annual review and the five-year mitigation Plan update. A notice regarding annual updates of the Plan and the location of Plan copies will be publicized annually after the HMP Planning Committee's annual evaluation.

Ms. Maritza Ruiz has been identified as the ongoing Municipality of San Sebastián All Hazard Mitigation Plan Coordinator, and is responsible for receiving, tracking, and filing public comments regarding this Plan. The contact information is:

Maritza Ruiz, Director
Federal Programs
Municipality of San Sebastián
P.O Box 1603 San Sebastián, P.R. 00685
Phone: 787-896-1550

The public will have an opportunity to comment on the Plan as a part of the annual mitigation planning evaluation process and the five-year mitigation Plan update. The HMP Coordinator is responsible for coordinating the plan evaluation portion of the meeting, soliciting feedback, collecting and reviewing the comments, and ensuring their incorporation in the five-year Plan update as appropriate; however, members of the HMP Planning Committee will assist the HMP Coordinator. Additional meetings may also be held as deemed necessary by the HMP Planning Committee. The purpose of these meetings would be to provide the public an opportunity to express concerns, opinions, and ideas about the Plan.

4.0 RISK ASSESSMENT

This section presents the results of the risk assessment conducted in the Municipality of San Sebastián. The risk assessment was prepared to comply with the federal requirements of DMA 2000, FEMA Region 2, and to meet the Puerto Rico Emergency Management Agency (PREMA) guidance for the development of local hazard mitigation plans. More importantly, it provides a foundation for the community's decision makers to evaluate mitigation measures that can help reduce the impacts of natural hazard events.

This section is organized around the risk assessment process shown in **Figure 4-1** and includes the following subsections:

- 4.1 44 CFR 201.6 Requirements for Risk Assessment
- 4.2 Methodology and Tools
- 4.3 Identification of Hazards
- 4.4 Profile of Hazards
- 4.5 Inventory of Assets
- 4.6 Assessing Vulnerability
- 4.7 Loss Estimates
- 4.8 Understanding Future Losses in San Sebastián

4.1 44 CFR 201.6 REQUIREMENTS FOR RISK ASSESSMENT

44 CFR 201.6(c)(2): states that "[t]he plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards."

The CFR goes on to include six specific requirements for the process of developing Local Hazard Mitigation Plan:

- **Identifying Hazards** per **Requirement §201.6(c)(2)(i):** The risk assessment shall include a description of the type of all natural hazards that can affect the jurisdiction.
- **Profiling Hazards** per **Requirement §201.6(c)(2)(i):** The risk assessment shall include a description of the location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.
- **Assessing Vulnerability: Overview** per **Requirement §201.6(c)(2)(ii):** The risk assessment **shall** include a description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description **shall** include an overall summary of each hazard and its impact on the community.

- **Assessing Vulnerability: Identifying Structures damaged by Floods per Requirement 201.6 (c)(2)(ii):** The risk assessment in all plans approved after October 1, 2008 must also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged by floods.
- **Assessing Vulnerability: Identifying Structures** per **Requirement §201.6(c)(2)(ii)(A):** The plan **should** describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area
- **Assessing Vulnerability: Estimating Potential Losses** per **Requirement §201.6(c)(2)(ii)(B):** The plan **should** describe vulnerability in terms of an estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.
- **Assessing Vulnerability: Analyzing Development Trends** per **Requirement §201.6(c)(2)(ii)(C):** The plan **should** describe vulnerability in terms of providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

4.2 METHODOLOGY AND TOOLS

The risk assessment process used for this project is consistent with the process and steps presented in FEMA Local Multi-Hazard Mitigation Planning Guidance and the FEMA Publication 386-2, "State and Local Mitigation Planning How-To Guide, Understanding Your Risks—Identifying Hazards and Estimating Losses" (FEMA 2001). **Figure 4-1** shows the four major steps that comprise the risk assessment process: Hazard Identification, Hazard Profiling, Vulnerability Assessment, and Loss Estimation.

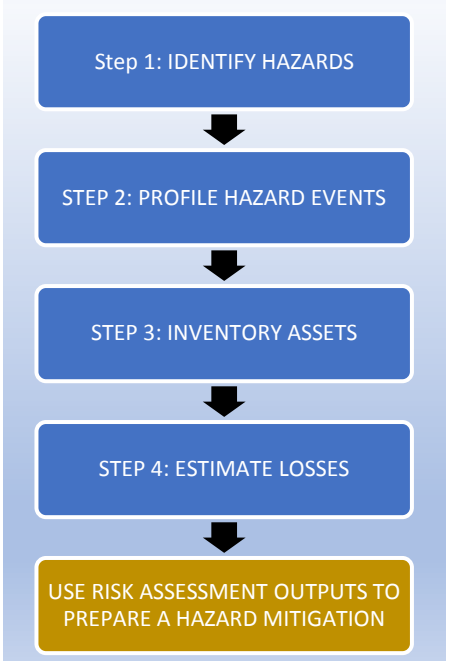

Figure 4-1 Risk Assessment Process

Step 1 – Identify Hazards

The first step of the risk assessment process is to identify the hazards of concern. Only natural hazards are evaluated in this HMP. Natural hazards are natural events that threaten lives, property, and many other assets. Often, natural hazards can be predicted, where they tend to occur repeatedly in the same geographical locations because they are related to weather patterns or physical characteristics of an area. The hazards of concern identified in the 2012 Municipality of San Sebastián Hazard Mitigation Plan were evaluated again for the 2018 HMP update. This time, wildfire and urban fire were evaluated together as one natural hazard.

Step 2 – Profile Hazard Events

The next step of the risk assessment is to prepare a profile for each hazard of concern. These profiles assist communities in evaluating and comparing the hazards that can impact their area. Each type of hazard has unique characteristics that vary from event to event. That is, the impacts associated with a specific hazard can vary depending on the magnitude and location of each event (a hazard event is a

specific, uninterrupted occurrence of a particular type of hazard). Further, the probability of occurrence of a hazard in a given location impacts the priority assigned to that hazard. Finally, each hazard will impact different communities in different ways, based on geography, local development, population distribution, age of buildings, and mitigation measures already implemented.

Step 3 – Inventory of Assets

To understand risk, a community must evaluate what assets it possesses and which assets are exposed or vulnerable to the identified hazards of concern. Hazard profile information combined with data regarding population, demographics, general building stock, and critical facilities at risk, located in Section 4, prepares the community to develop risk scenarios and estimate potential damages and losses for each hazard.

The inventory of assets quantifies what can be lost when a hazard occurs. Specifically, the people, places, and property that could be injured, damaged, or destroyed are quantified. To be consistent with the methodology outlined in the *"State and Local Mitigation Planning: How–to Guide: Understanding Your Risk"*, the Planning Committee collected the data described below to:

- Estimate or count the total number of buildings, value of buildings, and population in the Municipality.
- Determine the proportion of buildings, the value of buildings, and the population in located in hazard prone areas.
- Calculate the proportion of assets located in hazard areas.

To understand that vulnerability of people, buildings and infrastructure to natural hazards, a comprehensive inventory of assets was conducted in previous HMP version and revised with current data during the 2018 update process. Inventory data was categorized into a few asset categories, including population, general building stock, and infrastructure.

Population.

This was broken down to identify the number of people less than 18 years of age and the number of people over 65 years of age. These two demographic subgroups help define the municipality's social vulnerability as these two population groups are the most likely to need assistance during and/or after a hazard event.

General Building Stock.

The field assessment was used to classify the general building stock into two general occupancy categories: commercial and residential. Detailed below are the procedures used to identify the number of buildings and to estimate the exposure values of the general building stock (replacement and content values **Table 4-13** and

Table *4-14*)

- The numbers of housing units were identified from the 2010 US Census data. This allowed the Committee to identify the number of buildings per occupancy class. Since there were no commercial units listed in the US Census data a field assessment was necessary.

- An assessment matrix was used to relate the number of building to specific occupancy classes. Field surveys were used to identify how many buildings in an area were residential vs. commercial. This survey was conducted for several land use categories identified. Then the number of building identified as being residential and commercial were related to specific building types, showing the distribution of model building types throughout the municipality. Distribution information was compiled to determine the number of building types per specific occupancy class during the previous HMP version.
- An average replacement cost was developed for each building type. Replacement costs were based on the insurance policies for the municipality for 2012-2018 timeframe.

Critical Facilities and Infrastructure

A list of critical facilities and infrastructure was developed by the Committee. This list was then provided to the Consultant Project Team during the previous version. Detailed procedures used to identify and estimate exposure values of critical facilities (replacement and content values) are provided below:

- Facilities/structures were categorized by structural characteristics relevant to the prominent hazards addressed in the vulnerability assessment. The field investigation also allowed the Consultant Project Team to determine the vulnerabilities and risks of the structures for each possible hazard.
- Replacement and content values were estimated based on field inspections which indicated that approximate building area.

The final step of the inventory process is a vulnerability assessment, which facilitates an understanding of the proportion of buildings, the value of buildings, and the population that is in hazard areas. The results of the hazard identification and profile were used to understand characteristics of hazards (i.e. wind speed, flood depth, etc.) to assess the vulnerability parameters (specific damage and loss characteristics) of each asset identified. For instance, a wood frame building will have different damage and loss characteristics for a hurricane than a reinforced concrete structure. A hazard vulnerability assessment was assigned to each building type or facility to express. The vulnerability for the general building stock (model building types) and critical facilities and infrastructure in qualitative terms. Based on the vulnerability assessment for the general building stock, damage functions were developed to translate the hazard intensity data (given in terms of wind speed, ground shaking, depth of flooding, etc.) into its respective economic loss potential. In its simplest form, a damage function estimates the potential economic damage (e.g., cost to repair/replace the damaged components) of a building or group of buildings to a specified level of hazard intensity.

During the 2018 update process, the critical facilities inventory was provided to the consultant to perform site visits. Tetra Tech obtained the GIS location of each facility and identified the sites in aerial photograph. The location of the critical facilities was included in the hazard risk maps.

Step 4—Loss Estimation

The last step of the risk assessment is loss estimation. Hazard identification and profiling results are used together with the findings of the vulnerability assessment to understand potential losses for general building stock and critical facilities. Below are procedures for a prototypical census block in the municipality:

1. Hazard maps (location) and hazard profile information (intensity) were used to identify the natural hazard affecting area. Based on the intersection of hazard areas, each hazard intensity level (i.e. high winds, earthquakes).

2. Exposure to a specific hazard (i.e. number of buildings, % of total buildings, and value) was determined for identified buildings (general building stock and critical facilities).

3. A qualitative vulnerability level was assigned to each model building type to understand the vulnerability of buildings.

4. Qualitative vulnerability levels were related to specific loss estimation tables to determine possible damage to a structure (i.e. replacement and content value).

4.2.1 Uncertainties and Limitations

For this risk assessment, the loss estimates and exposure calculations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from (1) approximations and simplifications that are necessary to conduct such a study, (2) incomplete or outdated data on inventory, demographic, or economic parameters, (3) the unique nature and severity of each hazard when it occurs, and (4) the amount of notice that the residents must prepare for the event. These factors result in a range of uncertainty in loss estimates, possibly by a factor of two or more. Thus, potential exposure and loss estimates are approximate. These results do not predict precise results and should only be used to understand relative risk.

Data Sources, Hazard Model Assumptions, and Limitations

Data Sources, Hazard Model Assumptions, and Limitations are included below.

Ground Shaking Hazard Assessment: Data Sources, Ground Shaking Hazard Model Assumptions, and Limitations for San Sebastián

The hazard assessment was developed using the Seismic Hazard Maps (**Figure 4-2**) from the U.S. Geological Service (2003), which provides ground shaking intensity (expressed in terms of Peak Ground Acceleration (PGA) for 50-, 100-, 250-, 1,000-year return periods). This study is based on the probabilistic hazard methodology developed by the U.S. Geological Survey (USGS) as described by Frankel and others (1996, 2002), and present maps of probabilistic ground motions: peak ground acceleration (pga), 1.0-second spectral response, and 0.2-second spectral response, with 2% and 10% probability of exceedance in 50 years, corresponding to return times of approximately 2500 and 500 years, respectively. **Figure 4-3** shows the PGA (%g) with 2% probability of exceedance in 50 years from all modeled sources hazard curve for Puerto Rico.

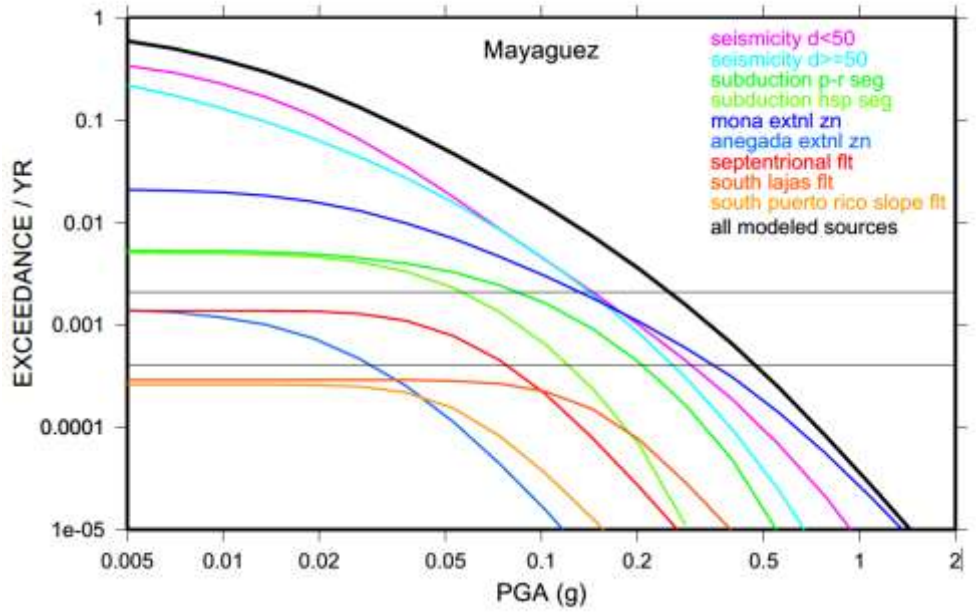

Figure 4-2 PGA Hazard Curves for Mayagüez[6]

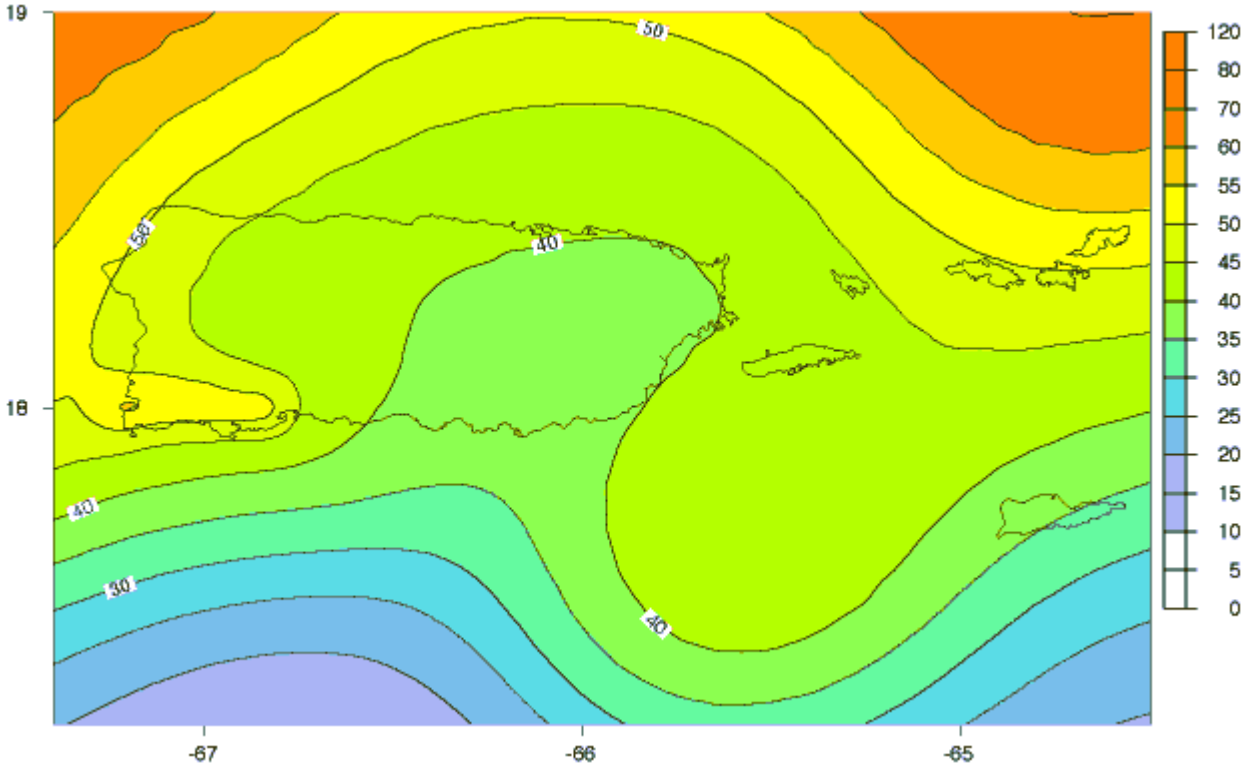

Figure 4-3 Hazard curve for West Area With 2% probability of exceedance in 50 years from all modeled sources[7]

[6] https://earthquake.usgs.gov/static/lfs/nshm/prvi/2003/maps/curves/mayaguez.pdf
[7] https://pubs.usgs.gov/of/2003/ofr-03-379/GIFS/fig04.gif

Like others in the USGS seismic hazard series, these maps will be used in earthquake mitigation and response planning, and derived engineering-design-motion maps will be considered for adopting in future updates of building codes and other structural design standards. The USGS methodology is based primarily on 1) gridded and smoothed historical seismicity generalized using exponential magnitude distributions with regionally determined *b* values, and 2) specific fault sources with published slip-rate or recurrence information. Where there is reason to suspect that the seismicity or fault components of the model are incomplete, they can be supplemented with sources based on geodetic or other deformation data. Earthquakes are assumed to occur randomly in time; the probabilistic ground motions represent time-independent seismic hazard.

The Mona Passage between Puerto Rico and Hispaniola coincides with a broad zone of active crustal extension. Bathymetry, subsea seismic imaging, and focal-mechanism data are all suggestive of normal faulting on generally north-south trending structures and east-west-directed extension. One of the largest bathymetric features in the Passage, the north-south-trending Mona Canyon, is thought to be normal-fault controlled, and was probably the site of a magnitude~7.5, tsunami, earthquake in 1918 that damaged northwestern Puerto Rico with large losses of life and property (Lafarge and McCann, 2003). We assign a rate of east-west extension of 5 mm/yr based on recent GPS geodesy results (Jansma and others, 2000), assume a *b* value of 1.0, and prorate faulting uniformly into each grid cell in the zone, using the method described by Frankel and others (1996) for computing hazard from areal zones.

Seismicity near PRVI is primarily related to: 1) highly oblique sub-duction of the North American plate beneath the terrines of the plate boundary zone along the main plate interface south of the Puerto Rico Trench, and 2) the interactions of several probable micro plates within the complex boundary zone. Geodesy and seismicity data suggest the existence of a Puerto Rico - northern Virgin Islands micro plate that is relatively rigid and seismically quiescent internally (Masson and Scanlon, 1991; Jansma and others, 2000). Most of the major seismogenic sources are concentrated offshore; thus, estimates of activity rates on specific structures can be highly uncertain, often based on indirect evidence such as seismicity patterns and focal mechanisms, bathymetry and shallow seafloor seismic imagery, regional geodesy, kinematic reasoning, and tectonic analogs. The Great Northern and Great Southern Puerto Rico faults, major left-lateral strike-slip systems active on Puerto Rico from the early Cretaceous to the early Miocene are now considered largely quiescent, although they seem to be associated with very small earthquakes, and may represent inherited zones of weakness (McCann, 1985). Prentice and others (2000) have determined a recurrence rate for one fault onshore southwestern Puerto Rico that they consider to be currently active; several other candidate faults have been identified in western Puerto Rico, but not yet evaluated pale seismically.

Seismic sources related to deformation along the main plate boundary include: mega thrust faulting along the plate interface, southward-deepening intarsia faulting within the sub ducting North American plate, and strike-slip faulting along several structures that strike sub parallel to the Puerto Rico trench north and northwest of Puerto Rico (**Figure 4-4**). These include the tectonically fault, the major plate boundary structure in central Hispaniola, which extends eastward across the northern Mona Passage toward Puerto Rico, and the so-called North and South Puerto Rico Slope fault zones and related structures. Sources related to micro plate interactions include two broad zones of roughly east-west tectonic extension, one west of Puerto Rico roughly coincident with the Mona Passage, and one southeast of Puerto Rico roughly coincident with the Anegada Passage. Extension within these zones is thought to be related to differences in rates of eastward motion (relative to North America) of crustal blocks south of the main plate boundary (e.g., McCann and others, 1987; Jansma and others, 2000): the Caribbean plate moves eastward relatively unrestricted, while blocks within the boundary zone are restricted by relatively high-standing tectonic

features like the Bahama Bank and Main Ridge. As discussed above, we include one terrestrial fault, the South Lajas fault onshore southwestern Puerto Rico (Prentice and others, 2000), in the hazard model. The Puerto Rico Seismic Network has registered 1,206 earthquakes (**Figure 4-5**) from January to May of 2018.

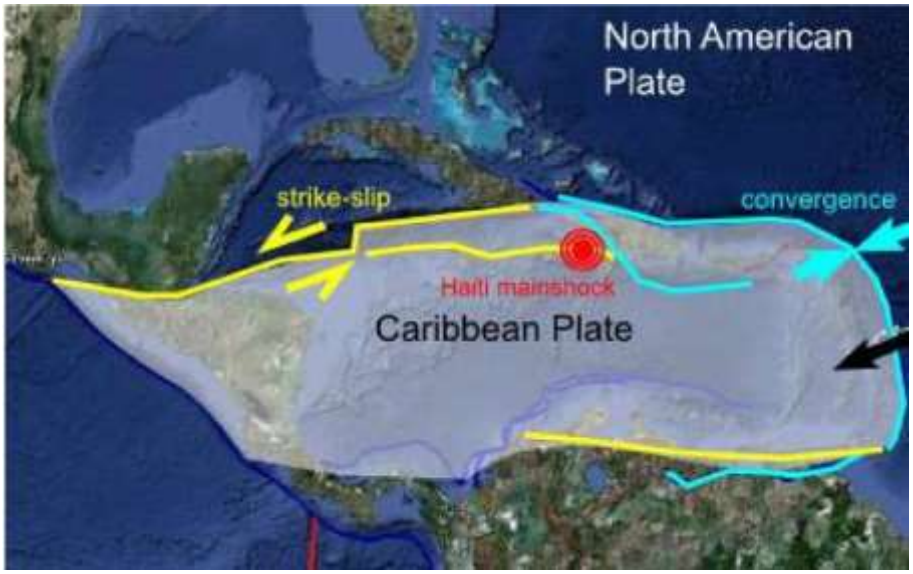

Figure 4-4 Regional Tectonic Plates Map

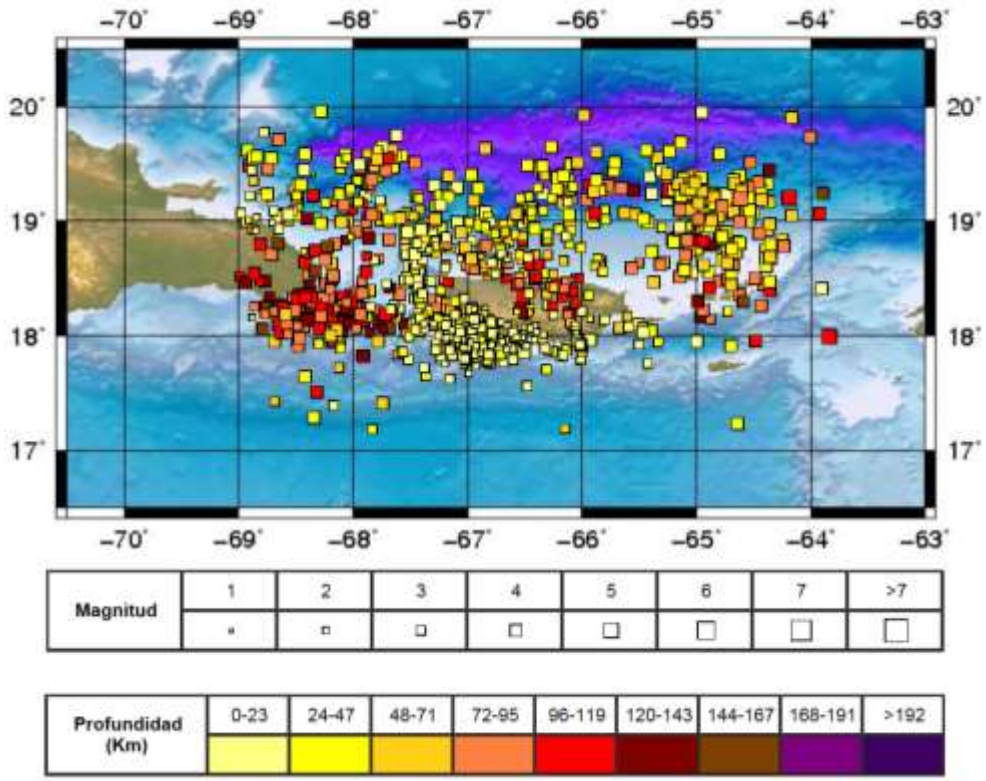

Figure 4-5 Earthquakes in Puerto Rico since January to May 2018.

Liquefaction Hazard Assessment: Data Sources, Hazard Model Assumptions, and Limitations for San Sebastián

The potential damage from liquefaction is conditional on the ground shaking amplitude (i.e., PGA), ground shaking duration, and groundwater depth.

- The relative liquefaction susceptibility of a region was characterized by evaluating its soil/geologic conditions and groundwater depth. Susceptibility rating ranging from very low to very high was assigned using the Youd and Perkins (1978) classification system (**Table 4-1**).
- To compute the damage potential (estimate losses), the baseline hazard frequency, intensity and susceptibility values (PGA) were computed against damage functions developed for a series of building types identified during field surveys.
- Puerto Rico is located in a seismically active region characterized by the convergence and lateral translation of the North America and Caribbean plates. Large earthquakes in 1670, 1787, 1867, and 1918 caused significant damage to major parts of the island, including the San Sebastián area. Pale liquefaction features, possibly caused by at least three different earthquakes since A.D. 1300, have been found in Holocene floodplain sediments at several sites in western Puerto Rico (Tuttle et al., this volume). The historic earthquakes and pale liquefaction features demonstrate that the opportunity exists for future liquefaction events to occur in Puerto Rico.

Table 4-1
Liquefaction Hazard

Geologic Unit	Description	Estimated Percent Liquefiable Texture (%)	Estimated Liquefaction Triggering Acc. (g)		Typical Groundwater Depth (m)	Liquefaction Hazard
			Mw 6.5	Mw 8.0		
Qs	Holocene swamp deposits	50	0.1	0.05	<1.5’	VERY HIGH
Qat/Qs	Artificial fill over swamp	<50	0.1-0.2	0.05-0.15	<3.0’	VERY HIGH
Qac	Late Holocene alluvial channels	<75	0.15	0.1	<1.5’	HIGH
Qb	Holocene beach deposits	80	0.15-0.2	0.1-0.15	<1.5’	MEDIUM-HIGH
Qt	Late Pleistocene to Holocene Terrace	35	0.2	0.15	<3.0’	MEDIUM
Qaf	Artificial fill	<50	0.2	0.15	1.5-6.0	MEDIUM
Qafe	Artificial road embankment fill	<50	0.25	0.15-0.2	1.5-6.0	MEDIUM
Qay	Holocene alluvium	40	0.2	0.15	<3.0’	MEDIUM
Qaf/Qay	Artificial fill over alluvium	<50	0.2	0.15	1.5-6.0	MEDIUM

Geologic Unit	Description	Estimated Percent Liquefiable Texture (%)	Estimated Liquefaction Triggering Acc. (g)		Typical Groundwater Depth (m)	Liquefaction Hazard
			Mw 6.5	Mw 8.0		
Qss	Late Pleistocene(?) dune sands	80	>0.3	>0.2	3.0-10	LOW-MEDIUM
Qvf	Late Pleistocene to Holocene valley fill	<30	>0.3	>0.25	1.5-6.0	LOW
Qf	Late Pleistocene to early Holocene fan	<10	>0.3	>0.25	1.5-6.0	LOW
Qfo	Mid Pleistocene to Pilocene fan deposits	<10	>0.3	>0.3	1.5-6.0	LOW
Qao	Late Pleistocene to Pilocene alluvium	<30	>0.3	>0.25	1.5-6.0	LOW
Qtb	Late Pleistocene to Holocene blanket	<10	>0.3	>0.25	1.5-6.0	LOW
QTt	Pleistocene alluvium	<10	>0.3	>0.3	3.0-10	LOW -VERY LOW
Bx	Bedrock	0	NA	NA	3.0-10	NEGLIGIBLE

Earthquake-Induced Landslide Hazard Assessment: Data Sources, Hazard Model Assumptions, and Limitations for San Sebastián

The potential damage from an earthquake-induced landslide is significantly influenced by ground shaking amplitude (i.e., PGA) and the landslide susceptibility category.

- Conditional probability of earthquake-induced landslides is a function of Peak Ground Acceleration (PGA).
- The relative earthquake-induced landslide susceptibility was classified using a soil association map developed by the National Cooperative Soil Survey that distributed a broad-based inventory of soils and non-soil areas into five distinct physiographic regimes.
- For each physiographic regime, susceptibility categories were assigned as a function of geologic group and slope angle.
- To compute the damage potential (estimate losses), the baseline hazard intensity— permanent ground deformation values (PGD)—was computed against damage functions developed for a series of building types identified during field surveys.

High Wind Hazard Assessment: Data Sources, Hazard Model Assumptions, and Limitations for San Sebastián

The development of the high wind hazard map included two distinct sets of data: one derived from a simulation model and the other from a wind hazard model.

- The wind hazard methodology was based on numerical modeling of hurricane motion and procedures developed by the American Society of Civil Engineers (ASCE, 2000) for calculating wind loads. It considers basic wind speeds, surface roughness and topography.
- Hurricane wind speeds are based on the hurricane simulation model described in Vickery et al. (2000). The simulation uses the hurricane database HURDAT28 to generate synthetic storms and predicts 100-year peak gust wind speed in a flat terrain model from 120 mph to 130 mph (Applied Research Associates, Raleigh, North Carolina (2001)).
- Wind speeds are affected by surface roughness due to vegetation, terrain features, and buildings (Vickery, 2001). The roughness effect is considered for "Exposure B" according to ASCE 2000 and is assumed for the entire island.
- Automated GIS procedures were used to develop a map that depicts ASCE topographic speed-up effects in which local terrain features were taken into consideration. These factors account for the slow down experienced as the hurricane moves inland and for when it speeds up as the wind runs up hill slopes.

Riverine Flooding Hazard Assessment: Data Sources, Hazard Model Assumptions, and Limitations for San Sebastián

The magnitude of riverine flood damages is increasing in San Sebastián. Flood events continue to have an impact on greater numbers of buildings. The assessment of damages was limited to the FEMA 100-year floodplain data.

- The assessment utilizes the FEMA 100-year flood as an indicator of the overall hazard.
- Flood elevations for the 100-year floodplain were derived from FEMA Q3 Flood Data.
- Because of significant inconsistencies between the digital Base Flood Elevations (BFEs) and the terrain model, the 100-year floodplain polygons were used to infer flood elevations.
- The resulting GIS layer was used to generate an estimate of flood surface elevations to understand damages and losses.

[8] HURDAT is the NationalHurricaneCenter's (NHC's) North Atlantic hurricane database. The original database of six-hourly positions and intensities was put together in the 1960s in support of the Apollo space program to help provide statistical track forecast guidance for tropical storms and hurricanes (Jarvinen et al., 1984).

Infrastructure and Critical Facilities: Data Sources, Hazard Model Assumptions, and Limitations for San Sebastián

The loss estimation methodology for critical facilities is undertaken in a similar fashion to the loss estimation procedure for entire building inventory for San Sebastián, adjusted to reflect limitations in the available data and to account for differences in the resolution level of the data. The limitations include the following:

- Use of standardized exposure values, as specific information for each facility type was not available.
- Limited attribute information for detailed structure classification.
- Use of a methodology sensitive to exposure values.
- The methodology is adequate for determining approximate expected losses for use in comparison between structures, and not for structural evaluation of individual structures.
- No data was readily available to conduct an analysis on lifelines (i.e., transportation, water and electric networks).

It should be noted that the use of damage curves does not evaluate the structural integrity of critical facilities, but only determines expected losses from several hazards for comparison purposes for the infrastructure in each region. The evaluation and expected behavior of a structure to any hazard should be undertaken with the services of a licensed and experienced structural engineer retained to provide facility specific assessments.

4.3 IDENTIFICATION OF HAZARDS

Hazards of Concern is defined as those hazards that are considered most likely to impact a community. These are identified using available data and local knowledge.

To provide a strong foundation for mitigation strategies considered in Section 6, the Municipality of San Sebastián focused on considering a full range of hazards that could impact the area, and then identified and ranked those hazards that presented the greatest concern. The hazard of concern identification process incorporated input from the Planning Committee, Operational Committee; review of the 2012 Municipality of San Sebastián Hazard Mitigation Plan (HMP) and previous hazard identification efforts; research and local, state, and federal information on the frequency, magnitude, and costs associated with the various hazards that have previously, or could feasibly, impact the region; and qualitative or anecdotal information regarding natural hazards and the perceived vulnerability of the study area's assets to them. **Table 4-2** documents the process of identifying the natural hazards of concern for further profiling and evaluation.

For the purposes of this update planning effort, the HMP Committee chose to group some natural hazards together, based on the similarity of hazard events, their typical concurrence or their impacts, consideration of how hazards have been grouped in Federal Emergency Management Agency (FEMA) guidance documents (FEMA 386-1, "Understanding Your Risks, Identifying Hazards and Estimating Losses; FEMA's "Multi-Hazard Identification and Risk Assessment – The Cornerstone of the National Mitigation Strategy"), and consideration of hazard grouping in the HMP.

The **flood** hazard includes riverine flooding, flash flooding and stormwater flooding. Inclusion of the various forms of flooding under a general "Flood" hazard is consistent with that used in FEMA's "Multi-Hazard Identification and Risk Assessment" guidance. Floods are one of the most common hazards in the United States and Puerto Rico. Flood effects can be local, impacting a neighborhood or community, or very large, affecting entire river basins and multiple municipalities.

An **earthquake** is caused by the breaking and shifting of rock beneath the Earth's surface. Ground shaking from earthquakes can collapse buildings and bridges; disrupt gas, electric, and phone service; and sometimes trigger landslides, avalanches, flash floods, fires, and huge, destructive ocean waves (tsunamis). The municipality of San Sebastián has no recent historic memory of liquefaction. The areas of greatest potential for this hazard are in the coastal sandy places. However, per Tuttle, et al (2005), several large to very large earthquakes have occurred in Puerto Rico during the last 400 years. One of the most remembered is the 1918 earthquake which induced liquefaction in the valley of Río Añasco and a tsunami in the west coast resulting in at least 114 death and $4 million in damages.

Given the geology and hydrogeology of the Municipality of San Sebastián, the Pueblo Ward is surrounded by Moderate to High **liquefaction** hazard areas.

Hurricane is a type of tropical cyclone, the generic term for a low-pressure system that generally forms in the tropics. A typical cyclone is accompanied by thunderstorms, and a counterclockwise circulation of winds near the earth's surface.

Due to the limited availability of budget resources, this mitigation planning effort has, at least initially, evaluated seven (7) natural hazards (earthquake, earthquake induced landslide, flood, high winds (hurricane), liquefaction, rain induced landslide, and wildfire). The Municipality may attempt to expand the scope of this HMP to include other less frequent natural hazards and/or additional technological and man-made (for example, transportation, terrorism) hazards as resources permit.

Table 4-2
Identification of Hazards of Concern

Hazard	Step 1 Is this a hazard that may occur in the Municipality of San Sebastián?	Step 2 If yes, does this hazard pose a significant threat to the Municipality?	Step3 Why was this determination made?
Coastal Erosion / Coastal Storm	No	N/A	• The Municipality of San Sebastián is not bounded by coastal waters; therefore, it is not directly impacted by coastal storms that result in coastal erosion.
Drought	Yes	No	• The State Plan for the Mitigation of Natural Hazards in Puerto Rico include drought as one of the dangers that could affect the island, however, Puerto Rico do not experience extreme drought conditions frequently. • According to FEMA, the two most recent drought conditions that have required Federal assistance correspond to May 26, 1964 (Presidential Disaster Declaration No. 170 due to extreme drought conditions) and August 29, 1974 (Presidential Statement Emergency No. 3002 due to drought impacts).

Hazard	Step 1 Is this a hazard that may occur in the Municipality of San Sebastián?	Step 2 If yes, does this hazard pose a significant threat to the Municipality?	Step3 Why was this determination made?
			• The most affected by drought areas are located southeast of the island due to climatic and topographic conditions.
Earthquake / Earthquake Induced Landslide	Yes	Yes	• FEMA identifies earthquake as a hazard. • The State Plan for the Mitigation of Natural Hazards in Puerto Rico includes Earthquake as one of the dangers that could affect the island. • In 2016, the Puerto Rico Seismic Network identified 26 earthquake tremors reported as felt. • A total of 1 earthquake event with magnitude equal or greater than 5.0 have been reported in Puerto Rico (2016).
Flood (Riverine, Flash, Stormwater)	Yes	Yes	• FEMA identifies flooding as hazard. • The State Plan for the Mitigation of Natural Hazards in Puerto Rico includes Flood as one of the dangers that could affect the island. • A total of 3 FEMA Disaster Declarations has been issue for severe storm events, some also identified as flooding events. o FEMA-4040-DR - Tropical Storm María, Declared October 18, 2011. Declaration for Individual Assistance for three municipalities (Juana Díaz, Naguabo, and Yabucoa) and Hazard Mitigation island-wide. o FEMA-4017-DR – Hurricane Irene, Declared August 27, 2011. Declaration for Individual Assistance for seven municipalities (Caguas, Canóvanas, Carolina, Cayey, Loíza, Luquillo, and San Juan) and Hazard Mitigation island-wide. Primary impact: damage to roads and bridges. o FEMA-4004-DR - Severe Storms, Flooding, Mudslides, and Landslides, Declared July 14, 2011. Declaration for Public Assistance for 12 municipalities (Añasco, Caguas, Camuy, Ciales, Hatillo, Las Piedras, Morovis, Orocovis, San Lorenzo, San Sebastián, Utuado, and Villalba) and Hazard Mitigation island-wide. Primary impact: damage to roads and bridges.
Hurricane and Severe Storms	Yes	Yes	• FEMA identifies Hurricane as hazard. • The State Plan for the Mitigation of Natural Hazards in Puerto Rico includes Hurricanes (strong winds) as one of the dangers that could affect the island. • A total of five (5) high wind (tropical storm, hurricane and severe storm) events, including FEMA declarations for Puerto Rico have occurred since 2011 - 2017. o FEMA-4040-DR - Tropical Storm María, Declared October 18, 2011. Declaration for Individual Assistance

Hazard	Step 1 Is this a hazard that may occur in the Municipality of San Sebastián?	Step 2 If yes, does this hazard pose a significant threat to the Municipality?	Step3 Why was this determination made?
			for three municipalities (Juana Díaz, Naguabo, and Yabucoa) and Hazard Mitigation island-wide. o FEMA-4017-DR – Hurricane Irene, Declared August 27, 2011. Declaration for Individual Assistance for seven municipalities (Caguas, Canóvanas, Carolina, Cayey, Loíza, Luquillo, and San Juan) and Hazard Mitigation island-wide. o FEMA-4004-DR - Severe Storms, Flooding, Mudslides, and Landslides, Declared July 14, 2011. Declaration for Public Assistance for 12 municipalities (Añasco, Caguas, Camuy, Ciales, Hatillo, Las Piedras, Morovis, Orocovis, San Lorenzo, San Sebastián, Utuado, and Villalba) and Hazard Mitigation island-wide. o FEMA-4336-DR- Hurricane Irma, declared on September 10, 2017. Designated Counties for Public Assistance: Naguabo, Las Piedras, Juncos, Gurabo, Carolina, San Juan, Guaynabo, Bayamon, Aguas Buenas, Comerio, Barranquitas, Orocovis, Ciales, Jayuya, Utuado, Adjuntas, Yauco, Hatillo, Camuy, Quebradillas, Patillas, Salinas. Designated Counties for Individual Assistance: Fajardo, Toa Baja. Designated Counties for Individual Assistance and Public Assistance: Vieques, Culebra, Luquillo, Loiza, Canóvanas, Toa Baja, Dorado, Vega Baja o FEMA-4339-DR – Hurricane Maria, signed by the President on September 20, 2017, all 78 Municipalities of the Commonwealth of Puerto Rico have been designated adversely affected by the disaster. All designated areas in the State of Puerto Rico are eligible to apply for assistance under the Hazard Mitigation Grant Program: Individual Assistance and Public Assistance (Categories A – G).
Liquefaction	Yes	Yes	• The State Plan for the Mitigation of Natural Hazards in Puerto Rico includes Liquefaction (earthquakes) as one of the dangers that could affect the island. • In the wards of Pueblo, Cruz, Voladoras, Rocha, and Capá, there are areas where liquefaction is considered from moderate, high, to very high hazard. • Tuttle, et al. (2005) found and studied 27 liquefaction features along Río Culebrinas. Their analysis suggests that the earthquake occurred in 1670 appears to produced liquefaction features along Río Culebrinas.
Rain-Induced Landslide	Yes	Yes	• The State Plan for the Mitigation of Natural Hazards in Puerto Rico includes Rain-Induced Landslides as one of the dangers that could affect the island. • Between 2011 and 2017, FEMA declared Puerto Rico experienced one landslide-related disasters (DR) classified as

Hazard	Step 1 Is this a hazard that may occur in the Municipality of San Sebastián?	Step 2 If yes, does this hazard pose a significant threat to the Municipality?	Step3 Why was this determination made?
			one or a combination of the following: severe storms, flooding, mudslides, landslides, and/or tropical storm. o FEMA-4004-DR - Severe Storms, Flooding, Mudslides, and Landslides, Declared July 14, 2011. Declaration for Public Assistance for 12 municipalities (Añasco, Caguas, Camuy, Ciales, Hatillo, Las Piedras, Morovis, Orocovis, San Lorenzo, San Sebastián, Utuado, and Villalba) and Hazard Mitigation island-wide.
Tsunami	No	N/A	• The State Plan for the Mitigation of Natural Hazards in Puerto Rico includes Tsunami as one of the dangers that could affect the island. • Tsunami is not identified as a hazard of concern in the Municipality of San Sebastián. • The Municipality of San Sebastián is not bounded by coastal waters.
Wildfire	Yes	Yes	• The State Plan for the Mitigation of Natural Hazards in Puerto Rico includes wildfires as hazard • Between January 1st and 25th, a total of 314 wildfires were reported across the west, west interior, southwest, south and southeast sections of Puerto Rico due to low relative humidity, moderate strong winds and a lack of rainfall. A total of 4,868 acres of land were burned. Damages were estimated at over $371,000. A total of 65 wildfires burned 127 acres in the municipalities of Añasco, Moca, Rincón, Aguada, Mayaguez, Hormigueros and San Germán.

4.3.1 Hazard Selection and Prioritization

This process included identifying an initial list of hazards and then selecting hazards of interest specifically relevant to the study area. During the first HMP Planning Committee held on March 1, 2018, the Municipality of San Sebastián identified a preliminary list of hazards of concern (**Table 4-2**).

From the list of nine (9) hazards of concern, the Planning Committee selected seven (7) as hazards of interest for the Municipality. These seven hazards include earthquake (ground shaking, earthquake-induced, landslide), high wind (including hurricane and tropical storm,) wildfire, and flooding (Riverine). **Table 4-3** summarizes the hazards of interest selected, historical event data, and sources identified and used for the project.

Table 4-3
Summary of Hazards of Interest for Municipality of San Sebastián

Hazard	Years	No. of Events	Potential/Significant Impacts	Available Data Sources and Maps
Earthquake (including Ground Shaking, Liquefaction, - Induced Landslide)	1918 to Present	11 major	Light to significant damages reported with these events. Note that in 2002, 967 earthquakes were reported in the Puerto Rico zone.	University of Puerto Rico Seismic Network, Integrated Hazard Assessment for Puerto Rico
High Wind (including Hurricanes and Tropical Storms)	1981 to 2018	26	Hurricane Hugo, Marilyn, Hortense and Georges. Hortense caused approx. 350,000 in damage to public infrastructure, while Georges caused the biggest impact on the Municipality. Others storms that impact the jurisdiction was Debby, Jeanne, Noel, Olga and Fay. The two most recent Hurricanes were Irma and María, a Category 4 (almost 5) system that hit Puerto Rico from southeast to northwest.	National Weather Service (www.srh.noaa.gov/), Municipality of San Sebastián
Riverine Flooding	1972 to present	major	1972 Rio Culebrinas (exceeded 30,000 cubic feet per second) 1975 Flooding associated with Tropical Storm Eloise was estimated to exceed a 50-year flood event. 1999 Rio Culebrinas went out of its banks flooding many sectors in San Sebastián	National Climate Data Center, USACE, Municipality of San Sebastián
Wildfire Landslide Induced by Rain	2017 - 2018		2017 – 24 wildfires January – April 23, 2018 – 30 wilfires.	Stg. Soto – Fire Department, Aguadilla Region

Note: Modified from FEMA 386-2, Worksheet No. 1 (FEMA 2001).

4.3.2 HAZARD DESCRIPTION

Earthquake Ground Shaking: Hazard Description

Puerto Rico is in the limit between the plates of North America and the Caribbean, an area of oblique sub-duction and lateral displacement between these two plates. The seismic activity is concentrated in eight zones listed below and shown in **Figure 4-6**:

- Puerto Rico Trench
- Slope faults at north and south of Puerto Rico
- North east of "Zona del Sombrero"
- To the west, at the Mona Canyon
- Mona Passage
- To the east, in the depressions of Virgin Islands and Anegada
- "Muertos" Depression to the south
- Southeast of Puerto Rico

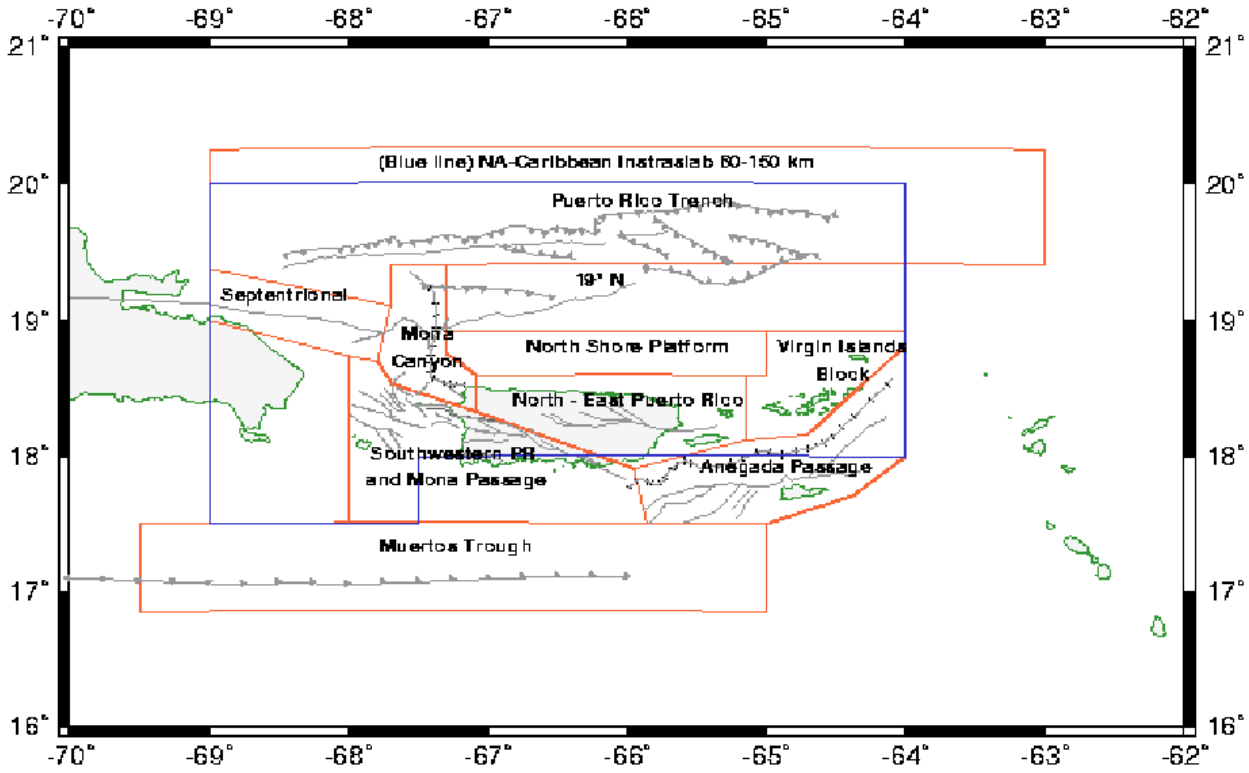

Figure 4-6 Ground Shaking Hazard Map

Earthquakes represent a particularly severe threat because of the irregular time intervals between events, the lack of adequate forecasting, and the catastrophic damage that can occur from a major event. An

earthquake is caused by the release of energy accumulated within or along the edge of the earth's tectonic plates. It is characterized by sudden ground shaking. The severity of an earthquake depends on the location of the seismic event (its epicenter) and the amount of energy released. As it occurs, the seismic waves radiate away from the earthquake location causing the ground to shake. The severity of the shaking increases with the amount of energy released and decreases with distance from the location of the earthquake. The ground shaking from the earthquake may be felt hundreds of miles from where it occurred. The intensity of the ground shaking is the result of several factors including the magnitude and type of earthquake, distance from the earthquake, soil conditions of the area, and the orientation of the site relative to the earthquake occurrence.

Earthquake Liquefaction: Hazard Description

Liquefaction is a phenomenon that causes areas of unconsolidated soils and high water tables to lose strength and act like viscous fluid when subjected to earthquake ground shaking. The frequency and intensity of liquefaction that can occur during an earthquake is based on several factors, including the geologic conditions of the area, groundwater depth, ground shaking intensity, and the magnitude of the earthquake.

Earthquake-Induced Landslide: Hazard Description

Landslides are abrupt movements of materials that become detached from slopes or cliffs; they move by free-fall, sliding, or slumping. Earthquake-induced landslides can occur in natural slopes, cut slopes in soil or weathered rock, or fill slopes. They are common where steep cut slopes are present in relatively shallow soils over un-weathered or fractured rock. The frequency and intensity of landslides that can occur during an earthquake is the result of several factors, including the geologic materials of the area, the slope, the water content of the slide material, the earthquake ground shaking, and the magnitude of the earthquake.

High Wind: Hazard Description / Extent

The extent (that is, magnitude or severity) of a specific storm (thunderstorm, tropical cyclone, tropical depression, tropical storm, and hurricane) is largely dependent upon sustained wind speed. Straight-line winds, winds that come out of a thunderstorm, in extreme cases, can cause wind gusts exceeding 100 mph. These winds are most responsible for hailstorm and thunderstorm wind damage.

The extent of a hurricane is categorized by the Saffir-Simpson Hurricane Scale. This scale categorizes or rates hurricanes from 1 (Minimal) to 5 (Catastrophic) based on their intensity. This is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on the slope of the continental shelf and the shape of the coastline, in the landfall region (National Hurricane Center [NHC], 2009). **Table 4-4** presents this scale, which is used to estimate the potential property damage and flooding expected when a hurricane makes land fall.

Table 4-4
Saffir-Simpson Hurricane Scale Definition

Category	Wind Speed (mph)	Storm Surge (feet above normal sea level)	Expected Damage
1	74–95	4–5	**Minimal:** Damage is done primarily to shrubbery and, trees unanchored mobile homes are damaged, some signs are damaged, no real damage is done to structures.
2	96–110	6–8	**Moderate:** Some trees are toppled, some roof coverings are damaged, and major damage is done to mobile homes.
3	111–130	9–12	**Extensive:** Large trees are toppled, some structural damage is done to roofs, mobile homes are destroyed, and structural damage is done to small homes and utility buildings.
4	131–155	13–18	**Extreme:** Extensive damage is done to roofs, windows, and doors, roof systems on small buildings completely fail, some curtain walls fail.
5	> 155	> 18	**Catastrophic:** Roof damage is considerable and widespread, window and door damage is severe, there are extensive glass failures and entire buildings could fail.

Source: Understanding Your Risks: Identifying Hazards and Estimating Losses. FEMA. 2001.

Riverine Flooding: Hazard Description

Flooding is defined as the accumulation of water within a water body and the overflow of excess water onto adjacent floodplain lands. Riverine flooding occurs when the volume of water exceeds that capacity of stream channel. Water overflows banks and causes flooding.

Flooding events have had substantial impacts on residents and property in San Sebastián. The most serious flooding problems are associated with the Rio Culebrinas and its tributaries. Flooding has caused extensive property damage, blocked roads, disrupted economic activities by shutting down critical facilities, and has caused repetitive damages to residential areas.

The Rio Culebrinas basin has a drainage area of 103 square miles (267 square kilometers). The river flows in a westerly direction from the central mountain range, through the towns of San Sebastián and Moca, before entering in the Municipality of San Sebastián. There have been 38 major floods on this river system since 1900 (US Army Corps of Engineers, 2002). The alluvial flood plain of Rio Culebrinas encompasses approximately 1,500 acres of land in the Municipalities of San Sebastián and Aguada. The USACE estimates that during a 100-year flood on the Rio Culebrinas, over 560 structures would be subject to flooding (USACE 2002).

WILDFIRE: HAZARD DESCRIPTION

Wildfire caused intentionally, accidentally or incidentally, by the fire that occurs in vegetated areas, trees and busters.

Dry conditions at various times of the year and in various parts of San Sebastián greatly increase the potential for wildfires. This type of fire cause major damage to infrastructure and weaken the side hills stability. Post-fire debris flows are particularly hazardous because they can occur with little warning, can exert great impulsive loads on objects in their paths, can strip vegetation, block drainage ways, damage structures, and endanger human life. Wildfires could potentially result in the destabilization of pre-existing deep-seated landslides over long time periods

Fire is any fire that occurs in a unwanted manner. The fire is the result of oxidation reactions of contact of a fuel with some heat. Urban Fires in San Sebastián may involve buildings, residences, warehouses and industries with potential for spread to adjoining structures. The urban fire hazard may involve areas where single family homes, multi-family occupancies and/or business facilities are clustered close together, increasing the possibility of rapid spread to another structure:

- Residential accidents (improper use of electrical appliances, faulty connections, grease fires, smoking, heating appliances or improper disposal of wood ashes).
- Industrial accidents (hazardous material incidents, explosions, transportation accidents)
- Acts of nature (lightning strikes, earthquake byproduct)
- Criminal acts (arson, illegal explosive devices, acts of terrorism)

RAINFALL- INDUCED LANDSLIDE: HAZARD DESCRIPTION

Rainfall-induced landslides are common in Puerto Rico. The presence of steep slopes in mountainous terrain, coupled with weathered soils and intense rainfall, leads to severe slope-stability problems throughout the island. Episodic triggering events such as hurricanes and earthquakes further exacerbate these problems. All physiographic provinces of the island have experienced landslides. The stability of natural and man-made slopes is a serious concern for government authorities and the civil engineering community in Puerto Rico. In this plan, we will present an overview of the rainfall induced landslide problem in San Sebastián, a summary of existing literature published on this subject, and proposes a rainfall intensity landslide threshold based on landslide events data. This threshold can be used as a potential landslide warning criterion.

4.4 PROFILE OF HAZARDS

This subsection includes data and information used to profile priority hazards in the Municipality of San Sebastián. This information is presented in the following format:

- hazard location, extent and distribution;
- known history of hazard occurrences[9];

[9] The description of history of hazards was based on research, interviews with municipal emergency management staff, and comments received from the public during workshops. A thorough review of hazard documents and interviews revealed that data was not readily available. Where data was not available, the project consultant team relied on hazard history data for the whole of Puerto Rico.

- frequency and magnitude as it relates to the risk assessment analysis and for determining the probability of future events; and

Please note that the information to compile a comprehensive history of hazards was very limited. Municipal staff, along with the consultant project team, worked diligently to gather information from a variety of sources including national data warehouses, local and regional emergency management offices, community workshops, and interviews with residents.

4.4.1 HAZARD PROFILE: EARTHQUAKE GROUND SHAKING

Earthquake Ground Shaking: Hazard Location, Extent and Distribution

The ground shaking hazard is most severe in areas of deep, unconsolidated alluvial sediments. These areas are susceptible to amplification of peak ground acceleration (PGA) during an earthquake. The extent and distribution of the ground shaking hazard in San Sebastián is varied because:

- The high and very high ground shaking hazard areas are well distributed throughout the Municipality.
- A major earthquake will lead to significant loss of life and the disruption of critical facilities, infrastructure and lifelines, especially in urban center. Resulting damages will severely impair emergency response and recovery functions.
- Residential and commercial losses are expected to be concentrated among buildings that are not designed to current International Building Code (IBC) standards (i.e. multi-story concrete buildings and older un-reinforced masonry structures, many of which are located in the urban center).

Earthquake Ground Shaking: Hazard History

As depicted above, San Sebastián falls into a relatively active seismic zone. During 2003 the PRSN located 947 earthquakes, this represents a decrease of 2.07% compared with the previous year (2002, 967 earthquakes).

The last major earthquake to strike in Puerto Rico was on October 11, 1918. The epicenter was in the Mona Canyon (between Puerto Rico and the Dominican Republic). This earthquake had an approximate magnitude of 7.5 on the Richter scale and was accompanied by a tsunami ("tidal" wave) which got up to 6 meters (19.5 feet) high. Damage was concentrated in the western area of the Island because this was the closest zone to the earthquake. The earthquake and tsunami killed about 116 people and caused more than 4 million dollars of damage. Numerous houses, factories, public buildings, chimneys, bridges and other structures suffered severe damage[10].

Table *4-5* provides a list of major earthquakes in the Island from 1918 to 2010.

[10] *M* is the magnitude that reflects the energy released by the earthquake. If it is not specified that the intensity is RF (Rossi Forell), it is MM (Modified Mercalli). Data compiled by University of Puerto Rico, Puerto Rico Seismic Network.

Table 4-5 Major Earthquakes occurred in Puerto Rico 1918 - 2010

Hazard	Date	Area Affected	Severity/Hazard Intensity	Damages/Economic Impact
Earthquake / Tsunami	October 18, 1918	Western Puerto Rico, Including San Sebastián	M= 7.5	Damage severe on western side of island. 4 million, 116 people dead
Aftershock of an earthquake of the 10/11/1918.	October 24, 1918	Western Puerto Rico, Including San Sebastián	Maximum intensity in the island was VII (RF).	Unknown
Aftershock of an earthquake of the 10/11/1918.	November 12, 1918	Western Puerto Rico, Including San Sebastián	Maximum intensity in the island was VI (RF, RT).	Unknown
Earthquake	February 10, 1920	Earthquake felt in all Puerto Rico	Maximum intensity was VI (DH), M=6.5	Unknown
Earthquake	December 18, 1922	Earthquake felt in all Puerto Rico	Maximum intensity in the island was VI (DH), M=6.3	Unknown
Earthquake	June 12, 1939	Earthquake felt in all Puerto Rico	Maximum intensity in the island was VI (DH)	Unknown
Earthquake	July 28, 1943	Earthquake occurred to the northwest of Puerto Rico	M=7.5 (PS)	Many people around Puerto Rico felt the event but it did not cause damages.
Earthquake/Tsunami	August 4, 1946	Intensity of up to VI in the Mona Island and the western coast of Puerto Rico. In the rest of the island an intensity of V was reported. A tsunami of 2 feet was observed in the western and north coast of the island.	This earthquake of magnitude 7.8 (PS)	Smaller damages in all Puerto Rico were reported (DH).
Earthquake / Tsunami	August 8, 1946	Earthquake in Dominican Republic Small tsunami in Mayagüez and San Sebastián	M=7.4	Unknown

Hazard	Date	Area Affected	Severity/Hazard Intensity	Damages/Economic Impact
Earthquake	March 23, 1979	Strong earthquake felt throughout the Caribbean; in Puerto Rico.	M=6.1, it was felt with Unknown an intensity of VI	Unknown
Earthquake	May 30, 1987	Strong earthquake felt in the southwest of the island, M=4.6, intensity VI. Epicenter near Boquerón.	There were light Unknown damages (USGS).	Unknown
Earthquake	Dec 24, 2010	Strong earthquake felt in the entire Island, Epicenter Central Region	M=5.4 intensity VI.	Unknown
Earthquake	Jan 13, 2014	Location: 19 N Fault Zone; deep: 36 km	M=6.4 mwp; Estimated Maximum Intensity: V in Arecibo, PR	Unknown

Source: University of Puerto Rico, Puerto Rico Seismic Network, USGS

Earthquake Ground Shaking: Hazard Frequency and Magnitude

The frequency of the ground shaking hazard event is based on a 100-year return period—the municipality has a 1 percent annual probability of observing the losses shown in the loss estimates subsection of this risk assessment. Statistical analysis was used to PGA values range from .10 to .50 and was broken into five hazard level determinations ranging from very low to very high. This is the best available information to determination the probability and magnitude of future hazard events. The following is a summary of annual earthquakes in the region of P.R. This report summarizes the frequency and magnitude as per reported by the Seismic Network of P.R.

2018

During 2013 the Seismic Network of P.R (SNPR) localized 1,293 earthquakes between latitude 17.00-20.00 N and longitude 63.5-69 W. 3 of these earthquakes were reported as "felt". These movements were reported and varied from a 3.83 to 4.40 magnitude. The depth of these earthquakes varied from 11 km to 17 km.

2017

During 2013 the Seismic Network of P.R (SNPR) localized 1,567 earthquakes between latitude 17.00-20.00 N and longitude 63.5-69 W. 3 of these earthquakes were reported as "felt". These movements were reported and varied from a 3.54 to 4.00 magnitude. The depth of these earthquakes varied from 4 km to 75 km.

2016

During 2013 the Seismic Network of P.R (SNPR) localized 1,422 earthquakes between latitude 17.00-20.00 N and longitude 63.5-69 W. 8 of these earthquakes were reported as "felt". These movements were reported and varied from a 2.90 to 4.55 magnitude. The depth of these earthquakes varied from 5 km to 114 km.

2015

During 2013 the Seismic Network of P.R (SNPR) localized 871 earthquakes between latitude 17.00-20.00 N and longitude 63.5-69 W. 8 of these earthquakes were reported as "felt". These movements were reported and varied from a 2.23 to 4.05 magnitude. The depth of these earthquakes varied from 5 km to 25 km.

2014

During 2013 the Seismic Network of P.R (SNPR) localized 1,648 earthquakes between latitude 17.00-20.00 N and longitude 63.5-69 W. 17 of these earthquakes were reported as "felt". These movements were reported and varied from a 2.65 to 6.4 magnitude. The depth of these earthquakes varied from 7 km to 127 km.

2013

During 2013 the Seismic Network of P.R (SNPR) localized 789 earthquakes between latitude 17.00-20.00 N and longitude 63.5-69 W. 13 of these earthquakes were reported as "felt". These movements were reported and varied from a 2.67 to 5.12 magnitude. The depth of these earthquakes varied from 4 km to 96 km.

2012

During 2012 the Seismic Network of P.R (SNPR) localized 2,849 earthquakes between latitude 17.00-20.00 N and longitude 63.5-69 W. 170 of these earthquakes were reported as "felt". These movements were reported and varied from a 6.4 to 20 magnitude. The depth of these earthquakes varied from 4 km to 179 km.

2010

During 2010 the Seismic Network of P.R (SNPR) localized 1,681 earthquakes between latitude 17.00-20.00 N and longitude 63.5-69 W. 68 of these earthquakes were reported as "felt" and 66 were in our region. These movements were reported and varied from a 1.01 to 5.70 magnitude. The depth of these earthquakes varied from 0.3 km to 200.7 km. The majority of these earthquakes were felt in all the island of P.R.

2009

During 2009 the Seismic Network of P.R (SNPR) localized 2,739 earthquakes between latitude 17.00-20.00 N and longitude 63.5-69 W. 45 of these earthquakes were reported as "felt" and 43 were in our region. These movements were reported and varied from a .5 to 5.2 magnitude. The depth of these earthquakes varied from 3.1 km to 115 km. The majority of these earthquakes were felt in all the island of P.R.

2008

During 2008 the Seismic Network of P.R (SNPR) localized 2,574 earthquakes between latitude 17.00-20.00 N and longitude 63.5-69 W. 53 of these earthquakes were reported as "felt" and 51 were in our region. These movements were reported and varied from a 1.01 to 5.70 magnitude. The depth of these earthquakes varied from 3.44 km to 119 km. The majority f these earthquakes were felt in all the island of P.R.

2007

During 2007 the Seismic Network of P.R (SNPR) localized 2,349 earthquakes between latitude 17.00-20.00 N and longitude 63.5-69 W. 49 of these earthquakes were reported as "felt" all in our region. These movements were reported and varied from a 0.3 to 4.9 magnitude. The majority of these earthquakes were felt in all the island of P.R.

2006

During 2006 the Seismic Network of P.R (SNPR) localized 2,253 earthquakes between latitude 17.00-20.00 N and longitude 63.5-69 W. 25 of these earthquakes were reported as "felt" all in our region. The majority of these earthquakes were felt in all the island of P.R.

2005

During 2005 the Seismic Network of P.R (SNPR) localized 1,086 earthquakes between latitude 17.00-20.00 N and longitude 63.5-69 W. 18 of these earthquakes were reported as "felt" all in our region. The majority of these earthquakes were felt in all the island of P.R.

2004

During 2004 the Seismic Network of P.R (SNPR) localized 1,047 earthquakes between latitude 17.00-20.00 N and longitude 63.5-69 W. 16 of these earthquakes were reported as "felt" all in our region. The majority of these earthquakes were felt in all the island of P.R.

Tectonic and seismic frequency map of Puerto Rico is shown in (**Figure 4-7**). Arrows show direction of plate movements. USGS (2011). **Figure 4-8** shows the Puerto Rico Trench area. Perspective view of the sea floor of the Atlantic Ocean and the Caribbean Sea. The Lesser Antilles are on the lower left side of the view and Florida is on the upper right. The purple sea floor at the center of the view is the Puerto Rico trench, the deepest part of the Atlantic Ocean and the Caribbean Sea.

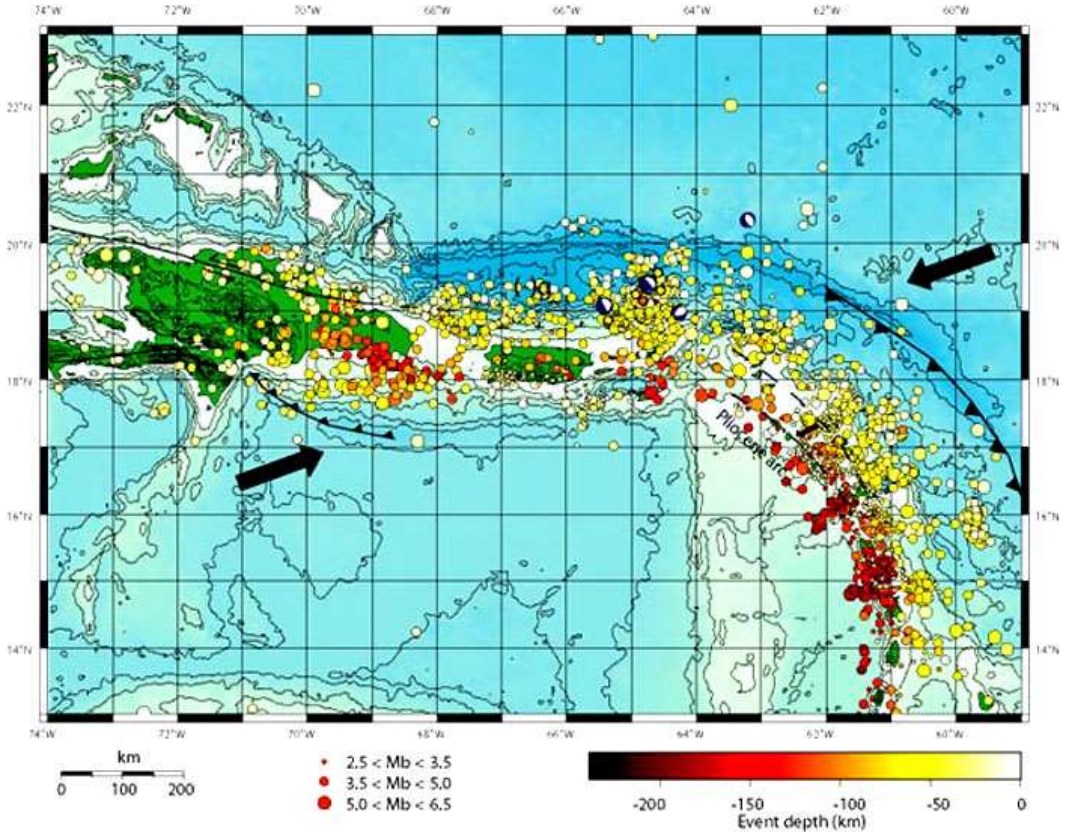

Figure 4-7 Tectonic and Seismic Frequency Map of Puerto Rico (2011)[11]

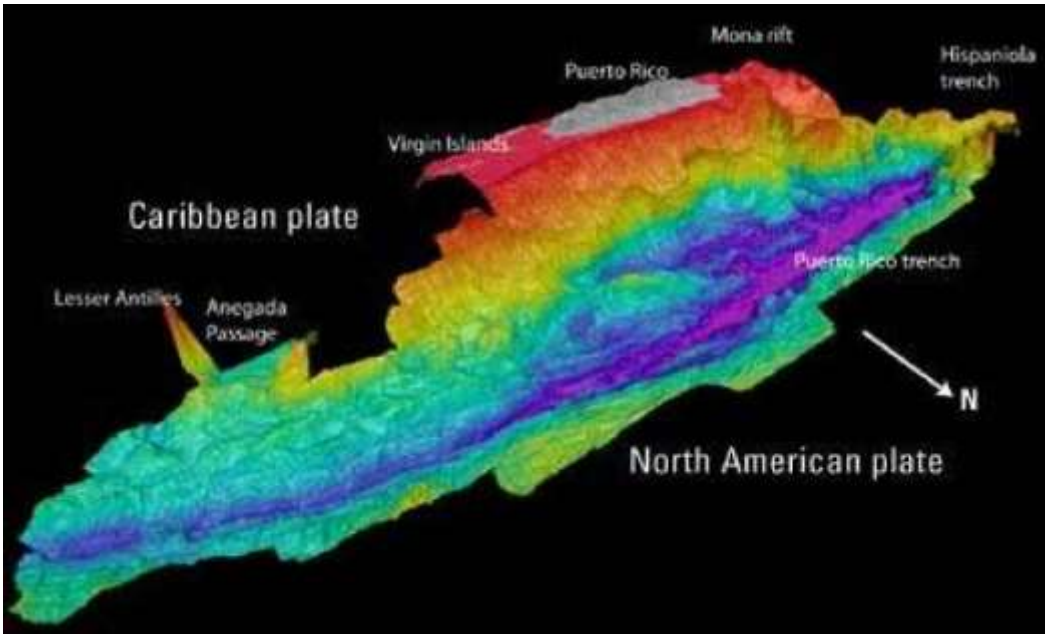

Figure 4-8 Puerto Rico Trench

[11] https://www.bibliotecapleyades.net/imagenes_ciencia/tsunami_earthquake62_08.jpg

4.4.2 HAZARD PROFILE: LIQUEFACTION

Liquefaction: Hazard Location, Extent and Distribution

The liquefaction hazard generally occurs in areas of deep, unconsolidated alluvial sediments. These areas are usually found in areas with high water tables. The urban center of San Sebastián is located in this area of unconsolidated alluvial sediments and many of the older historic buildings were constructed using un-reinforced masonry construction practices.

The extent and distribution of the liquefaction hazard in San Sebastián is varied because:

- Liquefaction hazard incrementally increases the damage (in addition to the ground shaking damage) to buildings due to the ground deformation.
- Low to moderate hazard level distribution throughout the remainder of municipality is not of great concern due to low densities of vulnerable structures (i.e. multi-story buildings).

Liquefaction: Hazard History

As discussed earlier in this section, hazard history data specific to San Sebastián does not exist for some hazards identified in this section, including the liquefaction hazard. Information on previous occurrences is not available.

Liquefaction: Hazard Frequency and Magnitude

The frequency of the liquefaction hazard event is based on a 100-year return period—the municipality has a 1 percent annual probability of observing the losses shown in the loss estimates subsection of this risk assessment. PGA values range from .10 to .50. The likelihood of a liquefaction event is conditional based on the abovementioned PGA values. Conditional probability was based on hazard levels on ground shaking map. At a PGA value of .50, areas with a very high-low ground shaking hazard level, the conditional probability for liquefaction was assumed to be 1%; for Very High 25%. Statistical analysis was used to break the range of conditional probability percentages into five hazard level determinations ranging from very low to very high.

4.4.3 Hazard Profile: Earthquake-Induced Landslide

Earthquake-Induced Landslide: Hazard Location, Extent and Distribution

In San Sebastián, moderate to high earthquake-induced landslide hazard intensity areas coincide with ground shaking and liquefaction hazard areas. This is due to the predominance of soft soils. However, potential damages related to this hazard are more likely to occur in mountainous areas that coincide with moderate ground shaking hazard levels. Figure 4 illustrates the varying susceptibility of geological materials in San Sebastián to earthquake-induced landslides.

The extent and distribution of earthquake-induced landslides is varied because:

- Damages from Earthquake-Induced Landslide hazard are expected to be significantly lower than earthquake ground shaking.

- The area's most prone to earthquake-induced landslides are steeply sloping land and land with unconsolidated consolidated sediments.
- Earthquake-induced landslides can threaten residential structures and infrastructure lifelines, particularly development along PR 2, PR 110, and the entrance of the urban center.

Earthquake-Induced Landslide: Hazard History

As discussed earlier in this section, hazard history data specific to San Sebastián does not exist for some hazards identified in this section, including the earthquake-induced landslide hazard. Information on previous occurrences is not available. Nevertheless, minor earthquakes have occurred causing some minor damages in recent years.

Earthquake-Induced Landslide: Hazard Frequency

The frequency of the earthquake-induced landslide hazard event is based on a 100-year return period—the municipality has a 1 percent annual probability of observing the losses shown in the loss estimates subsection of this risk assessment. PGA values range from .10 to .50. The likelihood of an earthquake induced landslide is conditional based on the abovementioned PGA values. Conditional probability was based on hazard levels. At a PGA value of .50 areas with a very high low ground shaking hazard level, the conditional probability for liquefaction was assumed to be 1%; for Very High 30%. The PGA values and soil and geology were used to break the PGA values into five hazard level determinations ranging from very low to very high.

4.4.4 Hazard Profile: High Wind

High Wind: Hazard Location, Extent and Distribution

For this HMP and as deemed appropriated by San Sebastián, the hurricane wind hazard includes windstorms, thunderstorms, and tropical cyclones (e.g. hurricanes, tropical storms, and tropical depressions), which are defined below.

Windstorm: Per the Federal Emergency Management Agency (FEMA), wind is air moving from high to low pressure. It is rough horizontal movement of air (as opposed to an air current) caused by uneven heating of the Earth's surface. It occurs at all scales, from local breezes generated by heating of land surfaces and lasting tens of minutes to global winds resulting from solar heating of the Earth (FEMA, 1997). A type of windstorm that is experienced often during rapidly moving thunderstorms is a derecho. A derecho is a widespread and long-lived windstorm associated with thunderstorms that are often curved in shape (Johns et al., 2011). The two major influences on the atmospheric circulation are the differential heating between the equator and the poles, and the rotation of the planet. Windstorm events are associated with cyclonic storms (tropical storms and hurricanes), thunderstorms and tornadoes (FEMA, 1997).

Thunderstorm: According to the National Weather Service (NWS), a thunderstorm is a local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder (NWS, 2005). A thunderstorm forms from a combination of moisture, rapidly rising warm air and a force capable of lifting air such as a warm and cold front, a sea breeze, or a mountain. Thunderstorms form from the equator to as far north as Alaska. These storms occur most commonly in the tropics. Many tropical land-based locations experience over 100 thunderstorm days each year (Pidwirny, 2007). Although thunderstorms generally

affect a small area when they occur, they are very dangerous because of their ability to generate tornadoes, hailstorms, strong winds, flash flooding, and damaging lightning. A thunderstorm produces wind gusts less than 57 mph and hail, if any, of less than 3/4-inch diameter at the surface. A severe thunderstorm has thunderstorm related surface winds (sustained or gusts) of 57 mph or greater and/or surface hail 3/4-inch or larger (NWS, 2005). Wind or hail damage may be used to infer the occurrence/existence of a severe thunderstorm (Office of the Federal Coordinator for Meteorology, 2001).

Tropical Cyclone: Tropical cyclone is a generic term for a cyclonic, low-pressure system over tropical or sub-tropical waters, containing a warm core of low barometric pressure which typically produces heavy rainfall, powerful winds and storm surge (National Hurricane Center [NHC], 2011). It feeds on the heat released when moist air rises and the water vapor in it condenses (Dorrego, Date Unknown). Depending on their location and strength, tropical cyclones can be known as any of the following: hurricane, typhoon, tropical storm, cyclonic storm and tropical depression (Pacific Disaster Center, 2006). While tropical cyclones begin as a tropical depression, meaning the storm has sustained winds below 38 mph, it may develop into a tropical storm (with sustained winds of 39 to 73 mph) or a hurricane (with winds of 74 mph and higher).

Tropical Depression: A tropical depression is an organized system of clouds and thunderstorms with a defined surface circulation and maximum sustained winds of less than 38 mph. It has no "eye" (the calm area in the center of the storm) and does not typically have the organization or the spiral shape of more powerful storms (Emanuel, Date Unknown; Miami Museum of Science, 2000).

Tropical Storm: A tropical storm is an organized system of strong thunderstorms with a defined surface circulation and maximum sustained winds between 39 and 73 mph (FEMA, 2007). Once a storm has reached tropical storm status, it is assigned a name. During this time, the storm itself becomes more organized and begins to become more circular in shape, resembling a hurricane. The rotation of a tropical storm is more recognizable than a tropical depression. Tropical storms can cause a lot of problems, even without becoming a hurricane; however, most of the problems stem from heavy rainfall (University of Illinois, Date Unknown).

Hurricane: A hurricane is an intense tropical cyclone with wind speeds reaching a constant speed of 74 mph or more (FEMA, 2004). It is a category of tropical cyclone characterized by thunderstorms and defined surface wind circulation. They are caused by the atmospheric instability created by the collision of warm air with cooler air. They form in the warm waters of tropical and sub-tropical oceans, seas, or Gulf of Mexico (NWS, 2000). Most hurricanes evolve from tropical disturbances. A tropical disturbance is a discrete system of organized convection (showers or thunderstorms), that originate in the tropics or subtropics, does not migrate along a frontal boundary, and maintains its identity for 24 hours or more (NWS, 2004). Hurricanes begin when areas of low atmospheric pressure move off the western coast of Africa and into the Atlantic, where they grow and intensify in the moisture-laden air above the warm tropical ocean. Air moves toward these atmospheric lows from all directions and circulates clock-wise under the influence of the Coriolis effect, thereby initiating rotation in the converging wind fields. When these hot, moist air masses meet, they rise up into the atmosphere above the low-pressure area, potentially establishing a self-reinforcing feedback system that produces weather systems known to meteorologists as tropical disturbances, tropical depressions, tropical storms, and hurricanes (Frankenberg, 1999).

Almost all tropical storms and hurricanes in the Atlantic basin, which includes the Gulf of Mexico and Caribbean Sea, form between June 1st and November 30th. This time frame is known as hurricane season. August and September are peak months for hurricane development. The threats caused by an approaching hurricane can be divided into three main categories: storm surge, wind damage and rainfall/flooding. For this plan, only wind damage will be discussed in association with hurricanes. Wind damage is the force of wind that can quickly decimate the tree population, down power lines and utility poles, knock over signs, and damage/destroy homes and buildings. Flying debris can also cause damage to both structures and the general population. When hurricanes first make landfall, it is common for tornadoes to form which can cause severe localized wind damage (Mandia, 2011).

HIGH WIND: HAZARD HISTORY / LOCATION

Puerto Rico and neighboring islands of the Caribbean are subject to frequent and severe impacts from hurricanes and tropical storms, including wind damage, heavy rainfall, landslides, scouring and flooding of river channels, and salt water inundation along shorelines. This hazard profile will concentrate on the effects of high winds. The main impacts from high winds are damages to buildings, utility lines, trees and other coastal ecosystems (Boose et al, 2004; Chambers, 2001).

The intensity of wind damage is often highly variable, ranging from leaf stripping and branch break to individual tree gaps to extensive blowdowns. Complex patterns of damage often result from the interaction of meteorological, topographic, and biological factors (Boose et al., 2004).

The mountainous topography of Puerto Rico affects both the overall intensity of hurricanes that make landfall, as well as the extent of local protection from damaging winds. Historical evidence suggests that Puerto Rico experiences frequent and intense disturbance from hurricane winds. The landscape of the island plays a part in damaging winds as well. The impacts of hurricane winds may be greatly modified by local topography. Hills and mountains may provide local protection from certain wind directions (Boose et al., 2004).

Hurricanes and tropical storms typically impact Puerto Rico between June and November, which is the official North Atlantic Basin hurricane season. Hurricanes frequently occur between August and October in Puerto Rico (Rivera, 2011). Hurricanes passing over Puerto Rico are rare and normally occur once every 20 years (Copeland, 2011). **Figure 4-9** illustrates the historical hurricane tracks near San Sebastián from 1852 to 2017.

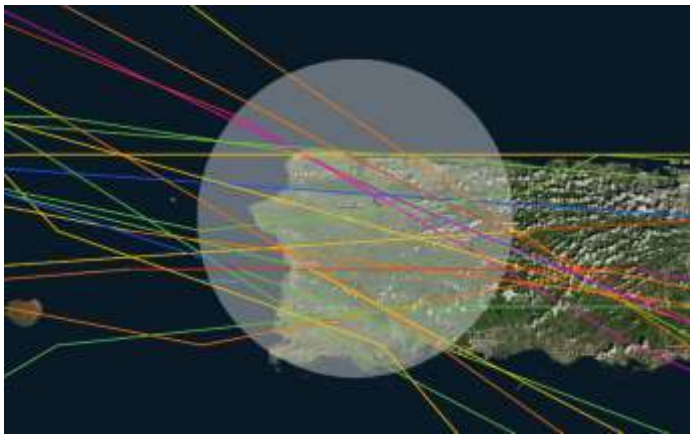

Figure 4-9 Historical Hurricane Tracks within 25 nautical miles from San Sebastián. From 1852 to 2017 (it does not include Hurricane María).

A total of 19 tropical storms and hurricanes have passed within 25 nautical miles from the Municipality of San Sebastián (**Table 4-6**). The data base does not include Hurricane María, a Category 4 (almost 5) hurricane that hit Puerto Rico September 10-30, 2017.

Table 4-6
Major High Wind Events

Hazard	Date	Category/Damages/Economic
Olga 2007	Dec 10, 2007 to Dec 16, 2007	Tropical Storm. Olga moved westward along the northern coast of Puerto Rico on December 11 and made landfall along the north central coast of PR around 0700 UTC. Maximum rainfall totals across the region ranged from around 11 inches in central PR. One death in PR were reported in association with Olga.
Jeanne 2004	Sep 13, 2004 to Sep 29, 2004	PR was impacted by tropical storm force winds and heavy rain, with flooding on a historic scale. The storm made landfall near Maunabo midday on September 15. The storm generally moved northwest through the island, exiting on the northwest coast near the town of Mayagüez around 11 p.m. San Juan reported a wind gust of 73 mph (117 km/h). Excessive rainfall resulted in damage to roads, landslides, and collapsed bridges. Eight people were reported dead in PR. Damages from the storm were estimated at $169.5 million (2004 USD).
Georges 1998	Sep 15, 1998 to Oct 01, 1998	Category 2 Hurricane. Passed over St Croix in the U.S. Virgin Islands and then entered Puerto Rico near Humacao and traveled through the interior of the island exiting just south of Mayagüez in Cabo Rojo. The hurricane traveled mainly in an E to W direction. Affected entire Island, including San Sebastián. $350,000 in direct damages to public facilities (i.e. parks, public buildings, roads).
Hortense 1996	Sep 03, 1996 to Sep 16, 1996	The hurricane crossed the southwest portion of the island dropping heavy rainfall of over 10 in (250 mm) in much of the territory's eastern half. Along the southern PR coast, Hortense caused coastal flooding and beach erosion. Across the island, Hortense left about 1.3 million people without power and 1.1 million customers without water. During the storm, 10,563 people evacuated to storm shelters. Across the island, 11,463 houses were severely damaged. The hurricane left $128.4 million in crop damage, primarily to coffee, plantains, and bananas. There was another $25 million from road damage. There were 19 deaths on the island, many of whom due to flash flood drownings. Some 1,400,000 people, about 40% of the population, lost power during and after the storm.
Frederik 1979	Aug 29, 1979 to Sep 15, 1979	Wind damage on nearby PR was of only minor extent and much less severe than in the Virgin Islands. However, torrential precipitation accounted for most of the damage, as the passage of Hurricane David less than a week earlier saturated soils, priming the area for floods induced by the passage of Frederic. Rainfall peaked at around 10 in (250 mm) in 12 hours in PR. Damage from Frederic in PR reached at least US$5 million, though western PR sustained minimal damage from the storm.
Betsy 1956	Aug 09, 1956 to Aug 21, 1956	Hurricane Betsy, known as Hurricane Santa Clara in Puerto Rico, was in 1956 the first North Atlantic hurricane to make landfall in PR in 24 years. Across PR, Betsy destroyed 15,023 houses and left $40 million in damage. There were sixteen deaths on the island, which was less than expected due to well-heeded warnings.
Baker 1950	Aug 18, 1950 to Sep 01, 1950	Hurricane Baker attained peak winds of 120 mph (195 km/h) near the Leeward Islands, traversed Antigua, and weakened to a tropical depression southwest of PR. It re-intensified south of Cuba, strengthened to a strong Category 2 hurricane in the Gulf of Mexico. No direct impact in PR record was found.
Unnamed 1932	Sep 25, 1932 to Oct 02, 1932	Unknown
Unnamed 1931	Sep 08, 1931 to Sep 16, 1931	Unknown
Unnamed 1928	Sep 06, 1928 to Sep 21, 1928	Unknown
Unnamed 1919	Sep 02, 1919 to Sep 16, 1919	Unknown
Unnamed 1916	Aug 21, 1916 to Aug 26, 1916	Unknown
Unnamed 1901	Sep 09, 1901 to Sep 19, 1901	Unknown
Unnamed 1899	Aug 03, 1899 to Sep 04, 1899	Unknown
Unnamed 1896	Aug 30, 1896 to Sep 11, 1896	Unknown
Unnamed 1893	Aug 13, 1893 to Aug 25, 1893	Unknown
Unnamed 1876	Sep 12, 1876 to Sep 19, 1876	Unknown
Unnamed 1867	Oct 27, 1867 to Oct 31, 1867	Unknown
Unnamed 1852	Sep 05, 1852 to Sep 06, 1852	Unknown

Note: Bolds identify those systems that passed directly through San Sebastián; **Source:** https://www.coast.noaa.gov/hurricanes/ Retrieved April 23, 2018

The Federal Government issued 8 Emergency Declarations and 28 Major Disaster Declarations for Puerto Rico from 1956 to 2017. Only 2 Emergency Declarations were issued for the term of years 2012-2018 before issue the two Major Disaster Declarations during the same term. The declarations were due to Hurricanes Irma and María. The Municipality of San Sebastián was only included in the Major Disaster Declaration for Hurricane María (DR-4339). The following bullets provide a summary of relevant information regarding these declarations. **Table 4-7** provides the list of all disaster declarations for Puerto Rico since 1956 to 2017.

Puerto Rico Hurricane Irma (EM-3384)

- Incident Period: September 05, 2017 - September 07, 2017
- Emergency Declaration declared on September 05, 2017
- Public Assistance - Dollars Approved: $16,181,033.08

Puerto Rico Hurricane Irma (DR-4336) – The Municipality of San Sebastián was not designated.

- Incident Period: September 05, 2017 - September 07, 2017
- Major Disaster Declaration declared on September 10, 2017
- Individual Assistance Applications Approved: 1,501
- Total Individual & Households Program Dollars Approved: $8,230,679.78
- Total Public Assistance Grants Dollars Obligated: $6,302,681.10

Puerto Rico Hurricane Maria (EM-3391)

- Incident Period: September 17, 2017 - November 15, 2017
- Emergency Declaration declared on September 18, 2017

Puerto Rico Hurricane Maria (DR-4339) – All municipalities in Puerto Rico, including San Sebastián, were designated to receive Individual Assistance and Public Assistance Funds.

- Incident Period: September 17, 2017 - November 15, 2017
- Major Disaster Declaration declared on September 20, 2017
- Individual Assistance Applications Approved: 456,024
- Total Individual & Households Program Dollars Approved: $1,159,019,315.55
- Total Public Assistance Grants Dollars Obligated: $2,196,591,569.78

Table 4-7
Disaster Declarations for Puerto Rico 1956-2017

Title	Declaration Date	Declaration Type
Puerto Rico Hurricane (DR-62)	1956-08-17 20:00	Major Disaster Declaration
Puerto Rico Extreme Drought Conditions (DR-170)	1964-05-25 20:00	Major Disaster Declaration
Puerto Rico Heavy Rains, Flooding (DR-296)	1970-10-11 20:00	Major Disaster Declaration
Puerto Rico Impact of Drought (EM-3002)	1974-08-28 20:00	Emergency Declaration
Puerto Rico Flooding (DR-455)	1974-11-29 19:00	Major Disaster Declaration

Title	Declaration Date	Declaration Type
Puerto Rico Tropical Storm Eloise (DR-483)	1975-09-18 20:00	Major Disaster Declaration
Puerto Rico Hurricane David (DR-597)	1979-09-01 20:00	Major Disaster Declaration
Puerto Rico Storms, Mud/Land Slides, Flooding (DR-736)	1985-05-30 20:00	Major Disaster Declaration
Puerto Rico Severe Storms, Flooding, Mudslides (DR-746)	1985-10-09 20:00	Major Disaster Declaration
Puerto Rico Heavy Rains, Flooding, Mudslides (DR-768)	1986-07-09 20:00	Major Disaster Declaration
Puerto Rico Severe Storms, Flooding (DR-805)	1987-12-16 19:00	Major Disaster Declaration
Puerto Rico Hurricane Hugo (DR-842)	1989-09-20 20:00	Major Disaster Declaration
Puerto Rico Flooding, Severe Storm (DR-931)	1992-01-21 19:00	Major Disaster Declaration
Puerto Rico Hurricane Marilyn (DR-1068)	1995-09-15 20:00	Major Disaster Declaration
Puerto Rico Hurricane Hortense (DR-1136)	1996-09-10 20:00	Major Disaster Declaration
Puerto Rico Gas Leak Explosion (EM-3124)	1996-11-20 19:00	Emergency Declaration
Puerto Rico Hurricane Georges (EM-3130)	1998-09-20 20:00	Emergency Declaration
Puerto Rico Hurricane Georges (DR-1247)	1998-09-23 20:00	Major Disaster Declaration
Puerto Rico Hurricane Lenny (EM-3151)	1999-11-16 19:00	Emergency Declaration
Puerto Rico Flooding (DR-1372)	2001-05-15 20:00	Major Disaster Declaration
Puerto Rico Severe Storms and Flooding (DR-1396)	2001-11-27 19:00	Major Disaster Declaration
PR Severe Storms, Flooding, Mudslides, and Landslides (DR-1501)	2003-11-20 19:00	Major Disaster Declaration
PR Tropical Storm Jeanne, Resulting Landslides & Mudslides (DR-1552)	2004-09-16 20:00	Major Disaster Declaration
PR Severe Storms, Flooding, Landslides, and Mudslides (DR-1613)	2005-11-09 19:00	Major Disaster Declaration
Puerto Rico Severe Storms and Flooding (DR-1798)	2008-09-30 20:00	Major Disaster Declaration
Puerto Rico Explosions and Fire (EM-3306)	2009-10-23 20:00	Emergency Declaration
Puerto Rico Severe Storms and Flooding (DR-1919)	2010-06-23 20:00	Major Disaster Declaration
PR Severe Storms, Flooding, Mudslides, LS Asoc. TS Otto (DR-1946)	2010-10-25 20:00	Major Disaster Declaration
PR Severe Storms, Flooding, Mudslides, And Landslides (DR-4004)	2011-07-13 20:00	Major Disaster Declaration
Puerto Rico Hurricane Irene (EM-3326)	2011-08-21 20:00	Emergency Declaration
Puerto Rico Hurricane Irene (DR-4017)	2011-08-26 20:00	Major Disaster Declaration
Puerto Rico Tropical Storm Maria (DR-4040)	2011-10-17 20:00	Major Disaster Declaration
Puerto Rico Hurricane Irma (EM-3384)	2017-09-05 15:11	Emergency Declaration
Puerto Rico Hurricane Irma (DR-4336)	2017-09-10 04:05	Major Disaster Declaration
Puerto Rico Hurricane Maria (EM-3391)	2017-09-18 14:50	Emergency Declaration
Puerto Rico Hurricane Maria (DR-4339)	2017-09-20 17:00	Major Disaster Declaration

Source: https://www.fema.gov/disasters/state-tribal-government/0/PR

Hurricane María

María was a very severe Cape Verde Hurricane that ravaged the island of Dominica at category 5 (on the Saffir-Simpson Hurricane Wind Scale) intensity, and later devastated Puerto Rico as a high-end category 4 hurricane (**Figure 4-10**). In Puerto Rico, the death toll is highly uncertain and the official number stands at 65, which includes an unknown number of indirect deaths. It should be noted that hundreds of additional indirect deaths in Puerto Rico may eventually be attributed to Maria's aftermath pending the results of an official government review. Puerto Rico was devastated by winds and floods.

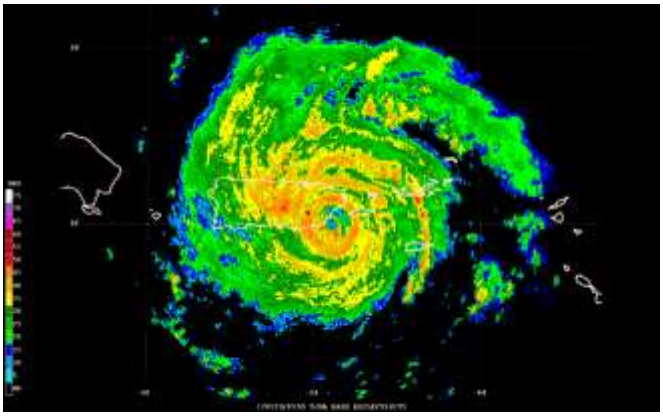

Figure 4-10 Radar image of Hurricane María at 0950 UTC, September 20, just before landfall in Puerto Rico.
Source: National Hurricane Center, 2018. Hurricane María (AL 152017) Tropical Cyclone Report.

The NOAA estimate of damage in Puerto Rico and the U.S. Virgin Islands due to Maria is 90 billion dollars, with a 90% confidence range of +/-$25.0 billion, or $65.0-$115.0 billion, which makes Maria the third costliest hurricane in U.S. history, behind Katrina (2005) and Harvey (2017). Maria is by far the most destructive hurricane to hit Puerto Rico in modern times, as the previous costliest hurricane on record for the island was Georges in 1998, which in 2017 dollars "only" caused about 5 billion dollars of damage.

The combined destructive power of storm surge and wave action from Maria produced extensive damage to buildings, homes and roads along the east and southeast coast of Puerto Rico. A storm surge also caused significant damage over the northwestern coastal area of Puerto Rico. Across the island, many buildings suffered significant damage or were destroyed. Numerous trees were downed, splintered and/or defoliated. River flooding was unprecedented in some areas, especially in the northern portion of the island. The La Plata River flooded the entire alluvial valley including the municipality of Toa Baja, where hundreds of families needed to be rescued from their roof tops. Maria knocked down 80 percent of Puerto Rico's utility poles and all transmission lines, resulting in the loss of power to essentially all the island's 3.4 million residents. Practically all cell phone service was lost and municipal water supplies were knocked out. At of the end of 2017, nearly half of Puerto Rico's residents were still without power, and by the end of January 2018, electricity had been restored to about 65% of the island. Just before Maria's center made landfall, extreme winds destroyed the WSR-88D radar in Puerto Rico.

The Engineering Office, Department of Municipal Public Works, Municipality of San Sebastián, prepared the Bridges and Roads Damage Report. It includes the address and damage description of 14 bridges and 28 roads due to Hurricane María. Most of these structures are included in the 2018-2023 Mitigation Actions list in this Plan.

High Wind: Hazard Frequency and Magnitude

The frequency of the high wind hazard event is based on a 100-year return period—the municipality has a 1 percent annual probability of observing the losses shown in the loss estimates subsection of this risk assessment. For this return period, wind speeds ranged from 90-122 mph for San Sebastián. This is the best available information to determination the probability and magnitude of future wind hazard events. Statistical analysis was used to break down the range of wind speeds into five hazard level determinations ranging from very low to very high.

4.4.5 HAZARD PROFILE: RIVERINE FLOODING

Riverine Flooding: Hazard Location, Extent and Distribution

Riverine flooding generally occurs along the Rio Culebrinas and in several low-lying areas (often areas not mapped by FEMA as part of the 100-year floodplain) throughout the Municipality, smaller tributaries are also susceptible to flooding from large meteorological systems, especially tropical storms. The storm waters in upstream tributaries drops quickly to lower elevations creating conditions that are ideal for flash flooding events. Figure 7 illustrates the varying susceptibility to riverine flooding throughout the Municipality.

The extent and distribution of Riverine flooding hazard is varied because:

- Riverine flood hazard areas are confined to the flood plain associated with -the Rio Culebrinas.
- Barrio Victoria, Urbanization Garcia is particularly prone recurrent flooding. Residential, commercial and institutional buildings (i.e. low-income housing) are prone to flooding.
- Infrastructure, especially a major electrical sub-station is prone to flooding.

Riverine Flooding: Hazard History

As shown in **Table 4-8**, there have been 10 major flood events in San Sebastián between 1972 and 1999. The events highlight a seasonal pattern to flooding that follows a distinct rainy season that occurs usually between June and November. Specific hazard history for river flooding was gathered by municipal staff. Personal interviews and comments gathered during public workshops were integrated into this report. In addition, the study contractor was able, with the assistance of the Municipality, to identify a few specific Riverine flooding events that have led to property damages in San Sebastián. These local flooding events include:

Table 4-8
Chronology of Major Floods in San Sebastián, 1972 to 1999.

Date	Affected Area	Severity/ Hazard Intensity	Damages/ Economic Impact
1972 (October)	Rio Culebrinas	Flood flow exceeded 30,000 cubic feet per second (cfs)	Unknown
September 16, 1975.	Rio Culebrinas. Tropical Storm Eloise. Largest flood of record with	50 Year Return Period	50 Years

Date	Affected Area	Severity/ Hazard Intensity	Damages/ Economic Impact
May 1980.	an estimated recurrence interval of 50 years.		
October 1981	Rio Culebrinas. Flood flow exceeded 30,000 cfs	Flood flow exceeded 30,000 cubic feet per second (cfs)	Unknown
May 1985	Rio Culebrinas. Flood flow exceeded 30,000 cfs	Flood flow exceeded 30,000 cubic feet per second (cfs)	Unknown
May 1986	Rio Culebrinas	Flood flow exceeded 30,000 cubic feet per second (cfs)	Unknown
August 1988	Rio Culebrinas	Flood flow exceeded 30,000 cubic feet per second (cfs)	Unknown
September 21, 1996	Hurricane Hortense, Rio Culebrinas overflowed and caused residential flooding, infrastructure damaged.	Estimated to be equivalent to 100-year event.	
September 21, 1998	Hurricane Georges, Rio Culebrinas overflowed and caused residential flooding, infrastructure damaged.	Unknown	Unknown
May 26 – 28, 1999	Civil Defense indicated that river Culebrinas went out of its banks flooding Palmar sector in San Sebastián	Unknown	Unknown
Nov 7, 1999	Heavy rains induced small streams to overflow their banks flooding nearby roads. At Corrales sector a center for the elderly had to be evacuated, and a few cars were swept away by the waters. Elsewhere, a church was reported flooded.	Unknown	Unknown

Localized information on riverine flooding was not available for the entire municipality. Information included in **Table 4-9** reflects information documented in USACE study on flooding in the Rio Culebrinas. Specific hazard history for river flooding was gathered by municipal staff. Personal interviews and comments gathered during public workshops were integrated into this report in previous versions.

Table 4-9
Major Recorded Annual Floods at Rio Culebrinas 1968-2004

Date	Flow (ft^3/s)
September 16, 1975	41,200
September 22, 1998	36,900
May 17, 2003	31,800
September 26, 2004	33,100
November 17, 1968	30.00
October 4, 1993	28,400

Source: United States Geological Survey (http://water.usgs.gov/pubs/FS/FS-051-96/#HDR05) and data compiled from the National Climatic Data Center (http://www.ncdc.noaa.gov/oa/ncdc.html).

The National Centers for Environmental Information of the NOAA reported 292 floods according to the NOAA Storm Data Publication for Puerto Rico[12] between January 1, 2012 to May 28, 2018. Fifty-five municipalities have been affected during 128 days with events. The Municipality of San Sebastián was impacted by the following significant events:

- Heavy Rain - May 13, 2013 (event 457010)

  An upper level trough combined with strong daytime heating and local effects producing scattered to numerous showers with isolated thunderstorms mainly across the San Juan Metropolitan area and over the Western Interior sections of Puerto Rico. PR-125, km 26.5 was reported flooded at Barrio Pozas.

- Heavy Rain - September 26, 2013 (event 478870)

  Strong daytime heating combined with sea breeze convergence to produced scattered showers with thunderstorms over the western interior section of Puerto Rico. Urban areas near road PR-119 were flooded due to Culebrinas River out of its banks.

- Heavy Rain - May 9, 2017 (event 703976)

  An upper level trough continued maintaining a wet weather pattern across the region. Flash flood warnings were issued due to heavy rain. Roads PR-446, KM 0.2 intersection with PR-125 near Selectos Supermarket were affected by flooded waters from Rio Culebrinas.

- Heavy Rain – June 18, 2017 (event 710752)

  Available low level moisture combined with daytime heating and local effects produced scattered to numerous showers with thunderstorms across the western interior and northwest sections of Puerto Rico. Flooding was reported at roads PR-125 and PR-446.

12 https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Flood&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=2012&endDate_mm=05&endDate_dd=28&endDate_yyyy=2018&county=ALL&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=99%2CPUERTO+RICO

Riverine Flooding: Hazard Frequency and Magnitude

The frequency of the Riverine flooding hazard event is based on a 100-year return period—the municipality has a one percent annual probability of observing the losses shown in the loss estimates subsection of this risk assessment. Based on the flood mapping and hazard analysis, flood depths ranged from 0-3.9 meters. Statistical analysis was used to break the range of flood depths into five hazard level determinations ranging from very low to very high. At the time, this should be considered the best available information to determine magnitude, impact and probability of future hazard events.

Table 4-10 shows the computed median runoff, by water-year, for Puerto Rico (USGS) Water Watch 2004-2008 as presented in previous versions. Since most floods events occur in Rio Culebrinas area, the HMP Planning Committee substituted the hydrology figure of previous version with **Figure 4-11** to show the Rio Culebrinas drainage area.

Table 4-10

Year	No. Stream gages	Run off (MM)	Run off (IN)	Rank
2004	66	1304.39	52.18	6
2005	3	1485.10	59.40	2
2006	68	1078.71	43.15	12
2007	18	735.31	29.41	39
2008	74	998.96	39.96	20

Computed median runoff, by water-year, for Puerto Rico (USGS) Water Watch 2004-2008

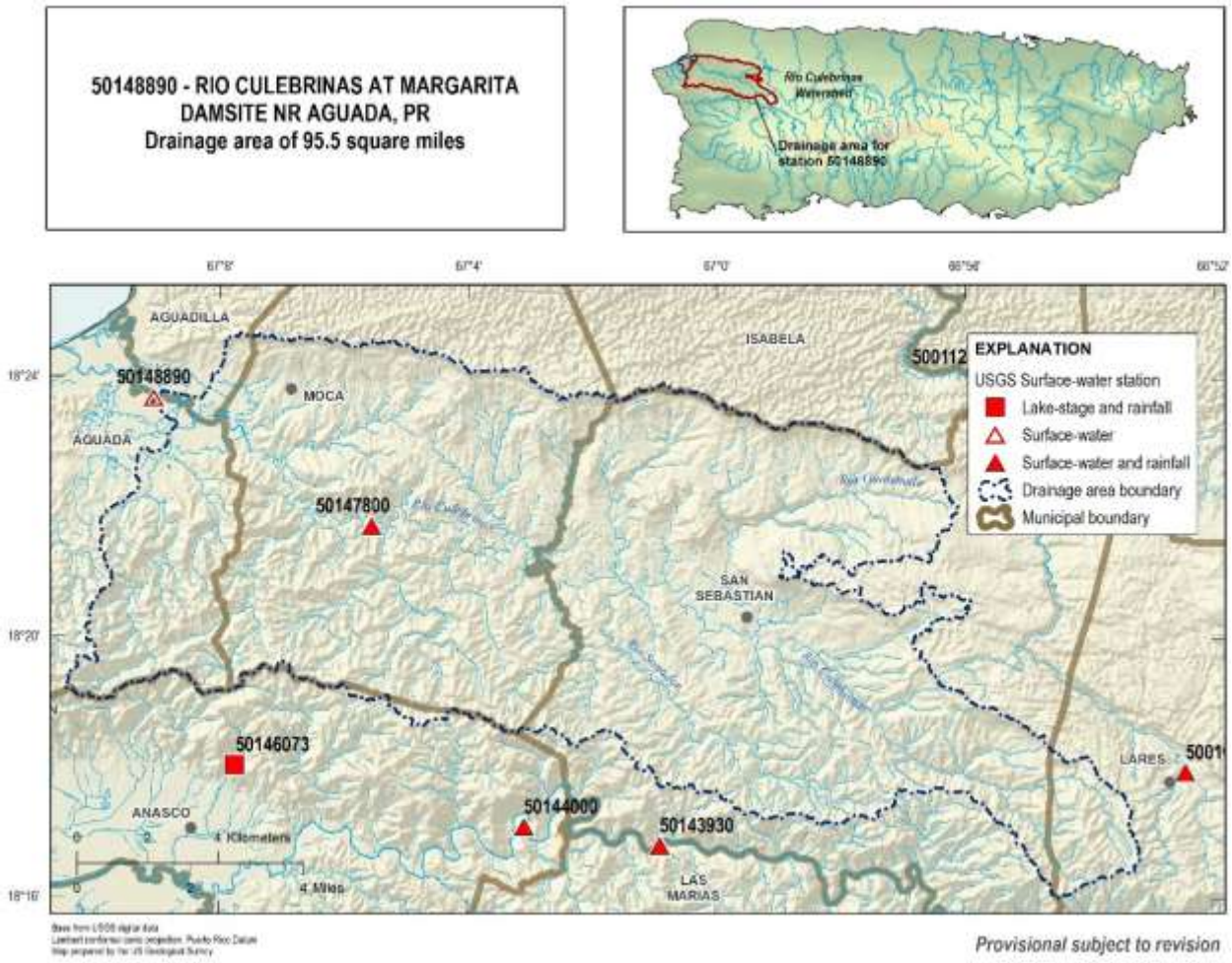

Figure 4-11 Río Culebrinas Drainage Area[13]

4.4.6 Rainfall-Induced Landslide

Rainfall-Induced Landslides are a major geologic hazard with estimated tens of million dollars in economic losses per year in Puerto Rico. The island of Puerto Rico experiences one or two large events per year, often triggered in steeply sloped areas by prolonged and heavy rainfall[14]. Identifying areas susceptible to landslides thus has great potential value for San Sebastián and would allow better management of its territory. Rainfall-Induced Landslide includes shallow soil slips, debris flow, debris slides, debris avalanches, and slumps (Larsen and Simon 1993). The factors contributing to the high landslide activity in San Sebastián are the steep slopes and the relatively moist condition of soils due to abundant rainfall, especially in the western part of the island. **Figure 4-12** shows the susceptibility map

[13] https://pr.water.usgs.gov/data/gis/drainage/DA_50148890_lttr.jpg

[14] Lepore, C., Kamal, S.A., Shanahan, P. et al. Environ Earth Sci (2012) 66: 1667. https://doi.org/10.1007/s12665-011-0976-1

for the three local models (top row) for (a) Blanco, (b) Cibuco, and (c) Coamo basins and susceptibility map for the whole island of Puerto Rico (bottom row). The hatched squares and circles are adapted from Pando et al. (2005); the irregular cross-hatched areas represent high susceptibility areas as identified by Monroe (1979).

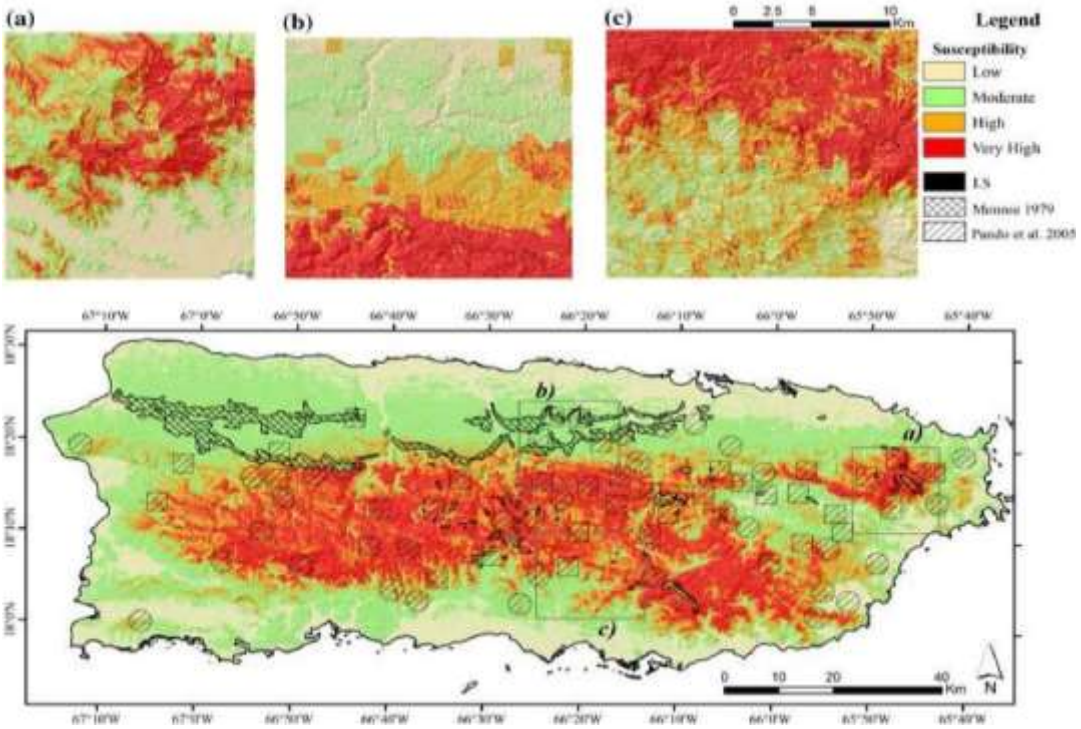

Figure 4-12 Puerto Rico Landslide Map

Landslides are triggered by factors such as heavy rainfall, seismic activity, and construction on hill-slopes. The leading cause of landslides in San Sebastián is intense and/or prolonged rainfall. A rainfall threshold for rainfall-triggered land sliding is delimited by 256 storms that occurred between 1959 and 1991 in the central mountains of Puerto Rico, where mean annual rainfall is close to or in excess of 2,000 mm. Forty one of the 256 storms produced intense and/or prolonged rainfall that resulted in tens to hundreds of landslides. A threshold fitted to the lower boundary of the field defined by landslide-triggering storms is expressed as I = 91.46 D-0.82 where I is rainfall intensity in millimeters per hour, and D is duration in hours. Landslide-producing storms occurred at an average rate of 1.2 per year. In general, the landslides triggered by short-duration, high-intensity rainfall events were mainly shallow soil slips and debris flows, while the long-duration, low-intensity rainfall produced larger, deeper debris avalanches and slumps. For storms that had durations of up to 10 h, land sliding did not occur until rainfall intensity was as much as three times as high as the rainfall intensity reported as sufficient to trigger landsliding in temperate regions. As storm durations approach 100 h, the rainfall conditions necessary to initiate landsliding in San Sebastián converge with those defined for temperate regions. **Table 4-11** provides a list of rainfall-induced landslides in Puerto Rico (1959-1991) and **Figure 4-13** shows the average temperature and precipitation for the Municipality of San Sebastián.

Table 4-11
Date and Characteristics of 41 Rainfall-Induced Landslides in Puerto Rico between 1959 and 1991 (Larsen y Simon 1993).

Número	Fecha	Año	Duración [h]	Precipitación acumulada [mm]	Intensidad [mm/h]
1	14-Oct	1976	2	142	71.12
2	27-Sep	1980	2	221	110.5
3	10-Dec	1975	3	203	67.73
4	15-Nov	1977	3	127	42.33
5	30-Oct	1976	4	102	25.48
6	18-Sep	1989	6	225	37.5
7	9-May	1982	6	203	33.87
8	9-Nov	1969	6	178	29.66
9	26-Jan	1969	6	127	21.16
10	27-Aug	1970	9	225	25
11	13-Jan	1965	9	544	60.44
12	3-Nov	1984	24	192	8
13	6-Dec	1987	24	493	20.54
14	6-Oct	1985	24	625	26.04
15	12-Sep	1982	48	330	6.88
16	6-Sep	1960	48	477	9.94
17	27-May	1980	48	288	6
18	23-Aug	1971	48	232	4.83
19	12-May	1986	48	279	5.81
20	9-Nov	1970	48	254	5.29
21	29-Aug	1979	72	502	6.97
22	9-Dec	1965	72	474	6.58
23	8-May	1970	72	254	3.53
24	4-Sep	1979	72	459	6.38
25	8-Dec	1970	96	419	4.36
26	26-Nov	1968	96	329	3.43
27	22-Apr	1969	96	268	2.79
28	15-May	1985	96	635	6.62
29	11-Dec	1981	96	740	7.71
30	18-May	1987	120	453	3.78
31	22-Oct	1978	120	459	3.83
32	24-Nov	1987	120	583	4.86
33	29-Nov	1960	144	438	3.04
34	4-Oct	1970	144	976	6.78
35	20-May	1981	144	254	1.76
36	5-Oct	1990	312	303	0.97
37	27-Aug	1961	24	456	19
38	4-May	1965	24	144	6
39	14-Oct	1962	24	216	9
40	23-Aug	1988	24	312	13
41	16-Apr	1988	12	168	14

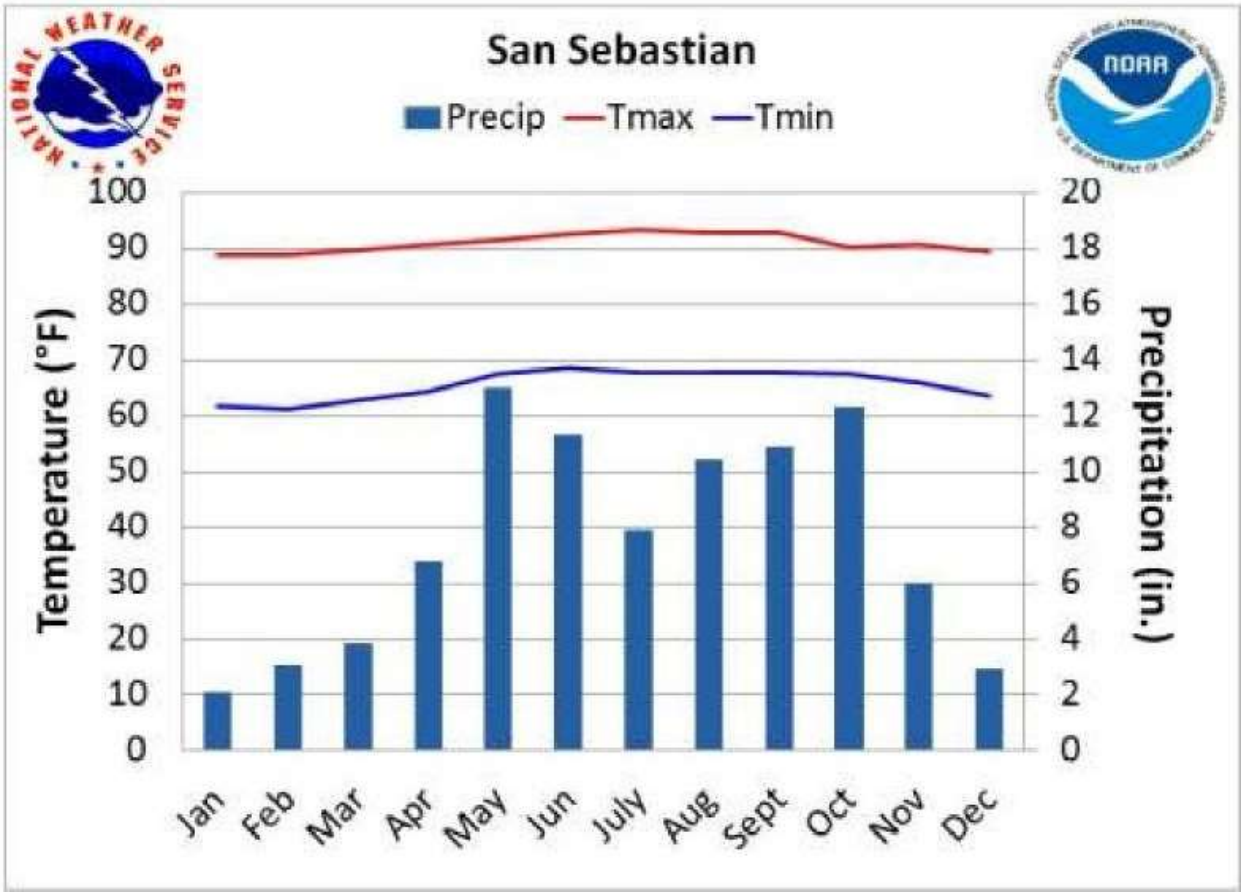

Figure 4-13 Average Temperature and Precipitation

Whenever a stationary cold front is present at the north region of the Island, the Municipality of San Sebastián is most likely to be affected by heavy rainfall causing flooding in many sectors and areas. Fire Hazard Description

Wildfire Hazard Location, Extent and Distribution

Dry conditions at various times of the year and in various parts of San Sebastián greatly increase the potential for wildfires. Post-fire debris flows are particularly hazardous because they can occur with little warning, can exert great impulsive loads on objects in the vegetation, block drainage ways, damage structures, and endanger human life. The extent and distribution of the Wildfire hazard is varied because:

- Wildfire levels range is very low to moderate with the highest intensity levels along the green areas in the woods and in the dump area.
- Infrastructure like power poles and telecommunication are susceptible to wildfire because there are along the wooded parts of the municipality.
- Wildfires could potentially result in the destabilization of pre-existing deep-seated landslides over long time periods.

Wildfire: Frequency and Magnitude

The Wildfire occurs several times a year, especially in times of high temperature. This occurs many times by a combination of high temperature, garbage in the green areas and dry grass areas. The frequency of Wildfire per year is shown in **Table 4-12**.

Table 4-12
Five-year Wildfire Frequency

Year	Wildfire frequency
2007	8
2008	21
2009	22
2010	14
2011	20
2017	24
2018[a]	30

(a) January – April 23, 2018. Provided by Sgt. Soto Aguadilla Region.

4.5 INVENTORY OF ASSETS

To be consistent with the methodology of the FEMA Publication 386-2, "State and Local Mitigation Planning How-To Guide, Understanding Your Risks—Identifying Hazards and Estimating Losses" (FEMA 2001):

- Estimate or count the total number of buildings and value of buildings.
- Please note that Section 2, entitled Community Profile, provides a demographic profile of San Sebastián. The following subsections are presented:
- General Building Stock
- Critical Facilities and Infrastructure

An important component of this Hazard Mitigation Plan is the identification of the general built environment. An understanding of the built environment provides an idea of the municipality's exposure (type of buildings and estimated value) the distribution of housing units.

Based on U.S. Census data, a building inventory profile was developed to estimate the distribution of commercial buildings. A rapid field survey was used to categorize number and types of buildings for select land use districts on the island. The following land use designations. They are:

- Urban Center (CU)

- Urban Peripheral (UP)
- Urbanization (UB)
- Rural Communities (RC)
- Rural Linear (RL)
- Manufacturing/Industrial (MA)

The **Urban Center (CU)** classification is comprised of areas of intensive use. This category refers to the traditional urban center, which is comprised mostly of commercial structures. Structure types vary from older historic un-reinforced concrete buildings to modern steel-frame buildings.

Emanating from traditional urban center, along main business thoroughfares, is the **Urban Peripheral (UP)** land use classification. This classification is mixed-use and consists of residential, retail establishments, businesses, financial, professional and repair services. Structure types vary from one and two story concrete structures to large steel frame concrete structures.

Suburban developments are found near to the urban periphery. **Urbanization (UB)** or suburban residential subdivisions tend to consist of homogeneous house types, predominately single story concrete residential homes.

The **Rural Community (RC)** is the most predominant land use classification found in the Municipality. Over the years, rural lands have been developed as a result of Law 26 (Ley 26)[15], that sought to use unproductive agricultural lands for residential development. These lands, known as "parcelas," usually occur in areas that are adjacent to rural roads. They are rural in character and typically consist of single and two family dwellings. Structure types vary from simple wood frame dwellings to one and two story concrete structures.

The **Rural Linear (RL)** land use classification has occurred in recently developed mountainous areas. It consists of a disorganized pattern of land use. Structure types vary from informal wooden frame structures to multi-family concrete structures.

The **Manufacturing/Industrial Areas (MA)** land use classification refers to portions of the municipality where the predominant structural types are single-story masonry, concrete or steel frame structures used for light industrial and manufacturing purposes.

The field investigation identified ten (10) representative building types in the municipality. For each land use classification, a "structural distribution ratio" was assigned to identify the percentage of different building types and uses (i.e., occupancy classes—residential and commercial). The basic structural systems were grouped into 10 model building types with the following general construction characteristics:

- Wood, Steel,
- Reinforced Concrete,

ram developed under a Department of Housing (Vivienda), Administration of Social Programs.

- Steel-Frame,
- Un-reinforced Masonry, and
- Un-reinforced Masonry.

The analysis generated a distribution of particular building types for each census block based on land use categorization. It allowed Consultant Project Team members to understand the distribution of model building types for a specific occupancy class, at the census block level. This provided the basis to estimate the total number of buildings and to aggregate replacement and content values for model building types.

Critical Facilities and Infrastructure

Facilities such as schools, police and fire stations, and hospitals, are known as "critical facilities." Infrastructure is separated into two distinct classes that have substantially different damage and loss characteristics: (1) transportation systems (key roads, ports, airports) and (2) utility infrastructure (electric power stations, potable water treatment plants, wastewater treatment plants, water pumps). For purposes of this plan, the following three-part definition of critical facilities and infrastructure shall apply:

Critical Facilities

Critical facilities are those facilities that provide services to the community and should be functional after a hazard event. They include:

- Government buildings necessary for continuity of operations
- Hospitals
- Police stations
- Fire stations
- Emergency Response
- Schools
- Shelters

Utilities and Infrastructure

Utilities and Infrastructure are facilities that, if damaged, could have far-reaching consequences for the environment. They include:

- Electrical Power Substations
- Water Treatment Plants, and
- Wastewater Treatment Plants
- Main Road System

A detailed list of critical facilities and infrastructure was developed by the Hazard Mitigation Committee and Director of Emergency Management. This list was then provided to the Consultant Project Team. It was identified that detailed attribute information needed to conduct a vulnerability and risk assessment

was missing. Therefore, site visits were undertaken with municipal staff to obtain information on structural characteristics and general conditions. Facilities and infrastructure were categorized by their structural characteristics relevant to vulnerability to the prominent hazards identified in the study.

General Building Stock

Building distribution and occupancy information collected during field surveys was integrated into a database to determine the number of representative building types across the municipality.

The compilation of this data provided project planners with the ability to differentiate between building types with substantially different damage and loss characteristics. It also provided critical information to assess the values of the general building stock across the municipality. **Table 4-13** below lists the estimated value for general occupancy classes used for this risk assessment. Exposure estimates are based on aggregated building replacement costs by insurance coverage policy for the 2011-2012 periods.

Table *4-14* includes the estimated values for the Municipality Critical Facilities. These values are more conservatives than the list obtained dated June 8, 2017. The list was not used since it is being updated due to Hurricane María recent hit.

Table 4-13
Estimated Values for General Occupancy Classes

Property Type	Num. of Buildings	Estimated Replacement Cost	Estimated Content Cost	Total Value
Private Property	16,147	$2,229,110,000	$48,011,600	$2,277,127,600
Commercial[16]	2,814	$945,104,860	$298,625,172	$1,243,730,032
Manufacturing	5	$35,413,400	$8,100,000	$43,513,000
Government / Public	121	$50,800,885	$2,257,600	$53,058,485
Total	20,087	$2,558,210,875	$630,013,600	$3,188,224,475

Table 4-14
Municipality of San Sebastián, Critical Facilities by class

Facility Type	Num. of Facilities	Exposure Building	Exposure Content	Total
Critical Facilities				
Police Stations	2	$1,400,000	$125,000	$1,525,000
Fire Stations	1	$380,000	$230,000	$610,000
Emergency Response	1	$500,000	$75,000	$575,000

[16] CRIM data

Facility Type	Num. of Facilities	Building	Exposure Content	Total
Hospital/Medical Clinic	3	$3,200,000	$1,250,000	$4,450,000
Government Buildings	6	$11,330,000	$2,500,000	$13,830,000
Schools	25	$7,500,000	$85,000	$7,585,000
Refuges	3	$750,000	$40,000	$790,000
Utilities				
Water Filtration Plants	1	$750,000	$1,200,000	$1,950,000
Pump Stations	15	$50,000	$0	$750,000
Power Station	1	$2,000,000	$0	$2,000,000
	Totals	**$27,860,000**	**$5,505,000**	**$34,065,000**

Notes: Modified from FEMA 386-2, Worksheet No. 3a (FEMA 2001).

4.6 ASSESSING VULNERABILITY

This analysis identified the number of people less than 18 years of age and the number of people over 65 years of age. These two demographic subgroups help define the municipality's social vulnerability as they are the most likely to need assistance during and/or after a hazard event. A series of GIS hazard overlay queries were performed to indicate where the people reside within the municipality relative to hazards.

- Determine the proportion of buildings, the value of buildings, and the population the Municipality of San Sebastián that are located in hazard areas, and
- Calculates the proportion of assets located in hazard areas.

The HMP Planning Committee identified 46 critical facilities during the 2018 update process. The facilities include the municipal city hall, legislature and finance building, wards community centers used by OMME during emergencies, medical facilities, fire house, water treatment plants, communication antennas, schools, among others. All these sites were located in aerial photos and plotted in **Figure 4-14**.

The maps of critical facilities and natural hazard areas in the Municipality of San Sebastián are shown in the following figures:

- **Figure 4-15** Earthquake Ground Shaking Hazard Areas
- **Figure 4-16** Liquefaction Hazard Areas
- **Figure 4-17** Earthquake Induced Landslide Hazard Areas
- **Figure 4-18** High Wind Hazard Areas
- **Figure 4-19** Riverine Flooding Hazard Areas
- **Figure 4-22** Rainfall Induced Landslide Hazard Areas
- **Figure 4-23** Wildfire Hazard Areas

The tables associated to these figures showing the impact on critical facilities located in natural hazard areas in the Municipality of San Sebastián are shown in the following tables:

- **Table 4-15** Earthquake Ground Shaking Hazard Areas
- **Table 4-16** Liquefaction Hazard Areas
- **Table 4-17** Earthquake-Induced Landslide Hazard Areas
- **Table 4-18** High Wind Hazard Areas
- **Table 4-19** Riverine Flooding Areas Hazard Areas
- **Table 4-22** Rain-Induced Landslide Hazard Areas
- **Table 4-23** Wildfire Area

The maps of potential new development and natural hazard areas in the Municipality of San Sebastián are shown in the following figures:

- **Figure 4-33** Earthquake Ground Shaking Hazard Areas
- **Figure 4-34** Liquefaction Hazard Areas
- **Figure 4-35** Earthquake Induced Landslide Hazard Areas
- **Figure 4-36** High Wind Hazard Areas
- **Figure 4-37** Riverine Flooding Hazard Areas
- **Figure 4-38** Rainfall Induced Landslide Hazard Areas
- **Figure 4-39** Wildfire Hazard Areas

The tables associated to these figures showing the impact on potential new developments located in natural hazard areas in the Municipality of San Sebastián are shown in the following tables:

- **Table 4-36** Earthquake Ground Shaking Hazard Areas
- **Table 4-37** Liquefaction Hazard Areas
- **Table 4-38** Earthquake-Induced Landslide Hazard Areas
- **Table 4-39** High Wind Hazard
- **Table 4-40** Riverine Flooding Hazard Areas
- **Table 4-41** Rain-Induced Landslide Susceptible Areas
- **Table 4-42** Wildfire Area

No.	Facility Name
1	City Hall
2	Finance and Municipal Legislature
3	Public Safety Office (OMME / Police)
4	Juncal Com Center
5	Hoyamala Com Center
6	Guacio Com Center
7	Cibao Com Center
8	Calabazas Com Center
9	Cancha LMM
10	CDT Cirugía Ambulatoria
11	Centro Medicina Cirugía Ambulatoria
12	Pepino Health Group
13	Fire House
14	Water Treatment Plant
15	Waste Water Treatment Plant (old)
16	Waste Water Treatment Plant (new)
17	Innovation WireLess Group
18	Innovation WireLess Group
19	AT&T Mobility Puerto Rico Inc.
20	WRSS
21	Puerto Rico Telephone Company, Inc.
22	Puerto Rico Telephone Company, Inc. h/n/c Claro
23	AT&T Mobility Puerto Rico Inc.
24	WLRP
25	Crown & Castle
26	Puerto Rico Telephone Company, Inc.
27	WCHQ
28	QMC Telecom
29	Red Tower Inc
30	Innovation WireLess Group
31	Red Tower Inc
32	Public Works
33	Public Works Shop
34	Solid Waste Transfer Station
35	Luis Aymat Cardona Coliseum
36	Ciudad de Oro
37	Escuela Elem Aurea Fuentes Méndez
38	Escuela Elem Aurora Méndez
39	Escuela Int Ernestina Méndez
40	Escuela Sup Manuel Méndez Liciaga
41	Escuela Sup Patria Latorre
42	Escuela Elem Ramón M. Torres
43	Escuela SU Bernaldo Méndez Jiménez
44	Escuela SU Carmelo Serrano Cubano
45	Escuela SU Máximino A. Salas
46	Esc Elem Emilio Charón

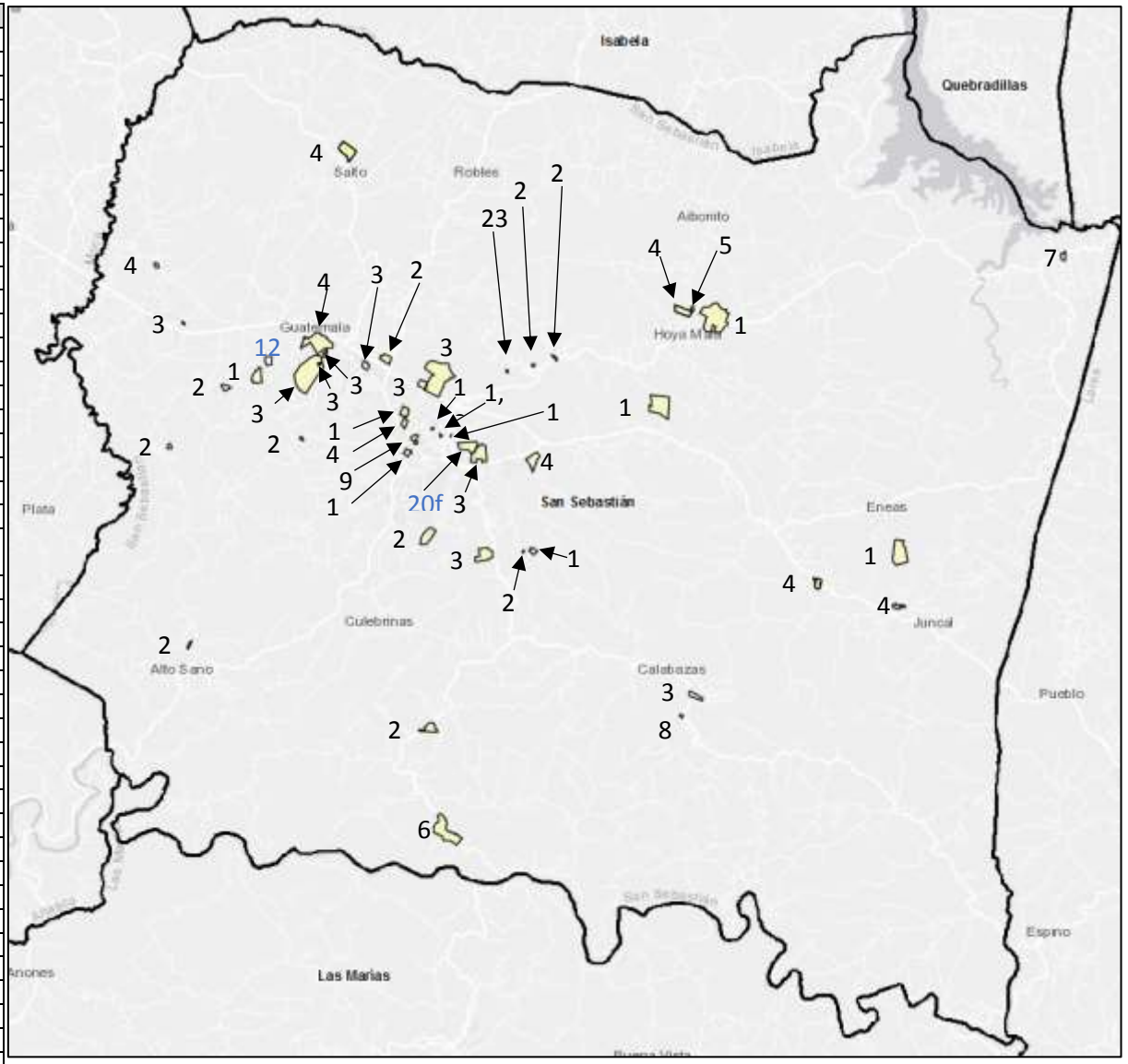

Figure 4-14 General Map of all Critical Facilities identified for the 2018 HMP Update

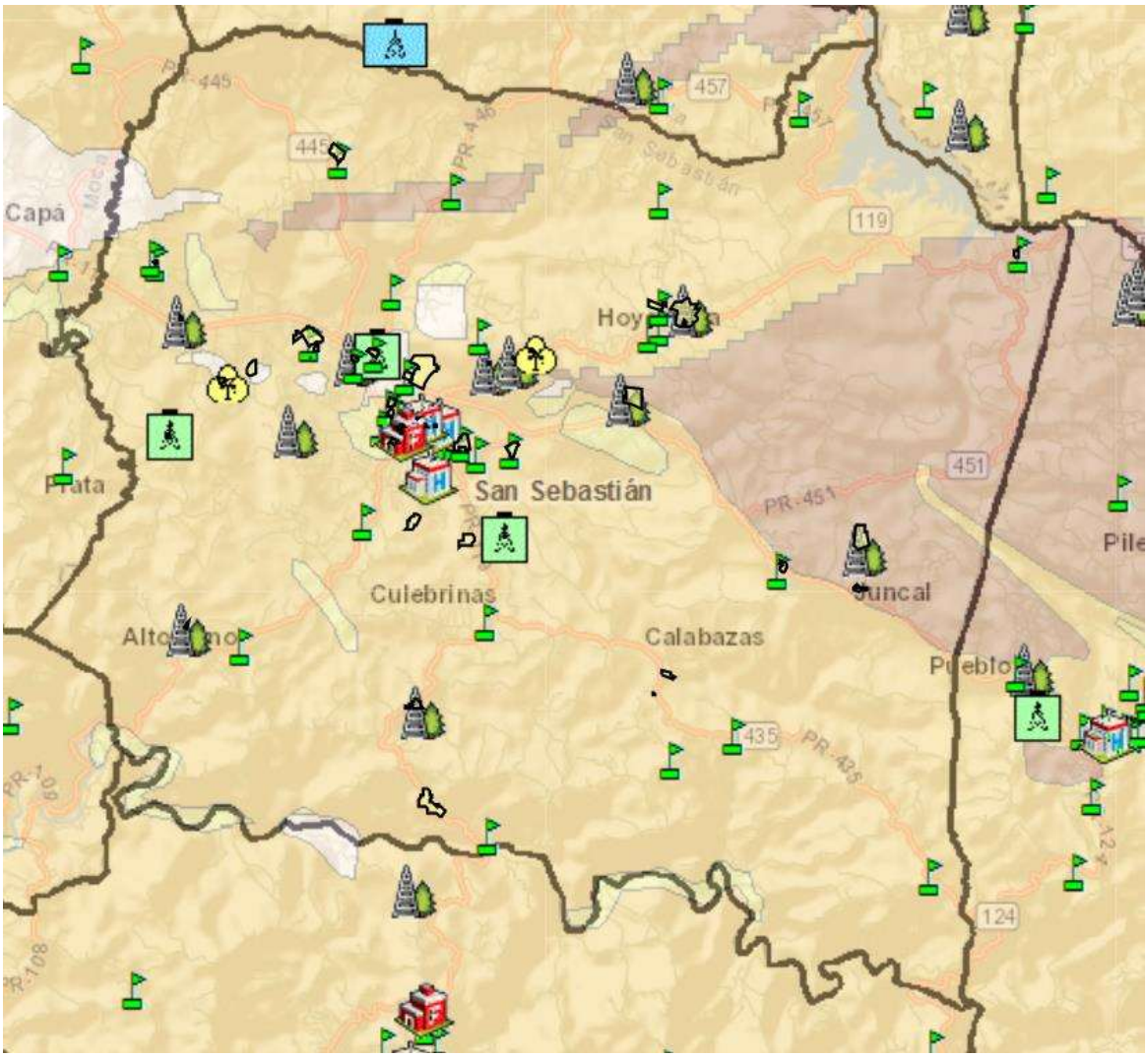

Figure 4-15 Critical Facilities and Earthquake Ground Shaking Hazard Areas in Municipality of San Sebastián

Table 4-15
Impact on Critical Facilities Located in Earthquake Ground Shaking Hazard Areas

	Facility Name	Type	Earthquake Hazard Areas				
			Very Low	Low	Moderate	High	Very High
1	City Hall	Municipal			X		
2	Finance and Municipal Legislature	Municipal			X		
3	Public Safety Office (OMME / Police)	EOC / Police			X		
4	Juncal Com Center	EOC / Emergency		X			
5	Hoyamala Com Center	EOC / Emergency			X		
6	Guacio Com Center	EOC / Emergency			X		
7	Cibao Com Center	EOC / Emergency		X			
8	Calabazas Com Center	EOC / Emergency			X		
9	Cancha LMM	Municipal			X		
10	CDT Cirugía Ambulatoria	Hospital			X		
11	Centro Medicina Cirugía Ambulatoria	Hospital			X		
12	Pepino Health Group	Hospital			X		
13	Fire House	Fire			X		
14	Water Treatment Plant	FP			X		
15	Waste Water Treatment Plant (old)	WWTP			X		
16	Waste Water Treatment Plant (new)	WWTP				X	
17	Innovation WireLess Group	Communication		X			
18	Innovation WireLess Group	Communication			X		
19	AT&T Mobility Puerto Rico Inc.	Communication		X			
20	WRSS	Communication			X		
21	Puerto Rico Telephone Company, Inc.	Communication			X		
22	Puerto Rico Telephone Company, Inc. h/n/c Claro	Communication			X		
23	AT&T Mobility Puerto Rico Inc.	Communication			X		
24	WLRP	Communication		X			
25	Crown & Castle	Communication			X		
26	Puerto Rico Telephone Company, Inc.	Communication		X			
27	WCHQ	Communication			X		
28	QMC Telecom	Communication			X		
29	Red Tower Inc	Communication			X		
30	Innovation WireLess Group	Communication			X		
31	Red Tower Inc	Communication			X		
32	Public Works	Municipal			X		
33	Public Works Shop	Municipal		X			
34	Solid Waste Transfer Station	Municipal			X		
35	Luis Aymat Cardona Coliseum	Municipal			X		
36	Ciudad de Oro	Elderly			X		
37	Escuela Elem Aurea Fuentes Méndez	School			X		
38	Escuela Elem Aurora Méndez	School			X		
39	Escuela Int Ernestina Méndez	School		X			
40	Escuela Sup Manuel Méndez Liciaga	School			X		
41	Escuela Sup Patria Latorre	School			X		
42	Escuela Elem Ramón M. Torres	School			X		
43	Escuela SU Bernaldo Méndez Jiménez	School			X		
44	Escuela SU Carmelo Serrano Cubano	School			X		
45	Escuela SU Máximino A. Salas	School			X		
46	Escuela Elem Emilio Charón	School			X		

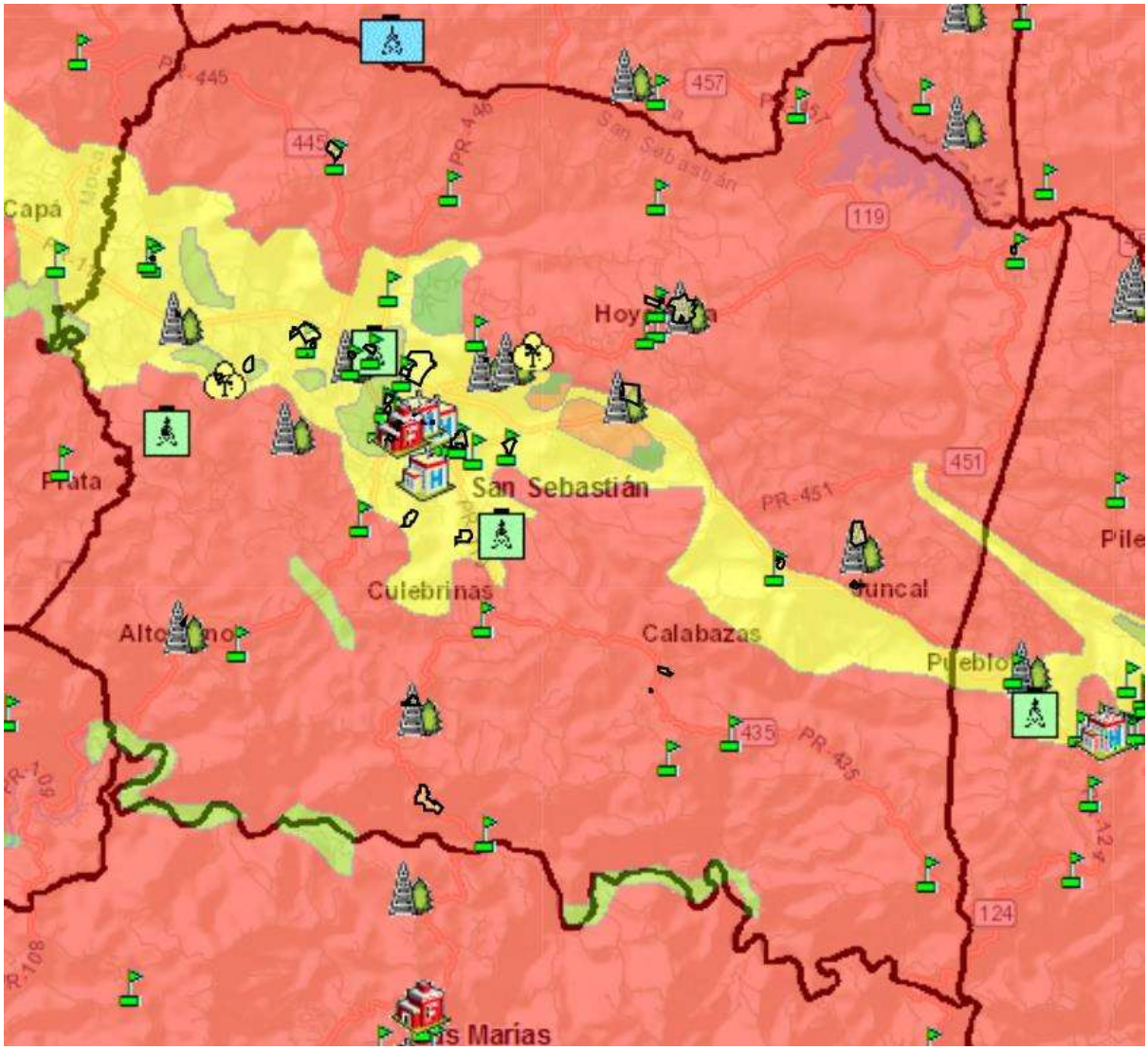

Figure 4-16 Critical Facilities and Liquefaction Hazard Areas in Municipality of San Sebastián

Table 4-16
Impact on Critical Facilities Located in Liquefaction Hazard Areas

	Facility Name	Type	Liquefaction Hazard Areas				
			Very Low	Low	Moderate	High	Very High
1	City Hall	Municipal			X		
2	Finance and Municipal Legislature	Municipal			X		
3	Public Safety Office (OMME / Police)	EOC / Police			X		
4	Juncal Com Center	EOC / Emergency	X				
5	Hoyamala Com Center	EOC / Emergency	X				
6	Guacio Com Center	EOC / Emergency	X				
7	Cibao Com Center	EOC / Emergency	X				
8	Calabazas Com Center	EOC / Emergency	X				
9	Cancha LMM	Municipal			X		
10	CDT Cirugía Ambulatoria	Hospital			X		
11	Centro Medicina Cirugía Ambulatoria	Hospital			X		
12	Pepino Health Group	Hospital			X		
13	Fire House	Fire			X		
14	Water Treatment Plant	FP	X				
15	Waste Water Treatment Plant (old)	WWTP			X		
16	Waste Water Treatment Plant (new)	WWTP			X	X	
17	Innovation WireLess Group	Communication	X				
18	Innovation WireLess Group	Communication	X				
19	AT&T Mobility Puerto Rico Inc.	Communication	X		X		
20	WRSS	Communication	X				
21	Puerto Rico Telephone Company, Inc.	Communication	X				
22	Puerto Rico Telephone Company, Inc. h/n/c Claro	Communication	X				
23	AT&T Mobility Puerto Rico Inc.	Communication	X				
24	WLRP	Communication			X	X	
25	Crown & Castle	Communication	X				
26	Puerto Rico Telephone Company, Inc.	Communication				X	
27	WCHQ	Communication	X				
28	QMC Telecom	Communication	X				
29	Red Tower Inc	Communication	X				
30	Innovation WireLess Group	Communication			X		
31	Red Tower Inc	Communication			X		
32	Public Works	Municipal			X		
33	Public Works Shop	Municipal			X	X	
34	Solid Waste Transfer Station	Municipal			X		
35	Luis Aymat Cardona Coliseum	Municipal			X	X	
36	Ciudad de Oro	Elderly			X		
37	Escuela Elem Aurea Fuentes Méndez	School	X				
38	Escuela Elem Aurora Méndez	School			X		
39	Escuela Int Ernestina Méndez	School			X		
40	Escuela Sup Manuel Méndez Liciaga	School			X		
41	Escuela Sup Patria Latorre	School			X		
42	Escuela Elem Ramón M. Torres	School			X		
43	Escuela SU Bernaldo Méndez Jiménez	School			X		
44	Escuela SU Carmelo Serrano Cubano	School	X				
45	Escuela SU Máximino A. Salas	School			X		
46	Escuela Elem Emilio Charón	School	X				

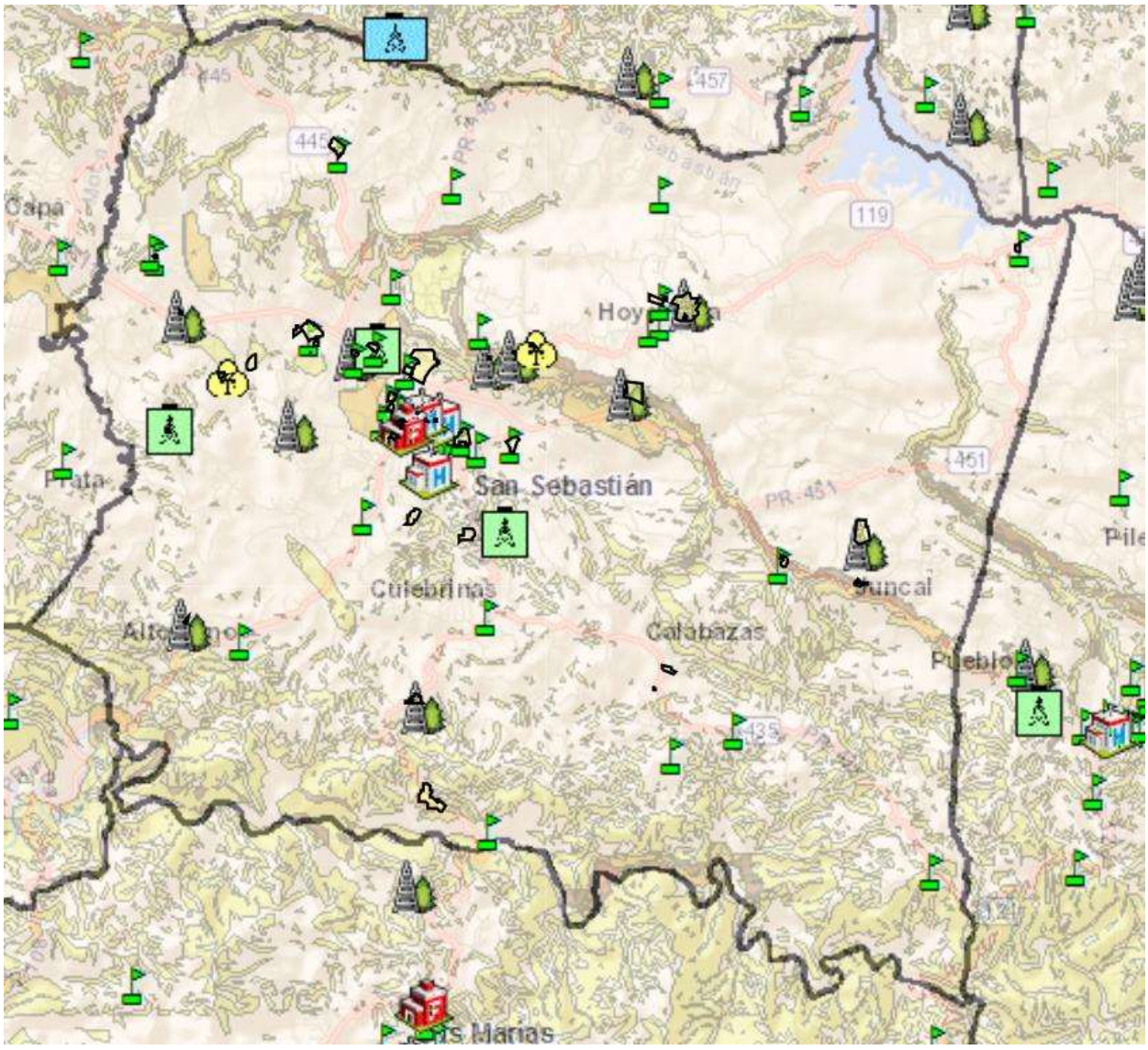

Figure 4-17 Critical Facilities and Earthquake Induced Landslide Hazard Areas in Municipality of San Sebastián

Table 4-17
Impact on Critical Facilities Located in Earthquake-Induced Landslide Hazard Areas

	Facility Name	Type	Earthquake-Induced Landslide Hazard Areas				
			Very Low	Low	Moderate	High	Very High
1	City Hall	Municipal	X				
2	Finance and Municipal Legislature	Municipal	X				
3	Public Safety Office (OMME / Police)	EOC / Police	X				
4	Juncal Com Center	EOC / Emergency					X
5	Hoyamala Com Center	EOC / Emergency	X				
6	Guacio Com Center	EOC / Emergency		X			
7	Cibao Com Center	EOC / Emergency	X				
8	Calabazas Com Center	EOC / Emergency	X				
9	Cancha LMM	Municipal	X				
10	CDT Cirugía Ambulatoria	Hospital	X				
11	Centro Medicina Cirugía Ambulatoria	Hospital	X				
12	Pepino Health Group	Hospital	X				
13	Fire House	Fire	X				
14	Water Treatment Plant	FP		X			
15	Waste Water Treatment Plant (old)	WWTP	X				
16	Waste Water Treatment Plant (new)	WWTP		X			
17	Innovation WireLess Group	Communication	X				
18	Innovation WireLess Group	Communication	X				
19	AT&T Mobility Puerto Rico Inc.	Communication					X
20	WRSS	Communication		X			
21	Puerto Rico Telephone Company, Inc.	Communication	X				
22	Puerto Rico Telephone Company, Inc. h/n/c Claro	Communication		X			
23	AT&T Mobility Puerto Rico Inc.	Communication		X			
24	WLRP	Communication		X			
25	Crown & Castle	Communication	X				
26	Puerto Rico Telephone Company, Inc.	Communication	X				
27	WCHQ	Communication	X				
28	QMC Telecom	Communication		X			
29	Red Tower Inc	Communication	X				
30	Innovation WireLess Group	Communication	X				
31	Red Tower Inc	Communication	X				
32	Public Works	Municipal	X				
33	Public Works Shop	Municipal		X			
34	Solid Waste Transfer Station	Municipal		X			
35	Luis Aymat Cardona Coliseum	Municipal		X			
36	Ciudad de Oro	Elderly		X			
37	Escuela Elem Aurea Fuentes Méndez	School		X			
38	Escuela Elem Aurora Méndez	School	X				
39	Escuela Int Ernestina Méndez	School	X				
40	Escuela Sup Manuel Méndez Liciaga	School	X				
41	Escuela Sup Patria Latorre	School	X				
42	Escuela Elem Ramón M. Torres	School	X				
43	Escuela SU Bernaldo Méndez Jiménez	School	X				
44	Escuela SU Carmelo Serrano Cubano	School	X				
45	Escuela SU Máximino A. Salas	School					X
46	Escuela Elem Emilio Charón	School	X				

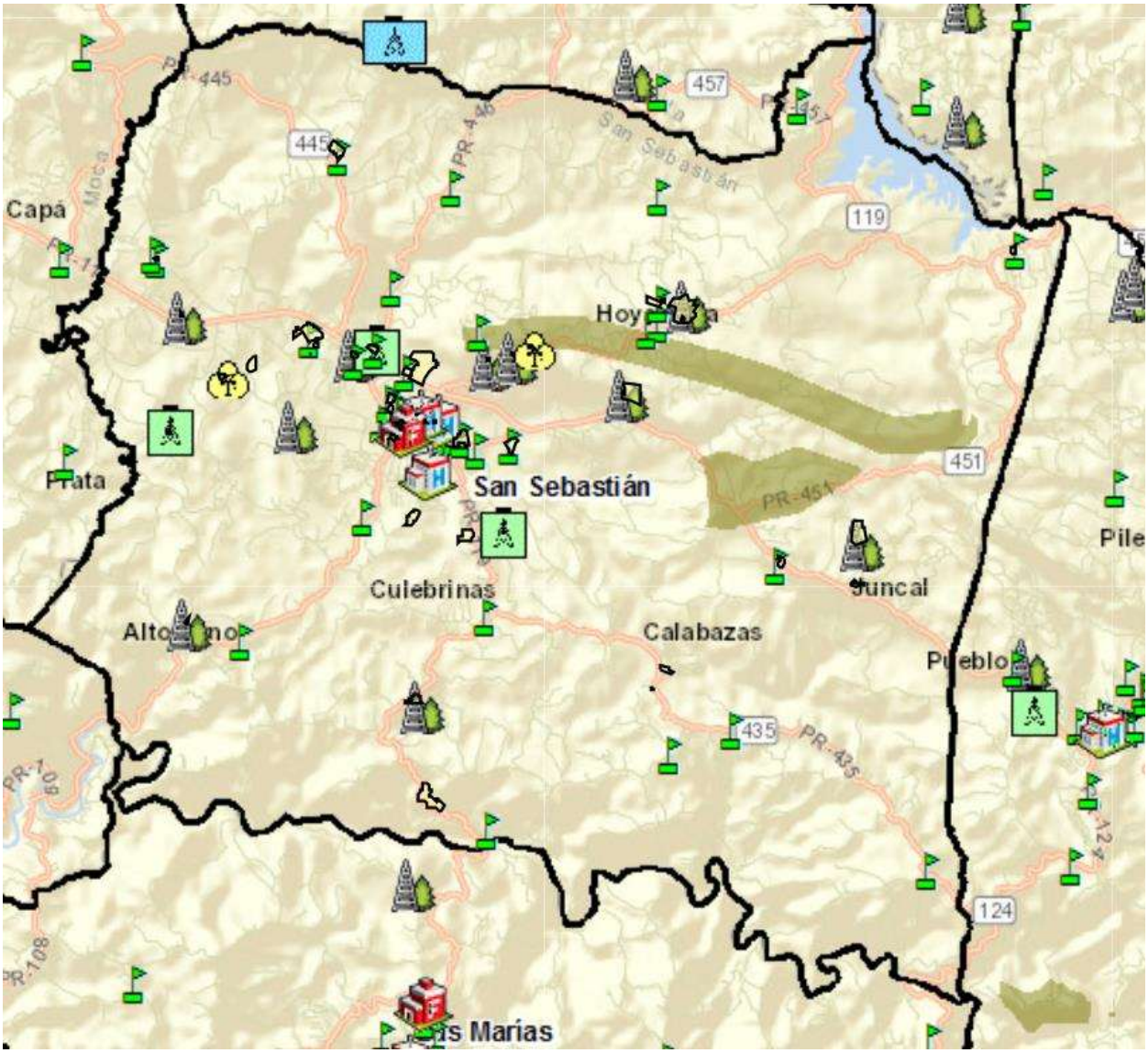

Figure 4-18 Critical Facilities and High Wind Hazard Areas in Municipality of San Sebastián

Table 4-18
Impact on Critical Facilities Located in High Wind Hazard Areas

	Facility Name	Type	Area of Stronger Wind Intensity Hazard	
			In Area	Outside Area
1	City Hall	Municipal		X
2	Finance and Municipal Legislature	Municipal		X
3	Public Safety Office (OMME / Police)	EOC / Police		X
4	Juncal Com Center	EOC / Emergency		X
5	Hoyamala Com Center	EOC / Emergency		X
6	Guacio Com Center	EOC / Emergency		X
7	Cibao Com Center	EOC / Emergency		X
8	Calabazas Com Center	EOC / Emergency		X
9	Cancha LMM	Municipal		X
10	CDT Cirugía Ambulatoria	Hospital		X
11	Centro Medicina Cirugía Ambulatoria	Hospital		X
12	Pepino Health Group	Hospital		X
13	Fire House	Fire		X
14	Water Treatment Plant	FP		X
15	Waste Water Treatment Plant (old)	WWTP		X
16	Waste Water Treatment Plant (new)	WWTP		X
17	Innovation WireLess Group	Communication		X
18	Innovation WireLess Group	Communication		X
19	AT&T Mobility Puerto Rico Inc.	Communication		X
20	WRSS	Communication		X
21	Puerto Rico Telephone Company, Inc.	Communication		X
22	Puerto Rico Telephone Company, Inc. h/n/c Claro	Communication		X
23	AT&T Mobility Puerto Rico Inc.	Communication		X
24	WLRP	Communication		X
25	Crown & Castle	Communication		X
26	Puerto Rico Telephone Company, Inc.	Communication		X
27	WCHQ	Communication		X
28	QMC Telecom	Communication		X
29	Red Tower Inc	Communication		X
30	Innovation WireLess Group	Communication		X
31	Red Tower Inc	Communication		X
32	Public Works	Municipal		X
33	Public Works Shop	Municipal		X
34	Solid Waste Transfer Station	Municipal		X
35	Luis Aymat Cardona Coliseum	Municipal		X
36	Ciudad de Oro	Elderly		X
37	Escuela Elem Aurea Fuentes Méndez	School		X
38	Escuela Elem Aurora Méndez	School		X
39	Escuela Int Ernestina Méndez	School		X
40	Escuela Sup Manuel Méndez Liciaga	School		X
41	Escuela Sup Patria Latorre	School		X
42	Escuela Elem Ramón M. Torres	School		X
43	Escuela SU Bernaldo Méndez Jiménez	School		X
44	Escuela SU Carmelo Serrano Cubano	School		X
45	Escuela SU Máximino A. Salas	School		X
46	Escuela Elem Emilio Charón	School	X	

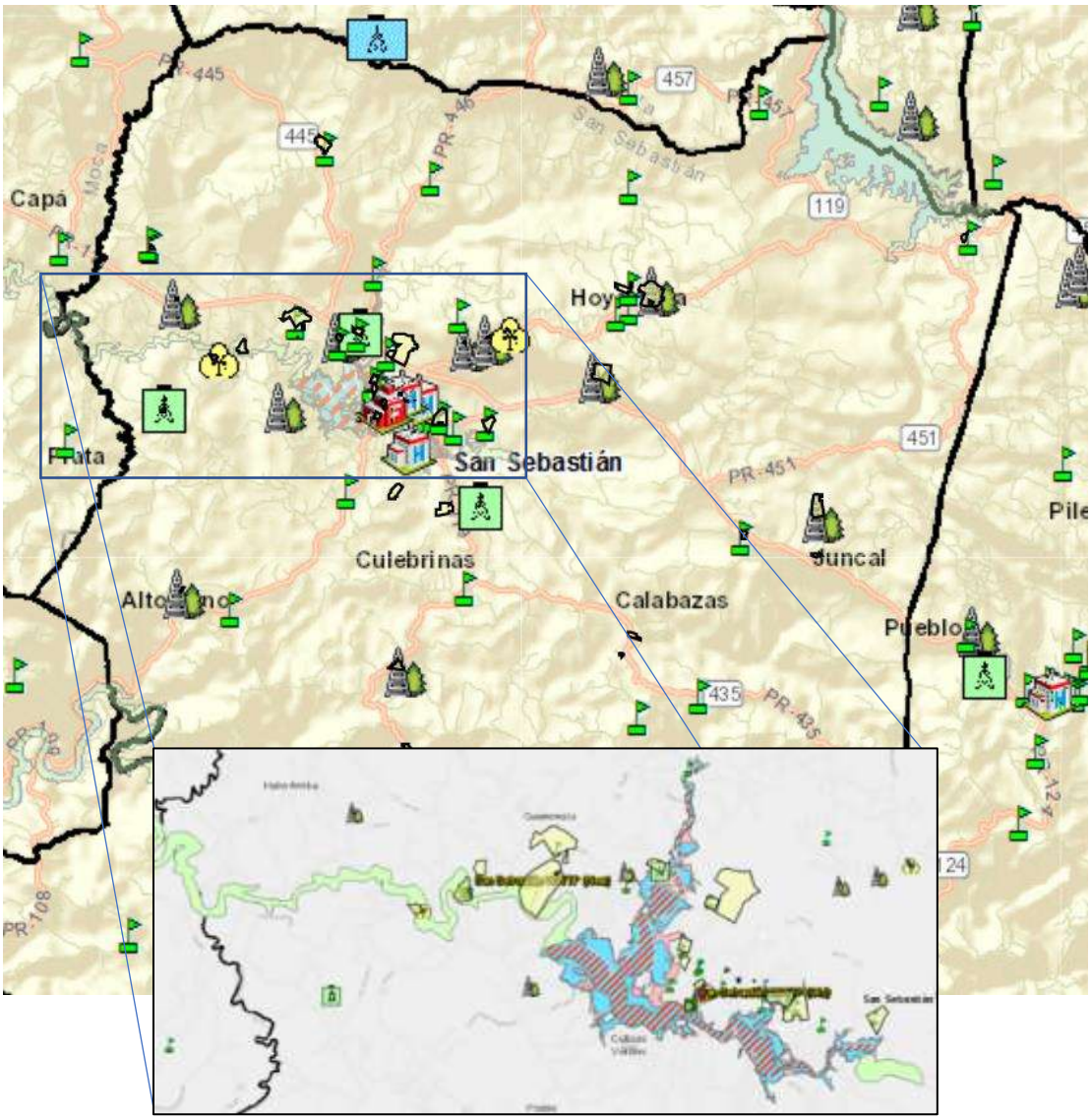

Figure 4-19 Critical Facilities and Riverine Flooding Hazard Areas in Municipality of San Sebastián

Table 4-19
Impact on Critical Facilities Located in Riverine Flooding Areas Hazard Areas

	Facility Name	Type	FEMA DFIRM	
			100-year	500-year
1	City Hall	Municipal		
2	Finance and Municipal Legislature	Municipal		
3	Public Safety Office (OMME / Police)	EOC / Police		
4	Juncal Com Center	EOC / Emergency		
5	Hoyamala Com Center	EOC / Emergency		
6	Guacio Com Center	EOC / Emergency		
7	Cibao Com Center	EOC / Emergency		
8	Calabazas Com Center	EOC / Emergency		
9	Cancha LMM	Municipal		
10	CDT Cirugía Ambulatoria	Hospital		
11	Centro Medicina Cirugía Ambulatoria	Hospital		
12	Pepino Health Group	Hospital		X
13	Fire House	Fire		
14	Water Treatment Plant	FP		
15	Waste Water Treatment Plant (old)	WWTP	X	X
16	Waste Water Treatment Plant (new)	WWTP	X	
17	Innovation WireLess Group	Communication		
18	Innovation WireLess Group	Communication		
19	AT&T Mobility Puerto Rico Inc.	Communication		
20	WRSS	Communication		
21	Puerto Rico Telephone Company, Inc.	Communication		
22	Puerto Rico Telephone Company, Inc. h/n/c Claro	Communication		
23	AT&T Mobility Puerto Rico Inc.	Communication		
24	WLRP	Communication	X	X
25	Crown & Castle	Communication		
26	Puerto Rico Telephone Company, Inc.	Communication	X	
27	WCHQ	Communication		
28	QMC Telecom	Communication		
29	Red Tower Inc	Communication		
30	Innovation WireLess Group	Communication		
31	Red Tower Inc	Communication		
32	Public Works	Municipal		
33	Public Works Shop	Municipal	X	
34	Solid Waste Transfer Station	Municipal		
35	Luis Aymat Cardona Coliseum	Municipal		
36	Ciudad de Oro	Elderly		
37	Escuela Elem Aurea Fuentes Méndez	School		
38	Escuela Elem Aurora Méndez	School	X	X
39	Escuela Int Ernestina Méndez	School		
40	Escuela Sup Manuel Méndez Liciaga	School		
41	Escuela Sup Patria Latorre	School		
42	Escuela Elem Ramón M. Torres	School		
43	Escuela SU Bernaldo Méndez Jiménez	School		
44	Escuela SU Carmelo Serrano Cubano	School		
45	Escuela SU Máximino A. Salas	School		
46	Escuela Elem Emilio Charón	School		

National Flood Insurance Program

FEMA reports only three communities in the loss statistics report as February 28, 2018: municipalities of Bayamón, Ponce, and the rest of Puerto Rico as one community. The total losses for Puerto Rico is 25,137 cases with total payments in the range of $137 million (**Table 4-20**). The municipality of San Sebastián has participation in the NFIP as part of the Puerto Rico community No. 7200000 with other 75 Municipalities (**Table 4-21**). The total policies in-force for Puerto Rico is 7,162 policies for $889 million dollars. The Puerto Rico Planning Board (PRPB) provided additional information regarding NFIP policies per request of the Municipality of San Sebastián. The PRPB reported a total of 189 policies in the Municipality of San Sebastián from 1997 to February 28, 2018. Only 10 policies were active by the time of preparing this plan. One repetitive loss was reported for the first time in the municipality (Bahomamey ward).

Table 4-20
Loss statistics in Puerto Rico as of February 28, 2018[17]

Community Name	Total Losses	Closed Losses	Open Losses	CWOP Losses	Total Payments
Bayamón, Municipality of	18	8	2	8	138,715.65
Ponce, Municipality of	76	39	10	27	279,433.59
Puerto Rico, Commonwealth	25,043	18,321	199	6,523	137,211,563.36
Total for PR	25,137	18,368	211	6,558	137,629,712.60

Table 4-21
Policy statistics in Puerto Rico as of February 28, 2018[18]

Community Name	Policies In-force	Insurance In-force whole $	Written Premium In-force
Bayamón, Municipality of	79	15,924,800	96,863
Guaynabo, Municipality of	1	115,000	839
Ponce, Municipality of	518	60,578,500	401,267
Puerto Rico, Commonwealth	6,564	813,274,600	5,364,172
Total for PR	7,162	889,892,900	5,863,141

Reducing the damages associated with new buildings, structures, and infrastructure, both public and private, is the most cost effective way to implement hazard mitigation. Dealing with the mistakes of the past is often too expensive. Given this key hazard mitigation concept, it is important to describe how this Plan addresses the need to implement hazard risk reduction measures for new structure and/or infrastructure.

[17] https://bsa.nfipstat.fema.gov/reports/1040.htm#72 retrieved April 23,2018
[18] https://bsa.nfipstat.fema.gov/reports/1011.htm#PRT retrieved April 23,2018

This element intent to "inform hazard mitigation actions for properties that have suffered repetitive damage due to flooding, particularly problem areas that may not be apparent on flooding maps. Information on repetitive loss properties helps inform FEMA hazard mitigation assistance programs under the National Flood Insurance Act."[19] This element requires to describe the type (residential, commercial, institutional, etc.) and estimate the number of repetitive loss properties locates in identified flood hazard areas. Since the use of flood insurance claim and disaster assistance information is protected by the Privacy Act of 1974, the municipality provided a general statistics summary regarding policies on Section 4.6.

Additional information on types of structures (residential, commercial, etc.) covered under NFIP, recommendation: include map of NFIP insured structures

The Municipality of San Sebastián requested NFIP Policies information to the Puerto Rico Planning Board. The HMP provides a summary of the statistics regarding those sites that have or have had policies since 1997, the number of active policies during year 2018 and the number of sites reported with repetitive losses. The PRPB reported a total of 189 policies in the Municipality of San Sebastián from 1997 to February 28, 2018. Only 10 policies were active by the time of preparing this plan. One repetitive loss was reported for the first time in the municipality (Bahomamey ward).

The repetitive loss property is located on road PR-125 however, the specific km provided by the PRPB (reserved by the municipality by the Property Act of 1974), does not exist. Personnel of the Municipality went to the field to find the property in the address provided by the PRPB but confirmed that it does not exist. Said that, the personnel moved to other sites that might be related however, the road Km does not reach the one provided by the PRPB. One of the possibilities in the same road is in Guatemala Ward but the subject property is in Bahomamey ward. This alternative area is classified as 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile (Zone X). A second alternative site is in another road but with the km provided by the PRPB however, it is in Juncal Ward (Zone X), instead of Bahomamey ward. **Figure 4-20** shows the Susceptible Flood Areas Map (FIRM 2009). The limits in yellow with red borders represent the areas where there are properties with active Flood Insurance in 2018. The central limit colored in red with yellow borders delimits road PR-125 where the PRPB identified a property with repetitive losses. **Figure 4-21** is the zone map for the area showing that most of the structures along road PR-125 are private properties. These structures are built in concrete and are used for commercial and residential purposes.

[19] FEMA 2011. Local Mitigation Plan Review Guide. Page 21.

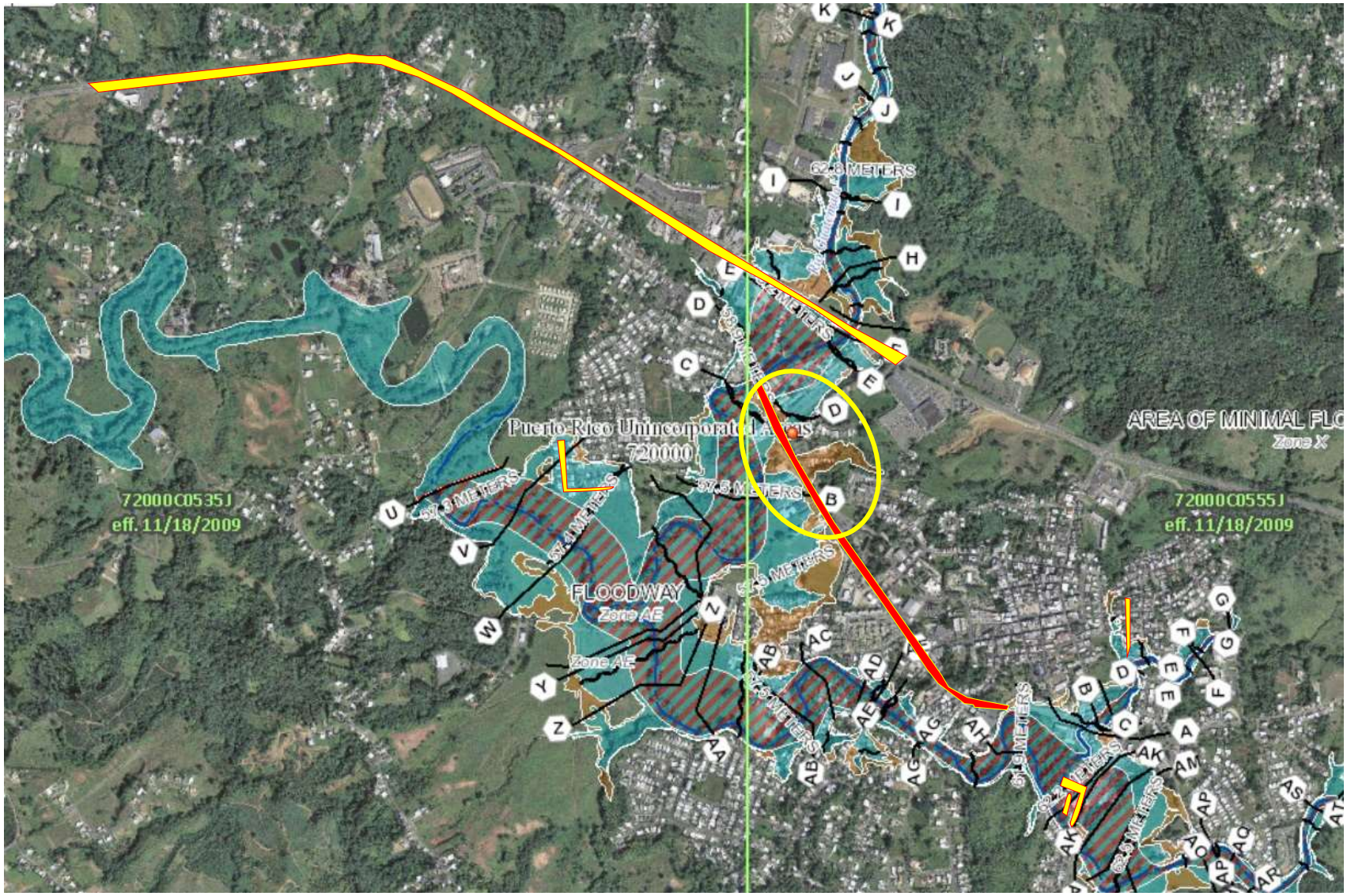

Figure 4-20 Susceptible Flood Map (FEMA FIRM 72000C0535J, 72000C0555J, 11/18/2009). The limits in yellow with red borders represent the areas where there are properties with active Flood Insurance in 2018; The central limit colored in red with yellow borders delimits road PR-125 where the PRPB identified a property with repetitive losses.

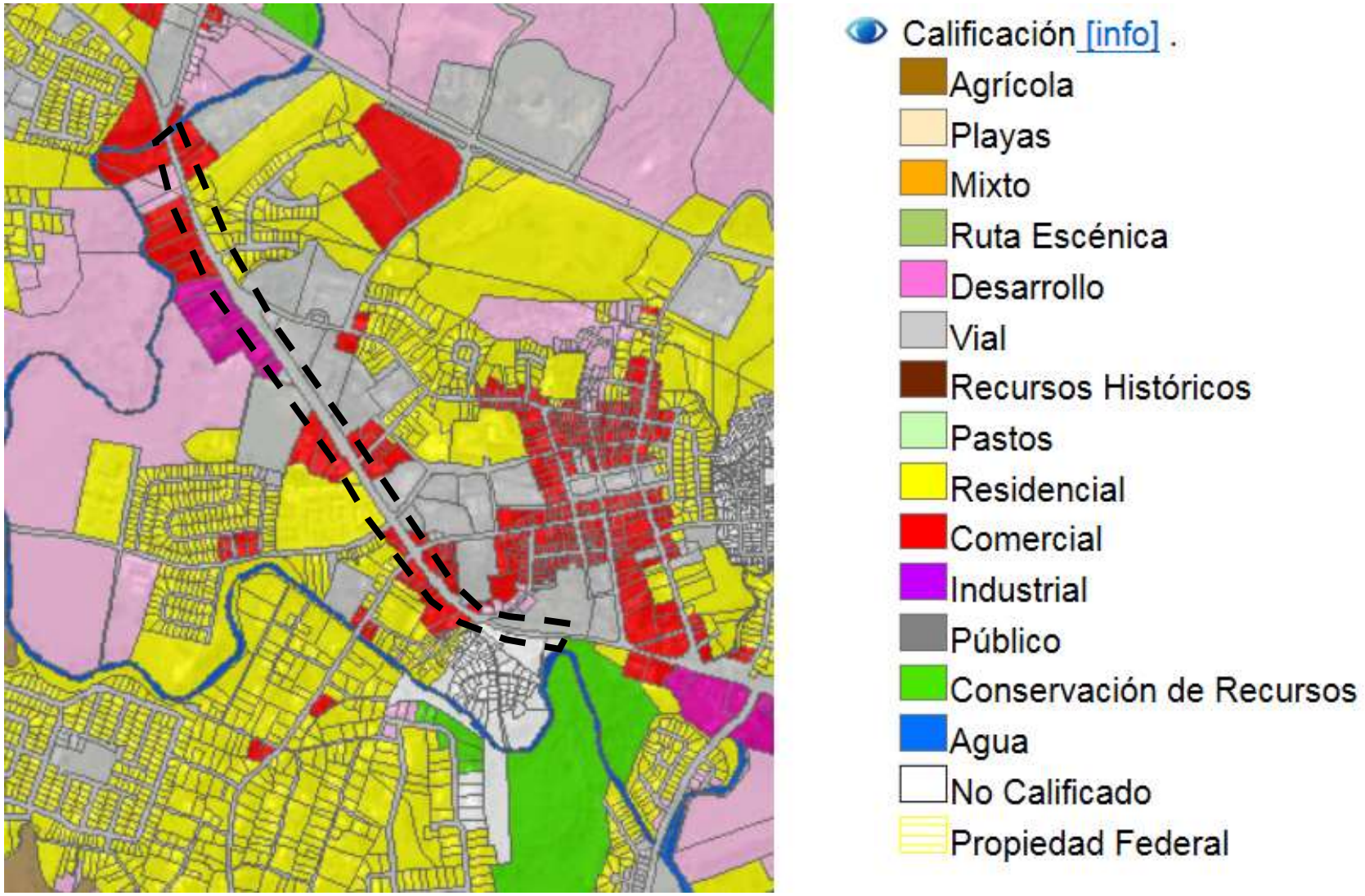

Figure 4-21 Zone Map along road PR-125 (dot lines area). Most of the sites are used for commercial, and residential purposes while other are used for industrial and public activities. (PRPB, 2018).

Additional Information on Repetitive Loss (events)

The Flood Insurance Policies information record by the PRPB includes data since year 1997. Even though the PRPB report does not mention the events where the repetitive loss property owner received FEMA's assistance, it can be suspect that at least two of the floods events listed on Table 4-8, impacted the repetitive loss property from 1972 to 1999.

The HMP also included information reported from NOAA between January 1, 2012 and May 28, 2018.Fifty-five municipalities have been affected during 128 days with events. Road PR-125 in Bahomamey ward (were the repetitive loss property is located), was impacted by the following significant events:

- Heavy Rain - May 9, 2017 (event 703976)
  An upper level trough continued maintaining a wet weather pattern across the region. Flash flood warnings were issued due to heavy rain. Roads PR-446, KM 0.2 intersection with PR-125 near Selectos Supermarket were affected by flooded waters from Rio Culebrinas.

- Heavy Rain – June 18, 2017 (event 710752)
  Available low level moisture combined with daytime heating and local effects produced scattered to numerous showers with thunderstorms across the western interior and northwest sections of Puerto Rico. Flooding was reported at roads PR-125 and PR-446.

Table 5-6 includes the complete list of mitigation actions for the period of 2018-2023. Mitigation Action No. 51 proposes a flood control project for bridge on municipal road PR-125 int., Urb. El Culebrinas, Culebrinas Ward while Mitigation Action No. 55 proposes a flood control project for bridge on municipal road PR-125 int., Puente Viejo Sector, bridge between Pozas and Bahomamey wards. Both mitigation actions are new for the updated HMP.

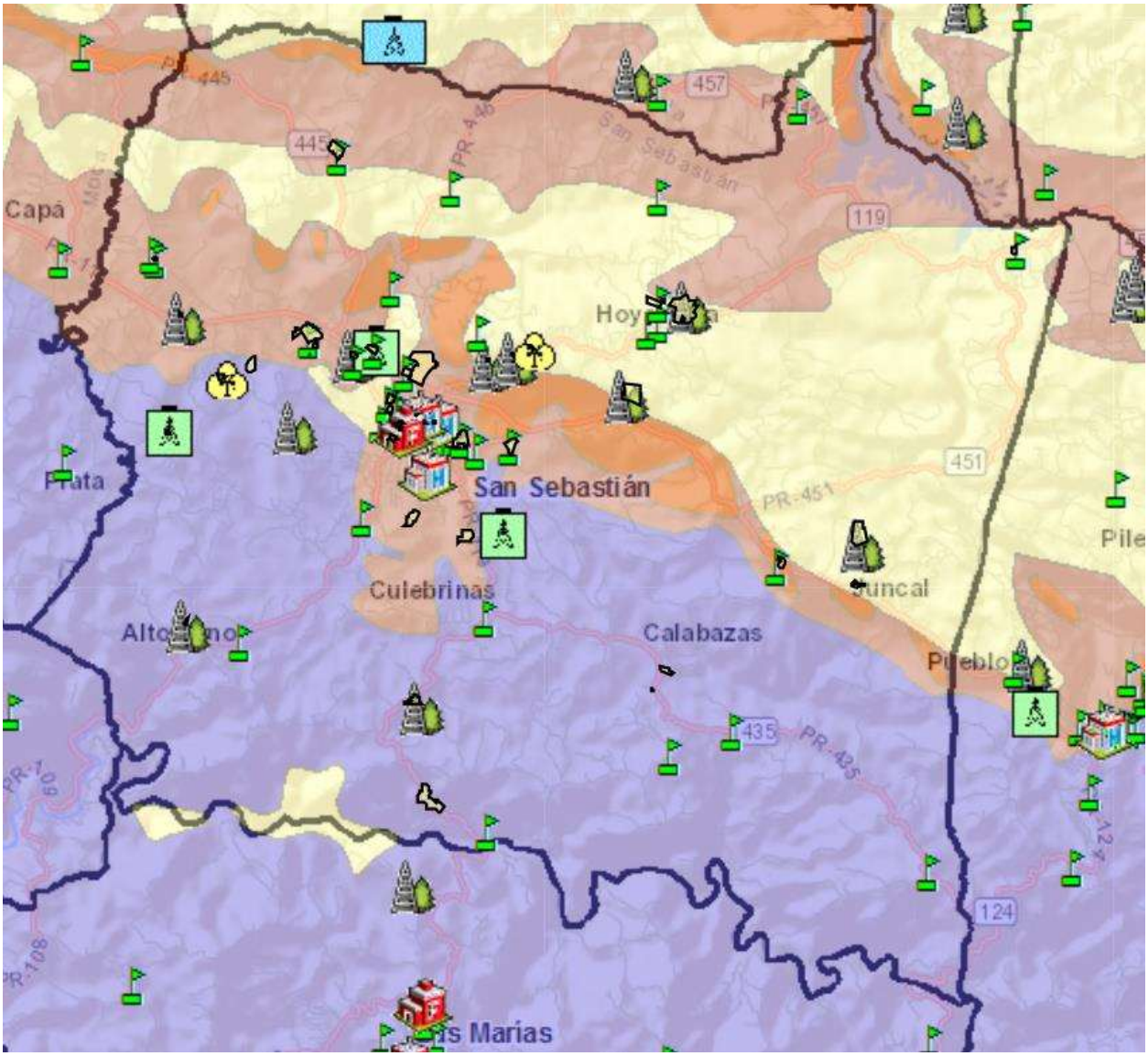

Figure 4-22 Critical Facilities and Rainfall Induced Landslide Areas in Municipality of San Sebastián

Table 4-22
Impact on Critical Facilities Located in Rainfall Induced Landslide Hazard Areas

	Facility Name	Type	Rain-Induced Landslide Susceptible Areas			
			Low	Moderate	High	Highest
1	City Hall	Municipal			X	
2	Finance and Municipal Legislature	Municipal			X	
3	Public Safety Office (OMME / Police)	EOC / Police			X	
4	Juncal Com Center	EOC / Emergency	X			
5	Hoyamala Com Center	EOC / Emergency	X			
6	Guacio Com Center	EOC / Emergency		X		
7	Cibao Com Center	EOC / Emergency	X			
8	Calabazas Com Center	EOC / Emergency		X		
9	Cancha LMM	Municipal			X	
10	CDT Cirugía Ambulatoria	Hospital			X	
11	Centro Medicina Cirugía Ambulatoria	Hospital			X	
12	Pepino Health Group	Hospital			X	
13	Fire House	Fire			X	
14	Water Treatment Plant	FP		X		
15	Waste Water Treatment Plant (old)	WWTP	X			
16	Waste Water Treatment Plant (new)	WWTP		X		
17	Innovation WireLess Group	Communication	X			
18	Innovation WireLess Group	Communication	X			
19	AT&T Mobility Puerto Rico Inc.	Communication	X			
20	WRSS	Communication		X		
21	Puerto Rico Telephone Company, Inc.	Communication	X			
22	Puerto Rico Telephone Company, Inc. h/n/c Claro	Communication	X			
23	AT&T Mobility Puerto Rico Inc.	Communication	X			
24	WLRP	Communication			X	
25	Crown & Castle	Communication		X		
26	Puerto Rico Telephone Company, Inc.	Communication		X		
27	WCHQ	Communication		X		
28	QMC Telecom	Communication		X		
29	Red Tower Inc	Communication		X		
30	Innovation WireLess Group	Communication			X	
31	Red Tower Inc	Communication			X	
32	Public Works	Municipal			X	
33	Public Works Shop	Municipal		X	X	
34	Solid Waste Transfer Station	Municipal			X	
35	Luis Aymat Cardona Coliseum	Municipal			X	
36	Ciudad de Oro	Elderly			X	
37	Escuela Elem Aurea Fuentes Méndez	School		X		
38	Escuela Elem Aurora Méndez	School			X	
39	Escuela Int Ernestina Méndez	School			X	
40	Escuela Sup Manuel Méndez Liciaga	School			X	
41	Escuela Sup Patria Latorre	School			X	
42	Escuela Elem Ramón M. Torres	School			X	
43	Escuela SU Bernaldo Méndez Jiménez	School			X	
44	Escuela SU Carmelo Serrano Cubano	School			X	
45	Escuela SU Máximino A. Salas	School			X	
46	Escuela Elem Emilio Charón	School	X			

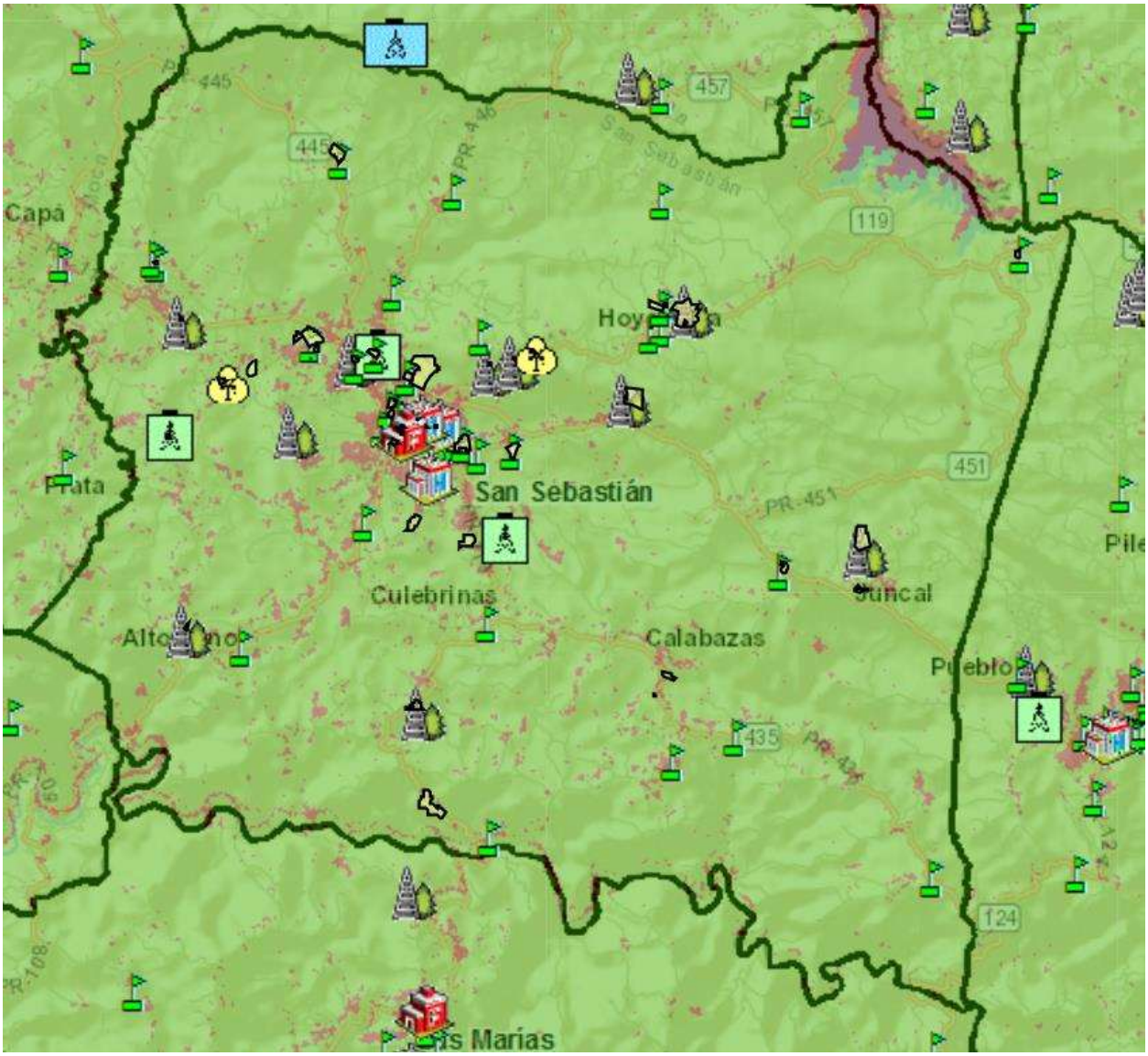

Figure 4-23 Critical Facilities and Wildfire Areas in Municipality of San Sebastián

Table 4-23
Impact on Critical Facilities Located in Wildfire Hazard Areas

	Facility Name	Type	Susceptibility level 0	Susceptibility level 1
1	City Hall	Municipal	X	
2	Finance and Municipal Legislature	Municipal	X	
3	Public Safety Office (OMME / Police)	EOC / Police		X
4	Juncal Com Center	EOC / Emergency		X
5	Hoyamala Com Center	EOC / Emergency		X
6	Guacio Com Center	EOC / Emergency		X
7	Cibao Com Center	EOC / Emergency		X
8	Calabazas Com Center	EOC / Emergency		X
9	Cancha LMM	Municipal	X	X
10	CDT Cirugía Ambulatoria	Hospital	X	
11	Centro Medicina Cirugía Ambulatoria	Hospital	X	
12	Pepino Health Group	Hospital	X	X
13	Fire House	Fire	X	
14	Water Treatment Plant	FP	X	X
15	Waste Water Treatment Plant (old)	WWTP	X	X
16	Waste Water Treatment Plant (new)	WWTP		X
17	Innovation WireLess Group	Communication		X
18	Innovation WireLess Group	Communication		X
19	AT&T Mobility Puerto Rico Inc.	Communication		X
20	WRSS	Communication		X
21	Puerto Rico Telephone Company, Inc.	Communication		X
22	Puerto Rico Telephone Company, Inc. h/n/c Claro	Communication	X	X
23	AT&T Mobility Puerto Rico Inc.	Communication		X
24	WLRP	Communication	X	X
25	Crown & Castle	Communication		X
26	Puerto Rico Telephone Company, Inc.	Communication		X
27	WCHQ	Communication		X
28	QMC Telecom	Communication		X
29	Red Tower Inc	Communication		X
30	Innovation WireLess Group	Communication		X
31	Red Tower Inc	Communication	X	
32	Public Works	Municipal		X
33	Public Works Shop	Municipal	X	X
34	Solid Waste Transfer Station	Municipal		X
35	Luis Aymat Cardona Coliseum	Municipal	X	X
36	Ciudad de Oro	Elderly	X	X
37	Escuela Elem Aurea Fuentes Méndez	School	X	X
38	Escuela Elem Aurora Méndez	School	X	X
39	Escuela Int Ernestina Méndez	School	X	
40	Escuela Sup Manuel Méndez Liciaga	School	X	X
41	Escuela Sup Patria Latorre	School	X	X
42	Escuela Elem Ramón M. Torres	School	X	
43	Escuela SU Bernaldo Méndez Jiménez	School	X	
44	Escuela SU Carmelo Serrano Cubano	School	X	X
45	Escuela SU Máximino A. Salas	School		X
46	Escuela Elem Emilio Charón	School		X

Following, the vulnerability assessment was used to estimate of losses to each hazard. The estimation of hazard related damage to buildings is based on the characteristics of the model building types and an estimate of the hazard intensity (wind speed, flood level, etc.). **Table 4-24** shows the potential loses amounts updated during the 2018 review process. The extent and severity of damage to structural and nonstructural components of a building is described by one of five damage states**:**

- Very Low, (no, or negligible damage)
- Low, (easily repairable damage mainly to part of nonstructural components and/or contents)
- Moderate, (considerable, yet repairable damage to mainly non-structural components)
- High (considerable damage to both structural and non-structural components), and
- Very high (that the extent of damage is too much to be repaired; the facility has to be demolished and replaced).

The qualitative vulnerability ratings relate to a percentage of damage for each model building type. The damage estimation methods for critical facilities and infrastructure are identical to those utilized to estimate damage with general building stock, except that classification or grouping of facilities was not needed.

Table 4-24
Municipal facilities identified at high risk areas

Municipality Property	Physical Address	Potential Hazard	Potential Loses
Edif Casa Alcaldía	3 Calle Padre Feliciano	EG, EQ, UF, HW	$1,200,176
Biblioteca Electrónica	Calle MJ Cabrero	EG, EQ, UF, HW	$4,023,242
Centro de Bellas Artes	Calle Severo Arana	EG, EQ, UF, RF, HW	$3,042,071
Cancha Luis Muñoz Marín	Carr 125 Km 21.8	EG, EQ, EL, UF, RL, HW, RF	$1,044,259
Terminal Carros Públicos	Calle Muñoz Rivera	EG, EQ, UF, HW	$2,970,459
Parque Juan Jose Beniques	Carr 111 Km 17	EG, EQ, RL, UF, HW	$12,020,000
Coliseo Luis Aymat Cardona	Carr 111 y Ave Arcadio Estrada Linares	EG, EQ, EL, RL, RF, HW	$13,776,491
Oficinas Manejo de Emergencias	Carr 125 Km 19.1 Bo Guatemala	EG, EQ, ELHW	$526,266
Edif de Finanzas	Calle Padre Feliciano Esq Severo Arana	CF	$564,000

Notes: Total Potential Loses updated 2018.
(EG) Earthquake Ground Shaking; (EL) Earthquake Landslide; (EQ) Earthquake Liquefaction; (RF) Riverine Flooding; (UF) Urban Fire; (WF) Wildfire; (RL) Rainfall Landslide; (HW) High Wind

4.7 LOSS ESTIMATES

This section of the risk assessment presents the "estimate of losses," including: exposure, damage, and loss estimates analyzed on a hazard-by-hazard basis. The findings support local and regional planners' understanding of the potential impacts of each hazard and enable a comparison of hazards by quantifying potential exposures impacts.

The loss estimates provided in this section were developed using available data, and the methodologies applied have resulted in an approximation of risk. These estimates should be used to understand relative risk from hazards and potential losses. However, it is important to understand that uncertainties are inherent in any loss estimation methodology, arising in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from approximations and simplifications that are necessary for a comprehensive analysis.

As outlined in previous sections, the risk assessment methodology utilized for this study was parametric. The risk analyses are based on a comprehensive methodology that incorporates approaches for:

- Characterizing Hazards, understanding the nature of the hazards (i.e. level of ground shaking, wind speed, depth of flooding);
- Categorization of the built environment, understanding number, distribution, and value of assets (i.e. general buildings & critical facilities),
- Vulnerability Analysis, understanding the damage and loss characteristics of identified buildings, and
- Estimating damage and losses to buildings and critical facilities.
- An examination and analysis of existing reports per hazard has been researched. Information has been found through various State and Federal agencies.
- As part of the Hazard Risk Assessment, Hazard Profile Description of San Sebastián was prepared. Risks were classified to which reference is made throughout the Plan.

Table 4-25
Hazard Impact and Potential Losses

Hazard Event	Population Impacted by risk	Percentage Of Affected Population	Number of buildings Residential and Commercial at Risk	Potential Losses
Earthquake-Ground Shaking	30,549	72%	10,183	$1,373,100,000
Earthquake-Liquefaction	2,112	5.0%	704	$9,932,500
Earthquake-Landslide	17,580	4.1%	5,680	$42,115,500
High Wind	34,368	81%	11,456	$153,408,678
Riverine Flooding	6,205	14.7%	2,068	$15,980,000
Wildfire	908	0.21%	302	$1,000,000
Urban Fire	3,642	11.6%	1,214	$18,250,000
Rainfall - Landslide	8,486	5.0%	2,828	$5,000,000

Family composition was taken as three (3) members to get the average of people affected by each hazard event. It took the total population of 42,430 and was divided into the total number of houses according with the US census.

Table 4-26
Loss Statistics – Puerto Rico as of February 28, 2018

Community Name	Total Losses	Closed Losses	Open Losses	CWOP Losses	Total Payments ($)
Bayamón, Municipality of	18	8	2	8	138,716
Ponce, Municipality of	76	39	10	27	279,434
Puerto Rico	25,043	18,321	199	6,523	137,211,563
Total for Puerto Rico	25,137	18,368	211	6.558	137,629,713

Sorce: FEMA 2018. Loss Statistics from Jan 1, 1978 through report as of 02/28/2018, retrieved April 17, 2018. <bsa.nfipstat.fema.gov/reports/1040.htm#72>

4.8 UNDERSTANDING FUTURE LOSSES IN SAN SEBASTIÁN

To understand the future vulnerability (potential losses) in San Sebastián so that mitigation options can be reasonably assessed, it is necessary to compare expected future losses throughout the municipality. A comparative assessment of future risk may provide a basis to understand how future development may increase vulnerability to each hazard. This subsection presents a brief methodology that was used to compare future risk, projects losses for 10, 20 and 30-years from today, and proposes a land use map The Plan provides critical baseline information (history, demographic profile, etc.), in addition to an understanding of the Municipality's development objectives. It is also the main instrument for strategic and integrated land use planning for the territory) that provides the basis for policy makers to assess ways to reduce vulnerability in years to come.

The final hazard mitigation plan discusses and provides an analysis of the frequency of mayor development projects, current public sector projects, pending mayor development projects, per barrio.

The risk projection model presented in **Figure 4-24** consists of three different components:

1. hazard intensity that is defined for a 100-year return period for each identified hazard,
2. exposure which is defined as the number of buildings (inventory) and value, and
3. the vulnerability or damageability of the building stock over time.
4. Hazard mitigation must be an integral component when reviewing building permit applications, conducting building inspections, reviewing subdivision proposals and conducting long-range land use studies for the Municipality

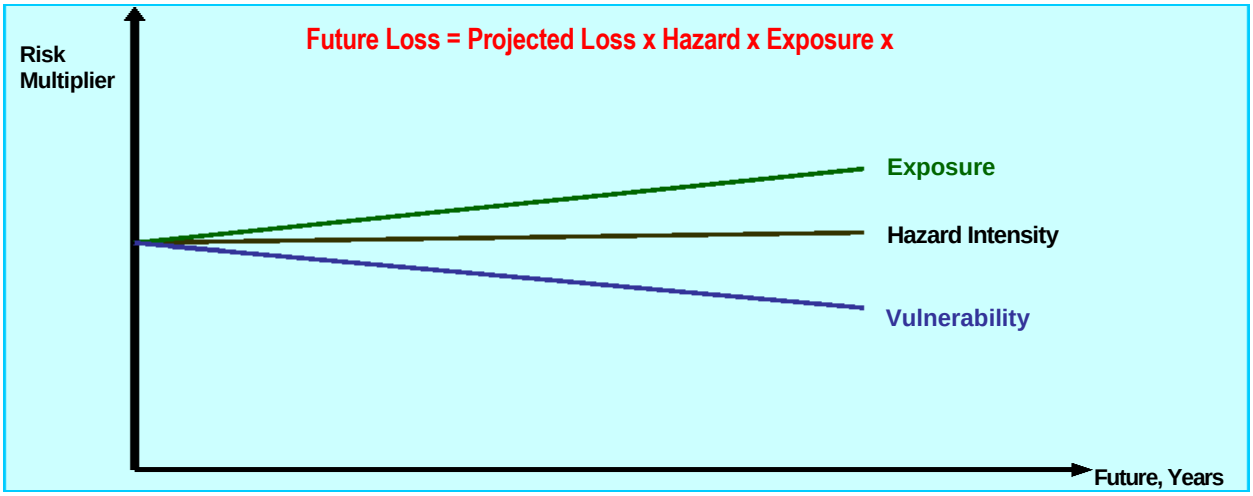

Figure 4-24 Components of Risk Projection Model

These components were systematically combined in a risk projection model to understand the potential future losses for each hazard. This methodology facilitates an understanding of how the following components of the risk assessment changed over time. A description of these components is provided below:

Hazard—the hazard intensity/frequency relationship was assumed to remain constant throughout the 10, 20, and 30 year periods. This means that the hazard intensity, which is based on 100-year return period, is not expected to change dramatically over time (i.e., the timeframe window chosen for the analysis).

Vulnerability—the general characteristics of the built environment are expected to change over time due to: a) regular code improvements and updates, b) degree and level of code enforcement, and c) improvements in the construction material and practices. A vulnerability multiplier was used to update/modify the building performance from the present to that of years 2010, 2020, and 2030.

- **Building Code**—Rico Codes 2018 repeals the Regulation No. 8222 of June 20, 2012, known as the "Puerto Rico Building Code". The Puerto Rico Codes 2018 were approved on November 15, 2018. The Puerto Rico Codes 2018 include the complete set of codes published under the name of Puerto Rico and each of the 10 ICC adopted codes. Act 161-2009, as amended, established that the codes will be revised every three (3) years, from the date of adoption.
- **Code Enforcement**—although formal building codes have been adopted by the central government in Puerto Rico, code enforcement continues to be poorly implemented in rural municipalities. The lack of regulatory control in rural municipalities is directly related to the comprehensive planning process in which municipalities must first complete and adopt a Plan Territorial to obtain regulatory responsibilities. Once adopted, it is expected that code enforcement will gradually improve throughout the municipality. A code enforcement multiplier was used to approximate improvements in the built environment.
- **Construction Practices**—it is assumed that construction practices, in terms of workmanship and materials, will improve over time. A construction multiplier was used to approximate improvements in the built environment.

Therefore, the risk projection model holds that vulnerability in the municipality will decrease over time (i.e., building performance for a given hazard type and intensity will improve over time).

Exposure—U.S. Census data is used to predict future exposure (number of buildings and value) across the municipality. The 2010 US Census reported a 1% decrease in the population of San Sebastián with a total of 42,430. There are 1,774 less people living is San Sebastián than 2000 census. The values were estimated based on a linear regression analysis for each land use classification defined during the field assessment. Therefore, the model assumes that exposure values will increase proportional to population growth and will be uniform across different land use categories in the municipality.

Table 4-27
Estimated Future Losses, Municipality of San Sebastián

Hazard	10-year No. Building	Potential Future Loss	20-year No. Buildings	Potential Future Loss	30-year No. Building	Potential Future Loss
Earthquake Ground	10,183	$1,373,100,000	18394	$1,317,071,470	19919	$1,289,931,384
Earthquake Liquefaction	720	$9,932,500	1988	$10,969,058	2153	$11,527,264
Earthquake Landslide	5,860	$42,115,500	10508	$44,680,178	11380	$46,020,468
High Wind	11,456	$153,408,678	25423	$139,895,149	27532	$133,591,559
Riverine Flood	2,068	$15,980,000	2558	$14,662,117	2770	$14,505,695
Urban Fire	302	$18,250,000	1776	$14,350,000	1735	$9,125,000
Wildfire	1,214	$1,000,000	15	$875,000	23	$783,640
Rainfall - Landslide	2,828	$5,000,000	215	$4,758,250	245	$3,845,500

4.8.1 SAN SEBASTIÁN DEVELOPMENT TRENDS

The Municipality of San Sebastián has experienced low residential, commercial development over the past decade. The past trend in housing and economic development can be expected to continue, however, it is not expected to be as strong as during the decade of the 1990s. The 2010 US Census reported a 1% decrease in the population of San Sebastián with a total of 42,430. There are 1,774 less people living in San Sebastián than reported in Census 2000. This trend reflects non-favorable conditions for business, industry and employment in the Municipality. A more conservative projection in new housing starts was used in estimating loss estimates for future development.

4.8.1.1 Changes in development to identify changes in supply and demand of urban development: Recent development (for example, construction completed since the last plan was approved)

Land Use

The land use for the Municipality of San Sebastián competed the following stages: Objectives, Memorial, Advance, and Program. This document outlined goals and strategies based on a complete analysis of the Municipality's population, its potential for growth, and the general needs that may arise from this growth. It also described the public policies that would guide the implementation of recommendations outlined in the Plan. The Land Zoning Comprehensive Plan (Plan de Ordenamiento Territorial) of San Sebastián was adopted by the Puerto Rico Planning Board through Resolution JP-PT-30-1 on April 24, 1998 and

was approved by the Governor of Puerto Rico through Executive Order No. 1998-38 on October 28, 1998.

As we mentioned on Section 6.5, the "Regulation" document of the Comprehensive Plan (Part IV, page 4), establishes that "the Plan will be reviewed in an integrated manner within a period of eight years (i.e. 2006)". The Governor of Puerto Rico approved an amendment to the Road Plan contained in the Comprehensive Plan through Executive Order No. 2002-04 on May 31, 2002. Since then, the Comprehensive Plan has not been amended. The Comprehensive Plan (Part IV, page 4), also provides that it "can be revised if significant changes occur that affect the classification of the soil adopted". As said before, the Comprehensive Plan has not been amended, since no significant changes that affect the classification of the soil adopted have occurred after year 2002. Per the Planning Board Permits database, most of the Location Consultations have been related to obtain permits to segregate lands.

Construction Permits Filed in OGPe Since the Previous Plan was Approved

The Puerto Rico Permit Management Office (OGPe, for its acronym in Spanish), keeps a record of all filed permits and location approvals (Location Consultations), formally filed in the Island. After the approval of Act 161-2009, as amended, known as the "Puerto Rico Permit Process Reform Act", the OGPe has used two (2) electronic platforms known as Sistema Integrado de Permisos (SIP, 2011- 2014) and Super SIP (2014-2019). The following aerial photos (**Figure 4-25**) show the distribution of all cases files under SIP (yellow boxes) and SUPER SIP (magenta dots). The cases are scattered distributed but a cluster can be noticed (red ovals). The reason for these clusters might be explained due the location of the San Sebastián Pueblo, Bahomamey and Guatemala Wards, the main socioeconomic area in the Municipality. It also has road PR-111 along these wards, connecting the Municipality of San Sebastián with the Municipality of Moca and the West Region.

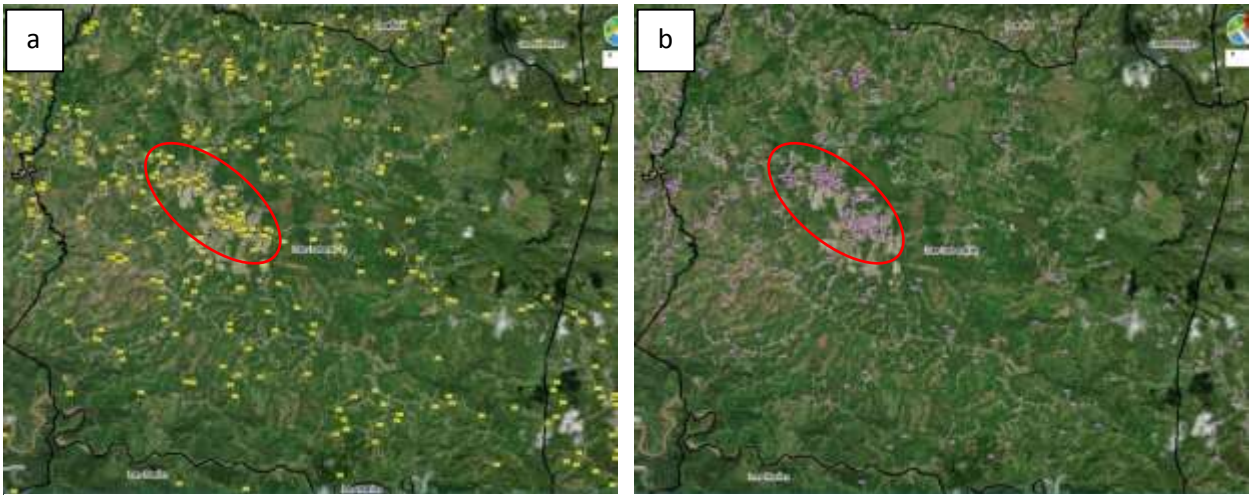

Figure 4-25 Aerial Photos Showing the Location Distribution of Construction Permits Filed in OGPe from 2011-2014 (a), and 2014 to present (b). Red oval shows the permits clusters for both periods

The total permitting filing activity has decreased from 256 cases in the first three (3) years after the implementation of the SIP to 217 cases during the last five (5) years of Super SIP. This does not necessary means that all the cases were approved or constructed, but at least gives an idea of the construction intention activity in the municipality. ***Table 4-28Table 4-28*** provides a data summary of the permits filed, per ward, in OGPe since 2011 and the difference between both periods.

Table 4-28 Number of Construction Permit Requests per Ward Filed in OGPe (2011-2019) for Projects in San Sebastián.

Wards	SIP (2011-2014) (3 years)	SUPER SIP (2014-2019) (5 years)	Difference (cases)
Aibonito	15	13	-2
Alto Sano	3	2	-1
Bahomamey	7	18	11
Calabazas	15	9	-6
Cibao	6	4	-2
Cidral	5	2	-3
Culebrinas	13	10	-3
Eneas	6	4	-2
Guacio	0	2	2
Guajataca	4	1	-3
Guatemala	20	25	5
Hato Arriba	23	20	-3
Hoya Mala	20	11	-9
Juncal	5	8	3
Magos	1	2	1
Mirabales	7	3	-4
Perchas 1	3	2	-1
Perchas 2	2	2	0
Piedras Blancas	12	4	-8
Pozas	28	19	-9
Robles	16	14	-2
Salto	25	24	-1
San Sebastián	12	8	-4
Sonador	8	10	2
Total	**256**	**217**	**-39**

The new platform has shown to be easier to manage by users and the community is much better related with the process. However, only six (6) of the 24 wards in San Sebastián showed an increase in the number of cases filed. Bahomamey Ward shows 11 more cases in 2019 vs 2014, Guatemala Ward shows five (5), and Juncal Ward shows three (3) more cases respectively. Even that, the reduction of almost 50% of the mean of cases filed shows the construction activity decrease in the municipality. The following graph (**Figure 4-26**), shows the distribution of permits filed in OGPe in descending order of frequency for years 2011-2014 and its counterpart data for years 2014 to present.

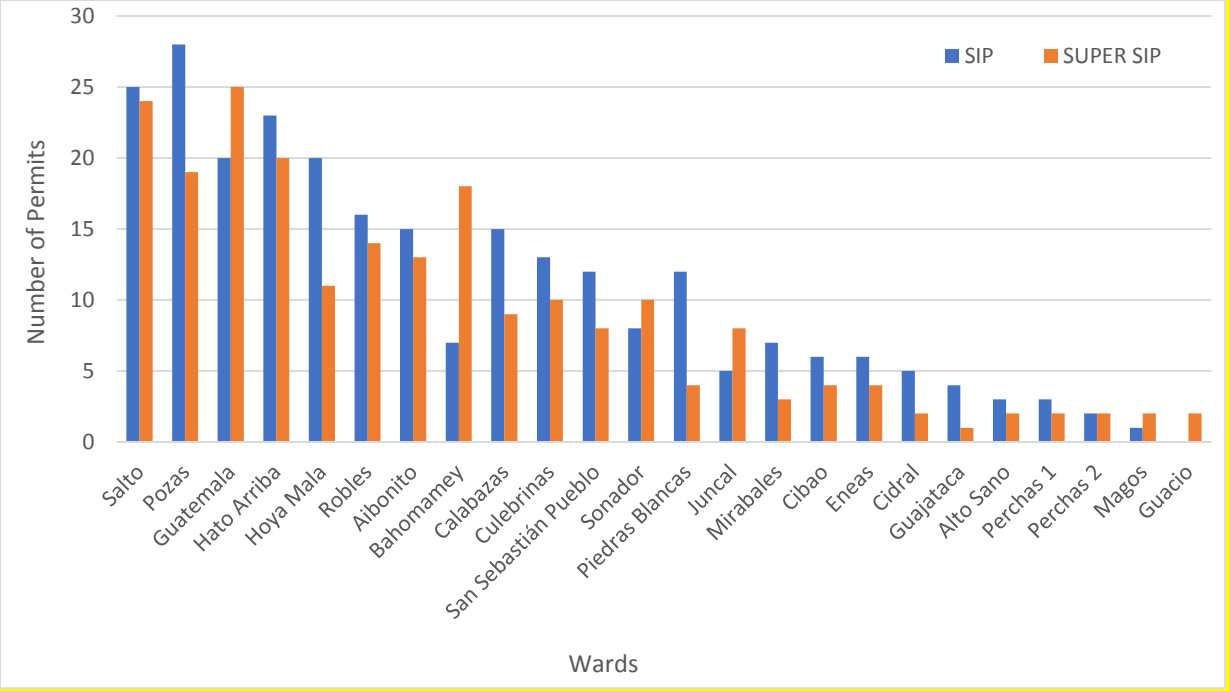

Figure 4-26 Distribution of Construction Permits per Ward Filed in OGPe for years 2011-2014 (blue) and 2014 to present (orange)

Construction Permits Filed in OGPe Since the Previous Plan was Approved for Proposed Projects in Development Expansion Areas

A total of 10 permits have been filed in OGPe for project which proposed sites are located in the Municipality of San Sebastián Development Expansion Area as approved in the "Plan de Ordenamiento Territorial" from year 2011 to present.

Development in Private Services Buildings
Only one (1) case has been filed in OGPe regarding private services from 2014 to 2018. Permit number 2018-236949-PCO-015731 was filed in OGPe on August 23, 2018 to remodeling an existing commercial facility to offer Maxillofacial services (dentist specialty).

Development in Commerce Buildings
Only two (2) permits have been filed in OGPe or commercial related projects during the study period. The first case was filed in July 2013 for a commercial sign and the second case was filed for remodeling an existing facility in September 2015.

Development in Industrial Building
No permits were found in OGPe database related to industrial proposed projects for years 2011 to 2014.

Institutional – Church
Two (2) churches filed construction permits in OGPe during the studied period. The first case was file to submit a structural design amendment (October 2013) and the second case was for the construction of a church building (October 2014).

Development in Government Public Services

The Municipality of San Sebastián filed three (3) cases for local government properties. The first case was for remodeling the municipal cemetery (October 2013). The second case was for remodeling the Early Head Start facilities in January 2016 and the last case was filed to construct the roof of the play area of the "Centro First Steps Head Start" in October 2019.

The Municipal Government has also completed several projects to improve our town during the last five (5) years. The following list provides the most outstanding construction / development projects occurred since the last HMP was adopted:

1. Impact on the Recreational Facilities of our Community Project: The Project consisted in reconstruction and rehabilitation works in the Farel Velázquez Sports Facilities in Robles Ward such as:
   - Construction of sidewalks
   - Parking Construction
   - Reconstruction of the bathrooms
   - Installation of playground equipment for children
   - Network installation on the roof of the court to prevent nesting of birds (pest control)
   - Structural improvements to the field
   - Painting of sports facilities, among other works
   - The investment made was $65,498.00

2. Ornamental Fountain: Adorns the entrance of our Sports Complex. It was built to bring beauty to the aesthetics of the place, to add a tourist attraction to our town, but more than anything to offer our citizens an element that identifies us as a town.

3. Café Hacienda La Fe: Tourist Restaurant located in the Sports Complex, to give the visitors of the place and our citizens an alternative to enjoy meals and refreshments. With an impressive view, cozy atmosphere and nostalgic air of yesteryear that provides the design of large house and wooden balconies.

4. Improvement of Urban Downtown Sidewalks: Work was done on the sidewalks of the downtown urban area and on the sidewalks of Ruiz Belvis Street and Severo Araña Street. This Project had an approximate investment of $103,579.00.

5. Rehabilitation of the Municipal Building for Center of Fine Arts and Multiple Uses of the Municipality of San Sebastián: For several years, we had a need as a Town, to be able to have an adequate place to carry out any type of activity, be it entertainment, educational activities, civic and cultural. Our new Center of Fine Arts was reborn there, completely restored and ready to be used. This project is ready to open during the next month of May 2019. Approximate investment of $1,893,370.00.

6. Remodeling of La Cancha Luis Muñoz Marín: This court was in complete decline, with broken stands, playground completely deteriorated, unusable toilets and physical appearance in abandonment. A lighting improvement plan was developed, an area was built to practice the sport of boxing, a new plastic floor was installed, the facilities were converted into three (3) volleyball courts, industrial fans were installed for ventilation, the bathrooms were improved, new bleachers were installed and other structural and aesthetic improvements were made. The investment of this project was $1,011,115.00

7. La Hamaca Museum: One of the cultural patrimonies was rescued, as was the old-school Julio Cancel Facundo of our town, to turn it into what is known today as the La Hamaca Museum, in recognition of our hammock craftsmen, who have put the name of our San Sebastian on high by far. Works completed includes the restoration of the Main Building, the rehabilitation of bathrooms with facilities for handicapped people, electrical room, among other improvements. The investment of this Project is $ 546,734.00

All these (and others) projects were completed inside the developed urban areas and represent improvements to existing facilities. For instance, they do not change (increased/decreased) the Municipality's vulnerability.

Housing Development

The first case of this group was filed to build a house in lot No. 41 of San Carmelo de la Plata II Project in May 2013. The case shows two (2) additional permit requests in 2015 and 2019 (second extension request). The project is identified as one of Social Interest Housing Project each unit having 3 rooms, 1 bathroom, living, kitchen, dining, laundry and garage. The second housing development project filed in OGPe during this period was Lomalinda Private Housing Development located at road PR-111 Km 16.4, Guatemala Ward, in July 2013. The 25 units have four (4) rooms, living, dining laundry, porch and double garage with a cost around the $230,000. The permit request for the private house of Maiteé Jiménez Santiago was filed in November 2012. The site is in road PR-111, Km. 16.8, Int., Guatemala, Ward.

Table 4-29, provides a summary of all above-mentioned cases including the case number, filed date, cadaster number, address, project name and type of permit. Then, the aerial photo (**Figure 4-27**), shows the site location for each case.

Table 4-29 Construction Permits, under SIP and SUPER SIP, in Development Espansion Areas

No. In Aerial Photo	Case No.	Filed Date	Cadaster	Address	Project Name	Type
2	2012-081183-PCO-44061	11/1/2012	099-069-224-44	Carr. PR-111, Km. 16.8, Int., Guatemala, Guatemala, San Sebastián	Residencia Maiteé V. Jiménez Santiago	Private house
5a	2013-154580-PCO-75580	5/7/2013	099-078-166-39	Carr. PR-125, Km 18.1 Int., Laberinto, Guatemala, San Sebastián	San Carmelo de La Plata II	Housing – Social Interest
3	2013-191421-PCO-87373	7/16/2013	099-069-432-03	PR-111, Km 16.4, Guatemala, San Sebastián	Rótulo Toyota San Sebastián	Commercial Sign
1	2013-191430-PCO-87628	7/22/2013	100-000-006-31	PR-446, Km 1.4, Urb. Lomalinda, Guatemala, San Sebastián	Proyecto Lomalinda	Housing Dev.
10	2013-199911-PCO-93870	10/4/2013	129-000-007-47	X=141776.568624 Y=254603.377558	Remodelación Cementerio Municipal	Municipal Cemetery remodeling
9	2013-213259-PCO-96708	10/18/2013	129-023-144-04	X=141990.915934 Y=255568.336567	Enmienda Construcción Iglesia Diseño Estructural	Church Construction Amendment

No. In Aerial Photo	Case No.	Filed Date	Cadaster	Address	Project Name	Type
8	2014-299557-PCO-28547	10/16/2014	129-023-144-37	Carr PR-125, Km. 22.5, Sector Rest Cuchilandia, Piedras Blancas, San Sebastián	Iglesia Metodista San Sebastián	Church Construction
6	2015-079050-PCO-114371	9/5/2015	099-089-239-02	X-138863.273844 Y=257007.32267	Remodelación Ferretería Aceros La Plata / remodelación Fachada Principal y Ampliación del Área de Venta de la Ferretería	Commercial - remodeling
5b	2015-084574-PCO-126548	10/16/2015	099-078-166-39	X=138828.381838 Y=257159.507475	San Carmelo de la Plata - Fase 2 / Urb. Residencial de Interés Social	Housing – Social Interest
7	2015-050230-PCO-148902	1/7/2016	099-000-009-69	X=138784.645691 Y= 138784.645691	Remodelación Early Head Start - CCP	Municipal Head Start Services - remodeling
5c	2019-266320-PCO-020226	5/24/2019	099-078-166-77	X=138826.039298 Y=257159.049826	San Carmelo de la Plata (2da Extensión) - Solar 41 / Construcción de un (1) Edificio Residencial del Proyecto de Interés Social San Carmelo de la Plata (Fase 2).	Housing – Social Interest
4	2019-285785-PCOC-003167	10/22/2019	099-079-239-08	X=138986.219169 Y=257138.789615	Construcción del Techo del Área de Juegos del Centro First Steps Head Start	Municipal Head Start Services

Note: all sites are located in Flood Zone “X”.

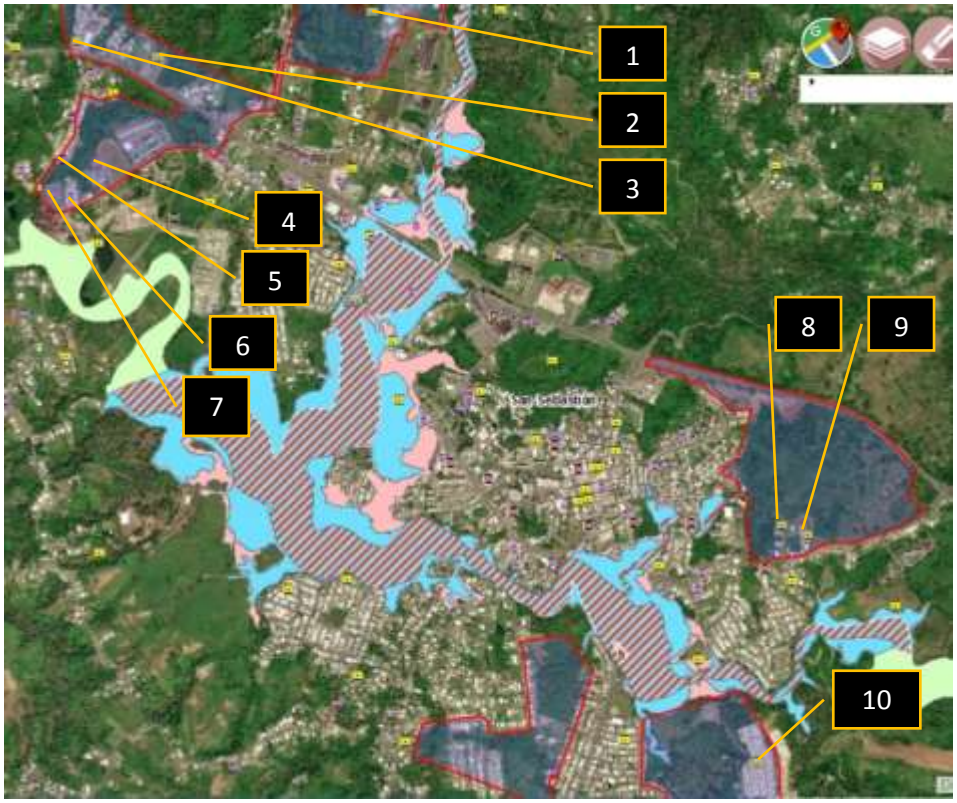

Figure 4-27 Aerial Photo showing the location of construction permits, under SIP and SUPER SIP, in Development Espansion Areas

The proponent must file a "Location Approval" or "Location Consultation" when the proposed project does not fit with the current land zone. Per the OGPe database, a total of 93 cases has been filed for projects proposed in San Sebastián, since 2011. Again, this does not mean that all cases were approved or constructed. The consultation is also needed when the land does not have a zone approved or for actions like land segregations. **Table 4-30** provides a data summary of the location consultations filed per ward, in OGPe since 2011.

Table 4-30 Number of Location Consultation Requests Filed in OGPe (2011-2019) for Projects in San Sebastián.

Wards	Location Consultation (2011-2019) (8 years)
Aibonito	4
Alto Sano	3
Bahomamey	0
Calabazas	13
Cibao	3
Cidral	0
Culebrinas	5
Eneas	2
Guacio	1
Guajataca	1
Guatemala	4

Wards	Location Consultation (2011-2019) (8 years)
Hato Arriba	4
Hoya Mala	7
Juncal	5
Magos	3
Mirabales	1
Perchas 1	4
Perchas 2	2
Piedras Blancas	4
Pozas	5
Robles	6
Salto	12
San Sebastián	0
Sonador	4
Total	**93**

The total of only 93 Location Consultations, since year 2011 to 2019, i.e., a mean of one (1) case filed per month during the whole period, also might suggest a slow activity. The following graph (**Figure 4-28**), shows the distribution of Location Consultations filed in OGPe in descending order of frequency since 2011 to present.

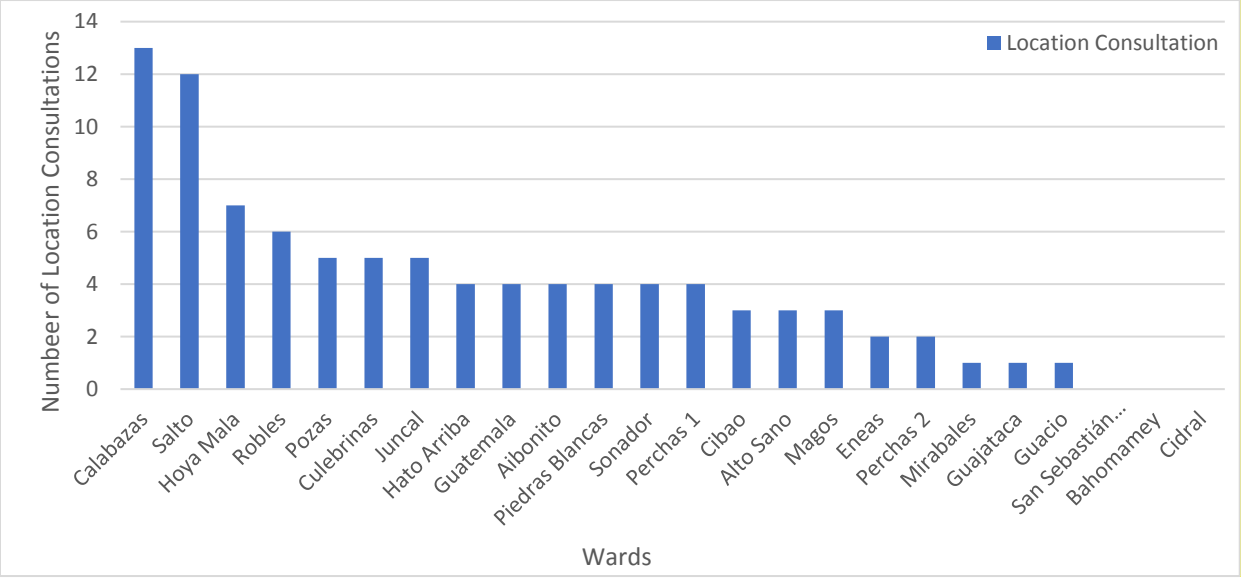

Figure 4-28 Distribution of Location Consultations Filed in OGPe for years 2011-2014 and 2014 to present

Changes in development that have occurred in hazard prone areas and increased or decreased the vulnerability since the last plan was approved: Construction Permits Filed in OGPe Since the Previous Plan was Approved for Proposed Projects in Prone Areas

The permitting cases for proposed project located in prone areas found in SIP dated between years 2012 and 2014 was very low. The first case for year 2012 is in road PR-111, Km. 17.7, Barrio Guatemala. The proposed project consisted in the extension of Rokayosa building Mezzanine level roof. The second case for the same year is in Emérito Estrada Rivera Ave., # 1151, Sector Los Álamos, Bahomamey Ward. This Project consisted in the improvements of Julio Soto Building. The third case of proposed project located in prone areas was the improvements to Supermercado Selectos in 2014. This site is in Emérito Estrada Rivera Ave., # 1214, Bahomamey Ward. This means that only three (3) cases for remodeling and improvements in existing commercial buildings occurred those three (3) years. All three (3) cases are in AE Flood Zones.

Table *4-31* provides a summary of the three (3) cases abovementioned. Then, the following aerial photo (**Figure 4-29**), shows the location of the three (3) cases.

Table 4-31 Number of Construction Permit Requests in Prone Areas Filed in OGPe (2011-2014) for Projects in San Sebastián

No. in Aerial Photo	Case	File Date	Cadaster	Address	Project Name	Flood Zone
1	2012-029126-PCO-16504	5/16/2012	099-090-001-75	Carr. 111, Km. 17.7, Barrio Guatemala, Guatemala,	Mezzanine Level Roof Extension for Rokayosa Bldg.	AE
2	2012-061101-PCO-32900	8/27/2012	100-091-133-18	Ave. Emérito Estrada Rivera, Núm. 1151, Sector Los Álamos, Bahomamey Ward	Ampliación Edificio Julio Soto	AE
3	2014-285939-PCO-22421	7/30/2014	129-001-135-08	Ave. Emérito Estrada Rivera, 1214, Sector, Bahomamey, San Sebastián	Ampliación Supermercado Selectos San Sebastián	AE

Figure 4-29 Aerial Photo Showing the Site Location of Construction Permits in Prone Areas Filed in OGPe from 2011-2014

The permitting activity for years 2014 to present did not change much. The first permit filed in 2015 was for remodeling Walgreens to create a new consultation room, repairs and maintenance. The second case in 2015 was to enlarge the parking lot and relocate the existing entrance and auto bank area. The "Centro Agropecuario de San Sebastián" filed a permit or improvements and minor rehabilitation in the facility and infrastructure in 2016. The final case was filed for remodeling a commercial site to be used as MPL Maxillofacial Surgery Office. As the previous three (3) cases, all the permits were filed for remodeling or improvements to existing commercial sites. This activity did not alter the flood levels and did not represent a significant environmental impact in the existing developed area. A total of seven (7) cases and the proposed remodeling activities (no development of new buildings), in seven (7) years (from 2011 to 2018), is not significant. These facts suggest that no changes in vulnerability have occurred during these years.

Table *4-32*, provides a summary of the four (4) cases abovementioned. The following aerial photo (**Figure 4-30 Aerial Photo Showing the Site Location of Construction Permits in Prone Areas Filed in OGPe from 2014-2018**shows the location of the four (4) cases.

Table 4-32 Number of Construction Permit Requests in Prone Areas Filed in OGPe (2014-2018) for Projects in San Sebastián

No. in Aerial Photo	Case	File Date	Cadaster	Address	Project Name	Flood Zone
1	2015-038822-PCO-051107	3/6/2015	100-081-134-27	X=140330.519999 Y=256874.089581	Walgreens # 361: Nuevo Cuarto Consultas, Reparación y Mantenimiento, optimización, actualización de materiales de marca (Branding)	0.2% Annual Chance Flood
2	2015-058331-PCO-081387	6/18/2015	100-081-453-01	X=140166.239716 Y=256955.610812	Ampliación del Estacionamiento y Reubicación del Acceso Existente y Carrileras del Autobanco	AE
3	2016-104106-PCO-177164	4/5/2016	100-091-133-09	X=140309.786376 Y=256596.050987	Centro Agropecuario de San Sebastián / Mejoras y Rehabilitaciones Menores de Facilidades y Reconstrucción de Infraestructura.	AE (Cauce Mayor)
4	2018-236949-PCO-015731	8/23/2018	099-090-001-75	X=140139.342986 Y=256819.305682	MPL Maxillofacial Surgery / Remodelación de un local comercial para ser utilizado como clínica dental.	AE (Cauce Mayor)

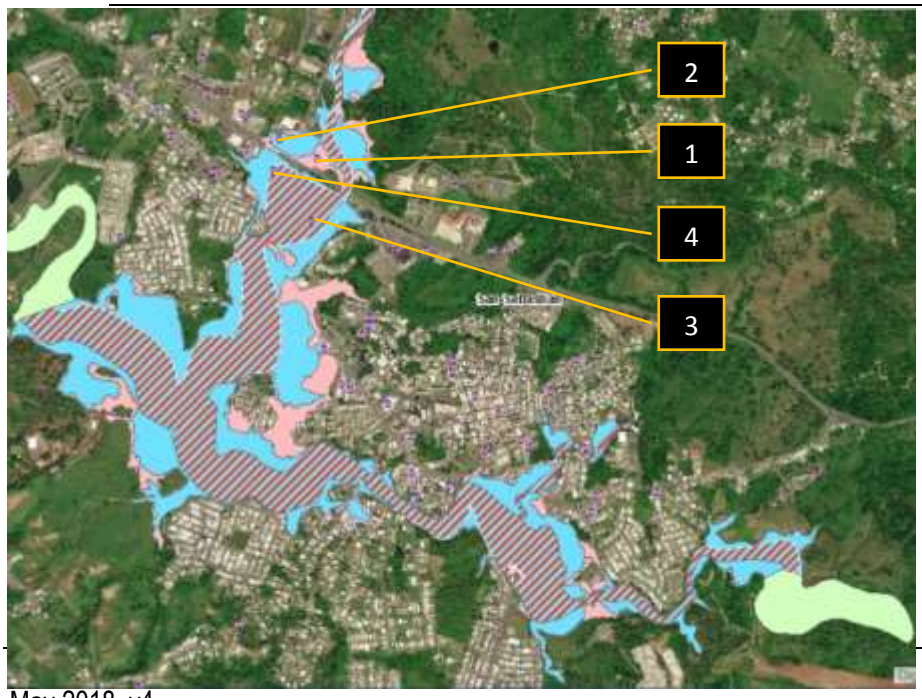

Figure 4-30 Aerial Photo Showing the Site Location of Construction Permits in Prone Areas Filed in OGPe from 2014-2018

Describe how this new building are in accordance with the construction codes and are safe developments.

The Land Zoning Comprehensive Plan (Plan de Ordenamiento Territorial) of San Sebastián was adopted by the Puerto Rico Planning Board through Resolution JP-PT-30-1 on April 24, 1998 and was approved by the Governor of Puerto Rico through Executive Order No. 1998-38 on October 28, 1998. All projects constructed after this date must follow the construction parameters described in the current Regulations, including the current Puerto Rico Building Code. Depending on the specific location of the propose project site, other rules might apply as per example, the Karsic Zone Special Planning Area Plan. The information of all the projects described before were obtained from the database of the OGPe. This means that all the projects followed the official permitting process of request, review and obtain a formal permit for the proposed activity in compliance with all current regulations and building codes. Structures constructed per the building codes should show better structural integrity, fire resistance, safe exits, lighting, ventilation, and construction materials. Building permits are generally required for any alteration that changes the structure, size, safety, or use of living space. Those projects located in prone areas were filed for remodeling on existing structures, not new ones.

Recently, the Government of Puerto Rico approved the New 2018 Building Code. Puerto Rico's 2018 Building Code represents the first significant revision since 2011. The codes include hazard resistant provisions that provide for safer construction in the Island. The new codes are more current than the codes currently observed by most mainland states. The most remarkable aspect of Puerto Rico's 2018 construction codes is the state of the art designs pertaining to wind speeds. The codes contain 316 wind microzone maps specific to every municipality in Puerto Rico.

4.8.1.2 Conditions that may affect the risks and vulnerabilities of the jurisdictions (for example, climate variability, declining populations or projected increases in population, or foreclosures).

Puerto Rico and the Municipality of San Sebastián were showing a constant population increase since, at least, year 1970. However, the Island has been going through a series of conditions that have caused a constant emigration during the last 10-15 years. The emigration started to be reflected in Census 2010 where the Island showed a population decrease of approximately 82,814 people. The Municipality of San Sebastián also showed a population decrease of approximately 1,774 people. **Table 4-33** summarized the data from 1970 to 2010.

Table 4-33 Population and Housing Units in Puerto Rico and the Municipality of San Sebastián: 1970 to 2010

Puerto Rico / Municipio	Population					Housing Units				
	1970	1980	1990	2000	2010	1970	1980	1990	2000	2010
Puerto Rico	2,712,033	3,196,520	3,522,037	3,808,603	3,725,789	713,713	993,678	1,188,985	1,418,474	1,636,946
San Sebastián Municipio	30,157	35,690	38,799	44,204	42,430	8,354	10,931	13,536	16,682	18,695
Difference (%)		18.35	8.71	13.93	-4.01		30.85	23.83	23.24	12.07

r = table show the revised Census 2000 population and/or housing unit counts that resulted from the Count Question Resolution (CQR) program. US Census Bureau, 2010 Census

The Census Flows Mapper[20] reports the following movers' statistics (**Table 4-34**), for the Municipality of San Sebastián during years 2011-2017. The continue population loss also contribute in an increasing number of vacancies.

Table 4-34 Movers' Statistic for San Sebastián (2010 – 2017)

Statistics	2010-2014	2011-2015	2012-2016	2013-2017
Population (1 yr and over)	40,910	40,279	39,583	38,784
Movers from a different state	452	290	252	165
Movers to a different state	657	958	872	1,066
Movers from a different county, same state	628	609	494	409
Movers to a different county, same state	594	790	847	783

The number of housing units has also been increasing since 1970. The total housing in San Sebastián was 18,695 units in year 2010 representing a lower rate increase of 12.07% compared with the three (3) previous Census were the housing development increased in 30%, 23.8% and 23.24%, respectively. The following graph (**Figure 4-31**), shows the population and housing development changes since 1970 to 2010. The numbers presented here shows a gradual decrease in total population while a modest increase in housing development occurred until 2010.

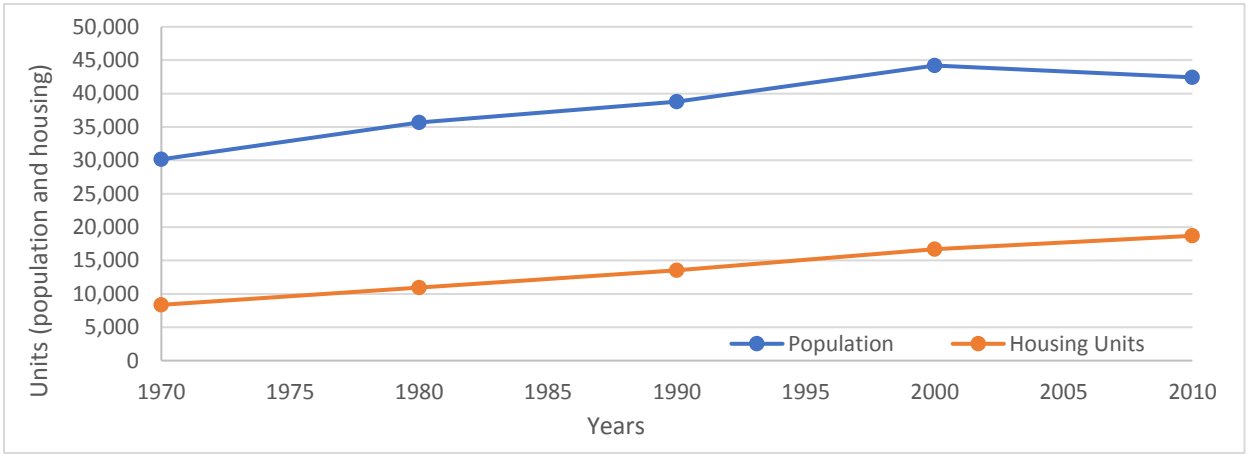

Figure 4-31 Changes in population and housing development from 1970 to 2010

The population in the Municipality of San Sebastián was of 42,430 people per Census 2010. The distribution of the population per ward was given in Table 2-2 (Section 2.3 of this document). A total of 16,047 housing units (of 18,695 total housing units), were occupied by 2010. A total of 11,638 units were occupied by the owners while the other 4,409 units were rented occupied. Census 2010 also established that, the average household size or owner-occupied units was 2.62 and 2.66 for renter-occupied units. The total vacant housing units in San Sebastián was 2,648 units, 747 of them, are used for seasonal, or occasional

[20] Total Net Migration Flows for San Sebastián, PR. Source: U.S. Census Bureau, 2011-2015 5-year American Community Survey. https://flowsmapper.geo.census.gov/map.html.

use. The vacancy rate of available housing is 4.9. The total number of occupied and vacant housing units, is included in **Table 4-35**.

Table 4-35 Housing Occupancy and Tenure in San Sebastian Wards: 2010

Area	Total housing units	Occupied housing units			Rented occupied	Average household size		Vacant housing units				
		Total	Owner occupied			Owner-occupied units	Renter-occupied units	Total	For seasonal, recreational, or occasional use	Vacancy rate		
			Number	Percent of occupied housing units						Available housing	Home-owner	Rental
Puerto Rico	1,636,946	1,376,531	986,165	71.6	390,366	2.7	2.63	260,415	59,537	4.9	2.8	9.9
San Sebastián	18,695	16,047	11,638	72.5	4,409	2.62	2.66	2,648	747	3.5	2.3	6.6
Aibonito	871	750	587	78.3	163	2.65	2.55	121	62	2	0.8	5.8
Alto Sano	390	344	270	78.5	74	2.56	2.74	46	17	2.5	0.7	8.4
Bahomamey	1,019	882	319	36.2	563	2.24	2.67	137	18	4.2	5.3	3.6
Calabazas	1,186	1,025	763	74.4	262	2.64	2.73	161	51	2.7	1.5	6
Cibao	552	441	361	81.9	80	2.73	0	111	31	4.9	4	8.9
Cidral	200	157	115	73.2	42	2.61	2.74	43	7	4.3	1.7	10.6
Culebrinas	1,656	1,454	1,079	74.2	375	2.63	2.46	202	58	3.4	2.2	6.7
Eneas	409	362	281	77.6	81	2.79	2.63	47	14	4.2	2.4	10
Guacio	269	223	175	78.5	48	2.81	3.1	46	7	3.5	2.2	7.7
Guajataca	240	210	163	77.6	47	2.84	2.34	30	13	0.9	0	4.1
Guatemala	1,149	1,006	813	80.8	193	2.45	2.69	143	42	3.8	3.5	4.9
Hato Arriba	850	747	597	79.9	150	2.65	2.65	103	36	3.2	2.1	7.3
Hoya Mala	1,628	1,376	1,001	72.7	375	2.58	2.66	252	78	3.7	2.6	6.5
Juncal	805	707	542	76.7	165	2.67	2.84	98	16	2.2	1.6	4.1
Magos	108	95	76	80	19	2.38	2.68	13	4	3.1	0	13.6
Mirabales	295	246	189	76.8	57	2.74	2.7	49	9	2.8	1.6	6.6
Perchas 1	425	345	239	69.3	106	2.53	2.75	80	23	4.2	2.8	7
Perchas 2	438	337	249	73.9	88	2.9	3.02	101	38	5.1	2.7	11.1
Piedras Blancas	1,160	1,012	641	63.3	371	2.43	2.71	148	34	2.7	2.4	3.1
Pozas	1,437	1,287	993	77.2	294	2.74	2.69	150	40	3	2.4	4.8
Robles	724	627	479	76.4	352	2.08	2.48	97	43	2.6	1.8	5.1
Salto	1,312	1,144	927	81	148	2.68	2.78	168	52	3	1	10.7
Pueblo	819	614	262	42.7	217	2.69	2.65	205	25	9.2	7.9	10.1
Sonador	753	656	517	78.8	139	2.83	2.52	97	29	4.3	2.1	11.9

Summary Population and Housing Characteristics: US Census Bureau, 2010 Census

The following graph (**Figure 4-32**), shows the total occupied and vacant housing units in the wards of San Sebastián per Census 2010. Per the OGPe permitting activity discussed previously, only 40 housing units were developed from 2011 to 2019.

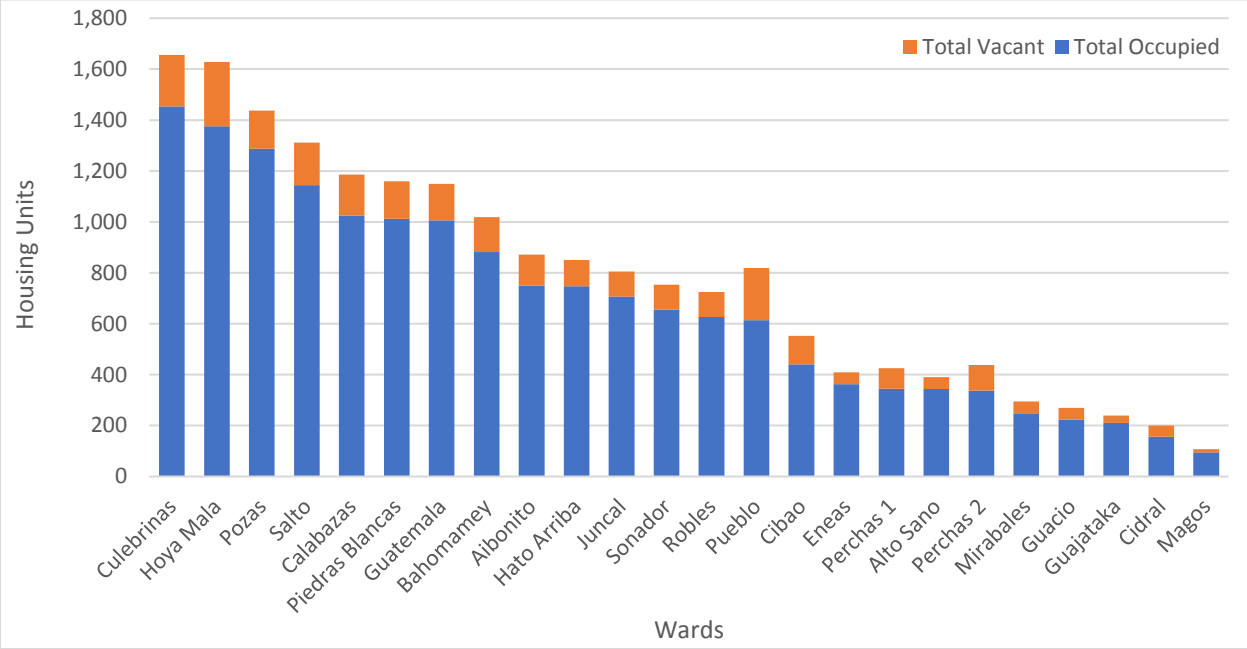

Figure 4-32 Distribution of total occupied and vacant housing units per ward in San Sebastian, 2010

The decrease in population in San Sebastián suggest a reduction in vulnerability since less people are exposed to the studied natural hazards. The few new buildings and development projects, all located in development expansion areas, also provide a sense of less vulnerability since they are located outside flood risk areas. The decrease number of population with a light increase in housing new units and vacant housing units available for rent and buying suggest that the Municipality does not need a huge housing development project for now.

Most relevant milestones for projects development in the Municipality of San Sebastián

The San Sebastián Pueblo is subject to high to very high vulnerability to earthquake, liquefaction, storm surge, flooding and urban fire. Limited staff resources for development review and building permitting/inspection are an issue for all municipalities in Puerto Rico, including San Sebastián. As part of the continuous Hazard Mitigation, the Municipality of San Sebastián must undertake the scope of the database currently being established must be extended in terms of the inventory and the potential damage of each hazard event. Additional data that must be collected, must include: structure size, structure value, contents value, occupancy or capacity, and/or any other special consideration.

The Municipal Office should focus careful attention by planners and building permit officials on evaluating compliance with the NFIP Program, development review and strict compliance with the building code on new projects. The municipality must have educational methods to create awareness of importance of NFIP to the residents that living in flooding areas and the importance of acquiring an insurance policy to protect their properties.

As described in the introduction to Section Five, a gradual elimination of the most vulnerable masonry structures within the San Sebastián Pueblo that do have historical significance should be implemented over the long term. New development in the Barrio Pueblo will certainly continue in the future, however, hazard mitigation concerns in the development review process are critical to ensure that new development incorporates disaster resistant construction practices.

The most extensive floodplain within the Municipality of San Sebastián is associated with the Rio Culebrinas. Existing urbanizations within the San Sebastián Pueblo is at extreme risk of flooding from the Rio Culebrinas. The Army Corps of Engineers completed the final feasibility study for a flood control project in early 2004 (Final Detailed Project Report and Environmental Assessment, USACE 20004). If Federal and local funding becomes available, this project can move into engineering design and construction within five to ten years. Until then, the low-lying urbanized area in the southern portion of San Sebastián Pueblo remains at risk.

The Municipality should pay careful attention to ensuring that any additional in-fill development within the urbanized floodplain area and especially any new residential or commercial development proposed within the upper portion of the Rio Culebrinas flood plain be consistent with all NFIP regulations. The Municipality should consider more restrictive zoning designations (open space or agricultural land use zoning districts) in the upper floodplain area that would be outside of the protection afforded by the proposed flood control project.

San Sebastián exhibits moderate to high earthquake hazard intensity levels and low to very low wind hazard intensity levels. Development review and building permit inspections in San Sebastián should concentrate on ensuring that earthquake and high wind concerns are addressed in future developments.

The most cost effective means of implementing hazard mitigation and leading the Municipality to a more sustainable future is to reduce the vulnerability of future development to the key natural hazards that threaten San Sebastián. Eliminating development in severely hazard prone areas or reducing the intensity of development in areas of moderate to high hazard intensity levels will go a long way to ensuring a more sustainable future for San Sebastián.

- The data base it is very important, San Sebastián must currently being established a good data base with a good inventory of all their facilities. To handle all the future projects with reliable data. This allows making better decision regarding any future planning. In addition, it is most important to increase the capabilities of planners and building permit officials in San Sebastián through training and seminars so that they can better integrate hazard mitigation concerns in the development review and building permit approval/inspection processes. Many the prioritized mitigation actions described in Section Five address the critical need to reduce the vulnerabilities associated with future development.

4.8.2 ASSESSING VULNERABILITY OF FUTURE DEVELOPMENT

To assess the future vulnerability, Hazard Maps were used to a) delineate areas at risk and define possible consequences, b) target development in areas less susceptible to natural hazards, and c) provide a basis to support planning decisions that will reduce the impact of natural hazards on people and property. It combines the hazard levels for each hazard to show the intensity or levels of hazard throughout the municipality. The hazard can then be used to inform the public about natural hazard potential and support general mitigation and land use planning activities.

An overall policy goal of this plan is to help the municipality make wiser planning decisions related to constraints imposed by natural hazards. Municipal planners should encourage development in areas of lower hazard. The maps were used to assess the vulnerability of proposed development (i.e. future development). The maps provided visual information in a spatial format. This helped to determine vulnerability based on the hazard intensity levels. This provided a general idea of which areas of the municipality have the greatest potential for damages.

Though the intention of the hazard maps is to be a tool for implementing sustainable development, its use should not preclude site-specific evaluations prior to new construction or the upgrading of buildings and other facilities.

As the municipality develops its plan review and permitting capabilities, the hazard maps can be used to identify critical hazard areas. It should be made to determine areas within the municipality where development should be restricted because of the presence of natural hazards, and areas where development should be encouraged because of the lower hazard potential. Where land is already developed, these techniques may be used to justify the imposition of requirements on existing development where such controls are necessary in high hazard zones, and to assess the benefits and costs of mitigating hazards.

The Municipality of San Sebastián also takes into consideration the compliance with Regulation 8486, Karst Zone Special Planning Area, June 16, 2014. This Regulation creates the overlying district zones for the karst zone. The Plan shows the Karst Restricted Special Planning Area (APE-RC), laying on the north area of San Sebastián. The karst landing outside the District APE-RC are designated as the Karst Zone Special Planning Area (APE-ZC), also in the north side of San Sebastián. These zoning overlapping layers prevail over existing zoning. Even though this Regulation was developed after the "Plan de Ordenamiento Territorial", the municipality took into consideration, together with the PRPB, the geological, soil, socio-economical aspects during the development of the phases in the way to be an autonomous municipality. The lands were classified as Urban Land (SU), Scheduled Building Land (SUP), Non-scheduled Building Land (SUNP), Common Rustic Land (SRC), and Specially Protected Rustic Land (SREP). As result, the Municipality of San Sebastián delimited the scheduled and non-scheduled development zones next to the developed area, outside from what we know today as the APE-RC karst zone.

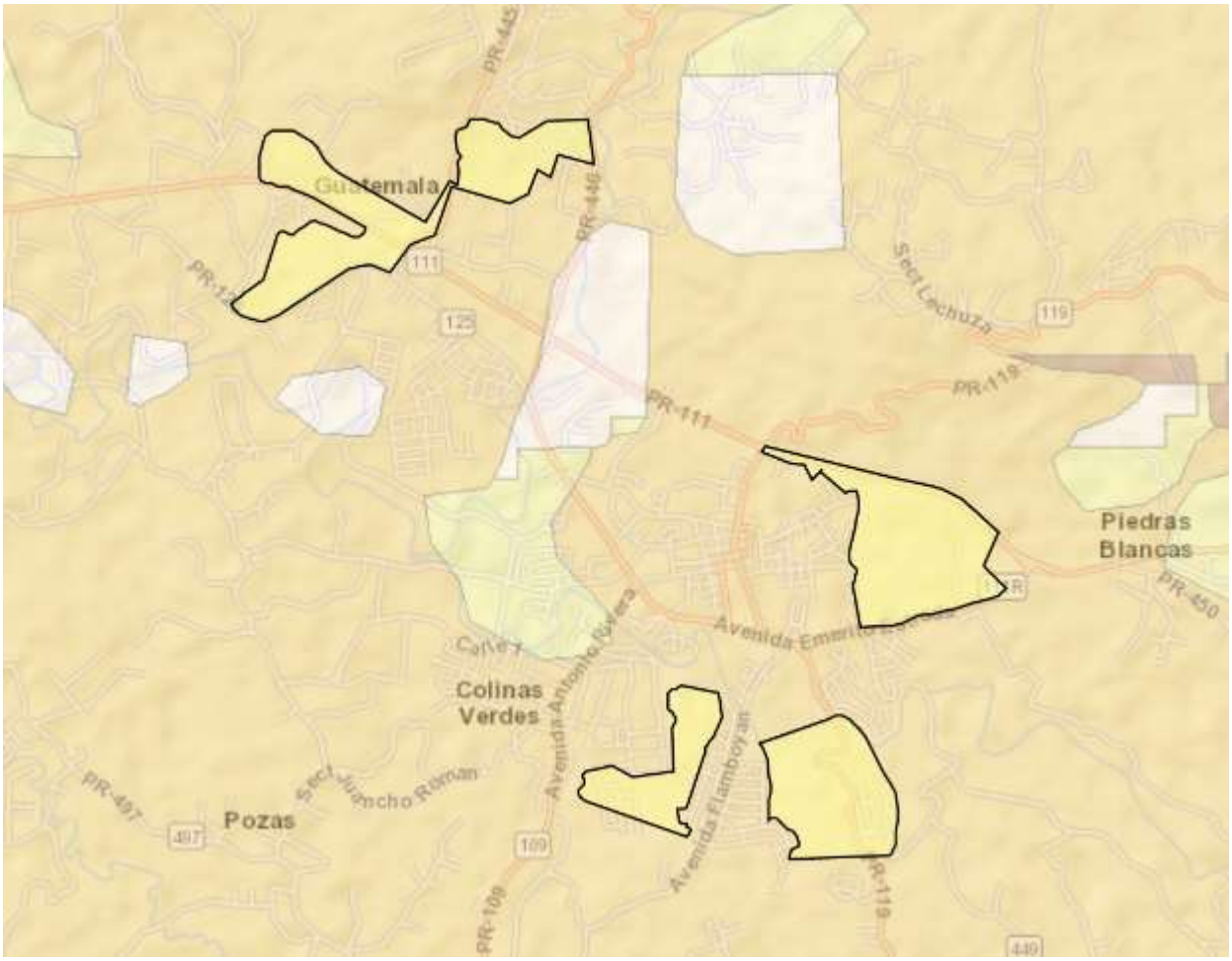

Figure 4-33 Potential New Development and Earthquake Ground Shaking Hazard Areas in Municipality of San Sebastián

Table 4-36
Potential New Development Located in Earthquake Ground Shaking Hazard Areas

	Facility Name	Earthquake Hazard Areas				
		Very Low	Low	Moderate	High	Very High
1	Ensanche Sur - Suelo Urbanizable Programado			X		
2	Ensanche Oeste - Suelo Urbanizable Programado			X		
3	Ensanche Noreste - Suelo Urbanizable No Programado			X		
4	Ensanche Este - Suelo Urbanizable No Programado			X		

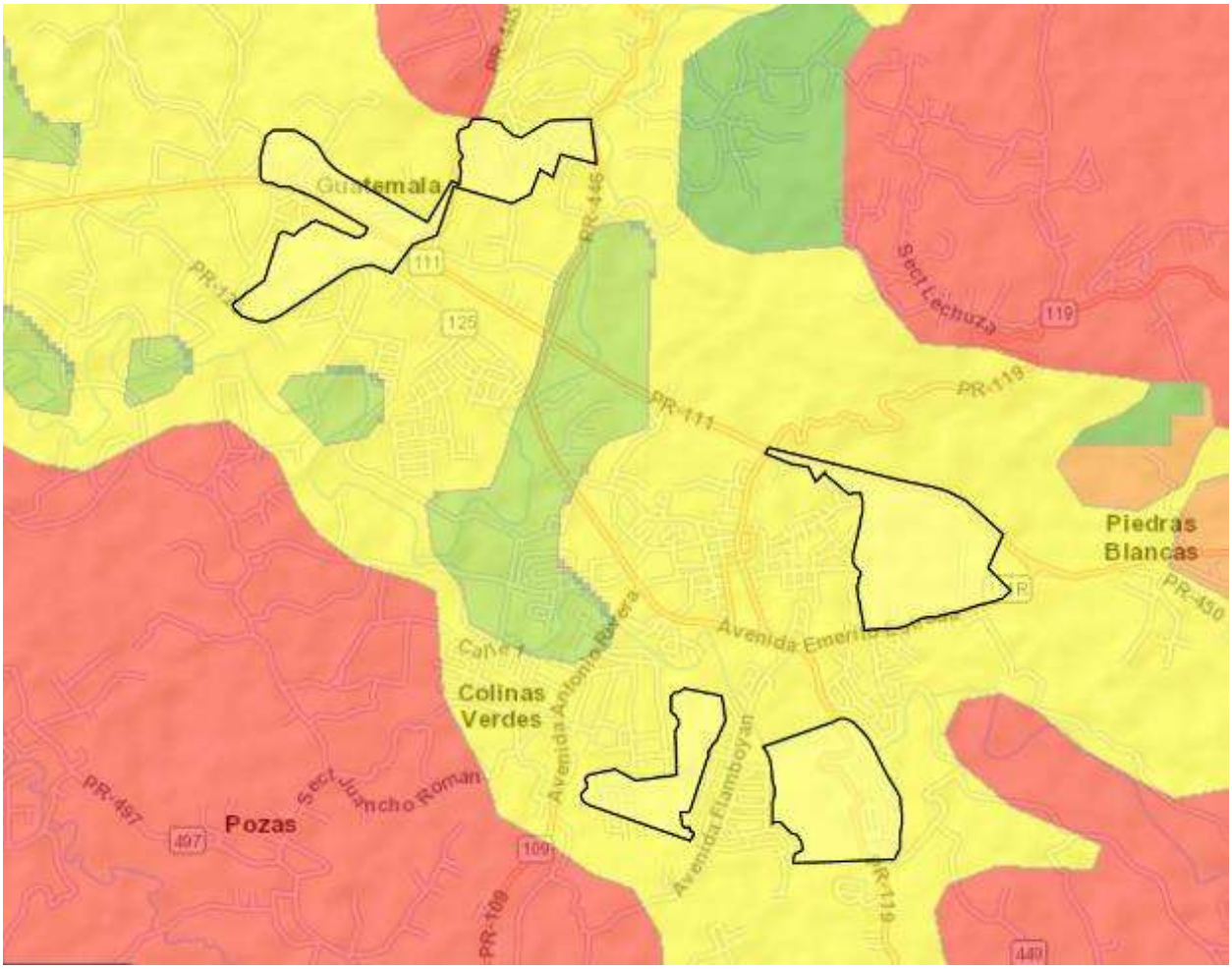

Figure 4-34 Potential New Development and Liquefaction Hazard Areas in Municipality of San Sebastián

Table 4-37
Potential New Development Located in Liquefaction Hazard Areas

	Facility Name	Liquefaction Hazard Areas				
		Very Low	Low	Moderate	High	Very High
1	Ensanche Sur - Suelo Urbanizable Programado			X		
2	Ensanche Oeste - Suelo Urbanizable Programado			X		
3	Ensanche Noreste - Suelo Urbanizable No Programado			X		
4	Ensanche Este - Suelo Urbanizable No Programado			X		

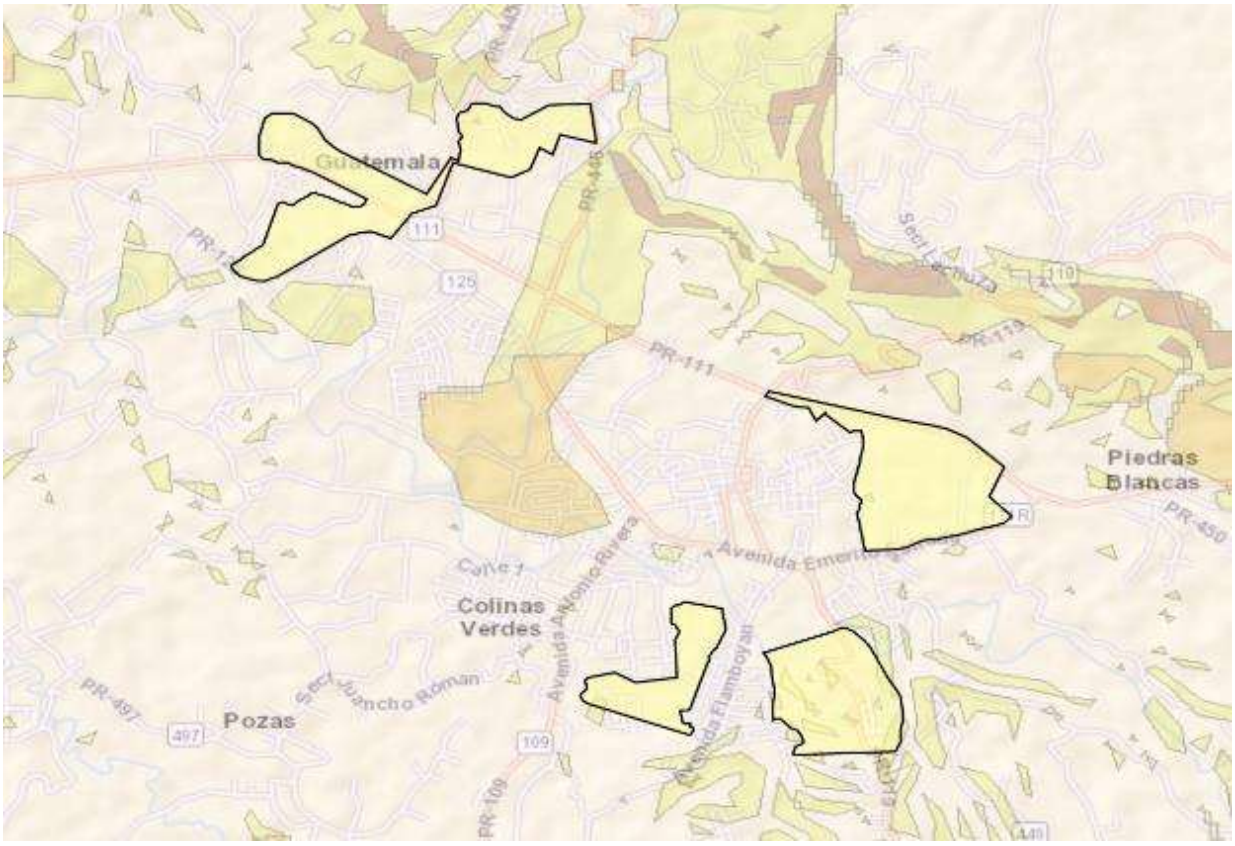

Figure 4-35 Potential New Development and Earthquake Induced Landslide Hazard Areas in Municipality of San Sebastián

Table 4-38
Potential New Development Located in Earthquake-Induced Landslide Hazard Areas

	Facility Name	Earthquake-Induced Landslide Hazard Areas				
		Very Low	Low	Moderate	High	Very High
1	Ensanche Sur - Suelo Urbanizable Programado	X				
2	Ensanche Oeste - Suelo Urbanizable Programado	X				
3	Ensanche Noreste - Suelo Urbanizable No Programado	X				
4	Ensanche Este - Suelo Urbanizable No Programado	X	X			

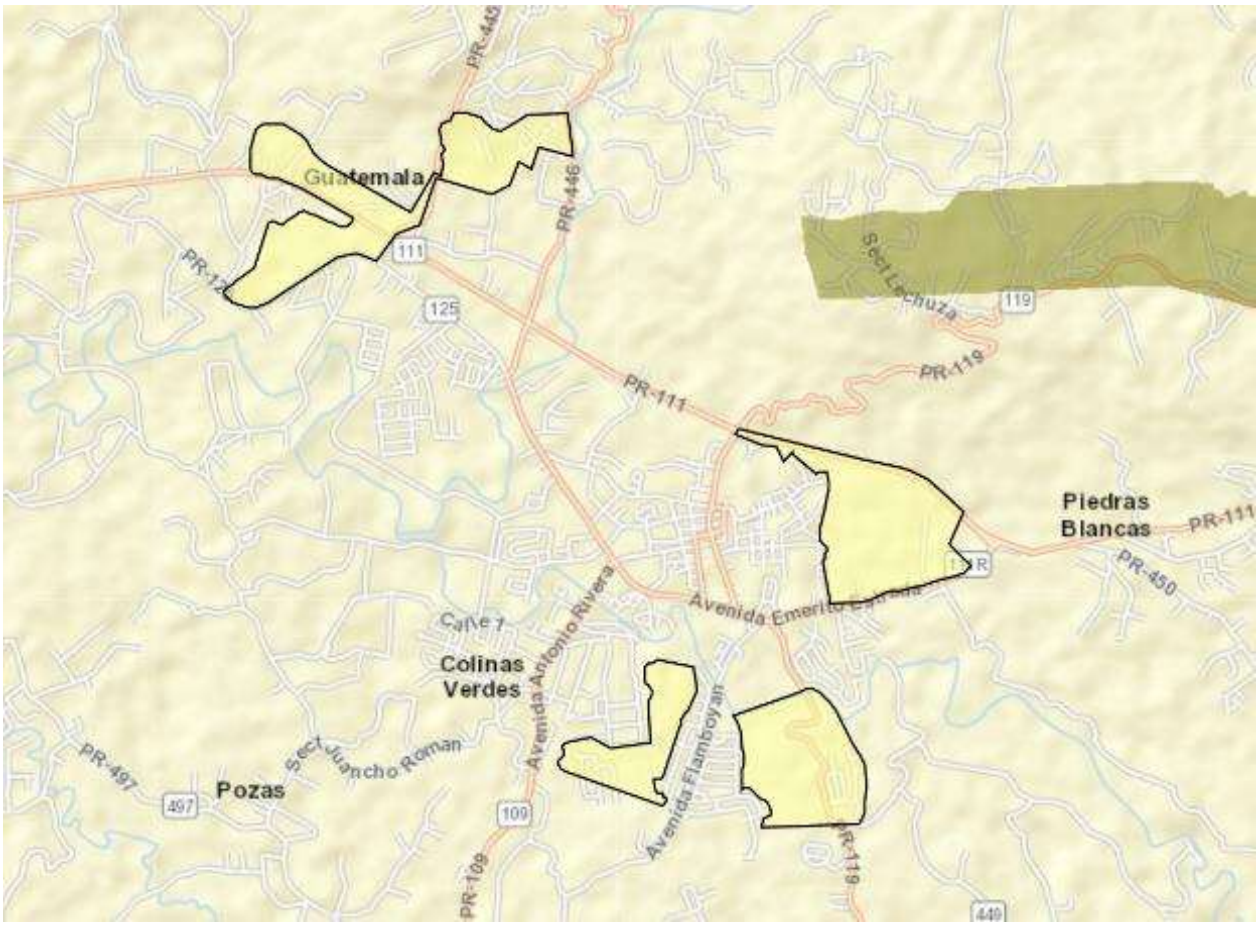

Figure 4-36 Potential New Development and High Wind Hazard Areas in Municipality of San Sebastián

Table 4-39
Potential New Development Exposed to the High Wind Hazard

	Facility Name	Area of Stronger Wind Intensity Hazard	
		In Area	Outside Area
1	Ensanche Sur - Suelo Urbanizable Programado		X
2	Ensanche Oeste - Suelo Urbanizable Programado		X
3	Ensanche Noreste - Suelo Urbanizable No Programado		X
4	Ensanche Este - Suelo Urbanizable No Programado		X

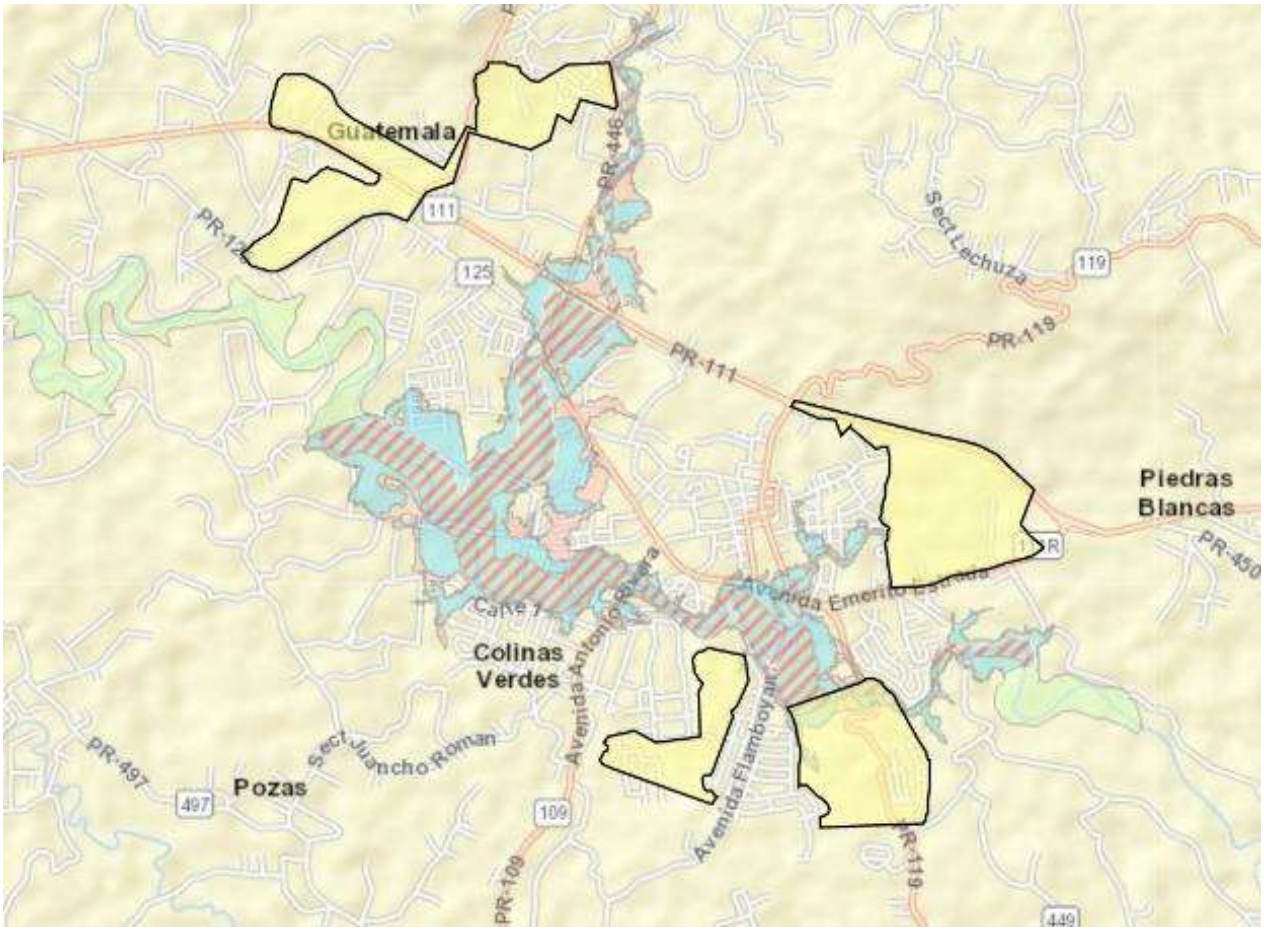

Figure 4-37 Potential New Development and Riverine Flooding Hazard Areas in Municipality of San Sebastián

Table 4-40
New Development/Potential Development in the Municipality of San Sebastián and indication of its Presence in the DFIRM for 100-yr or 500-yr.

	Facility Name	FEMA DFIRM 100-year	FEMA DFIRM 500-year
1	Ensanche Sur - Suelo Urbanizable Programado		
2	Ensanche Oeste - Suelo Urbanizable Programado		
3	Ensanche Noreste - Suelo Urbanizable No Programado		
4	Ensanche Este - Suelo Urbanizable No Programado	X	X

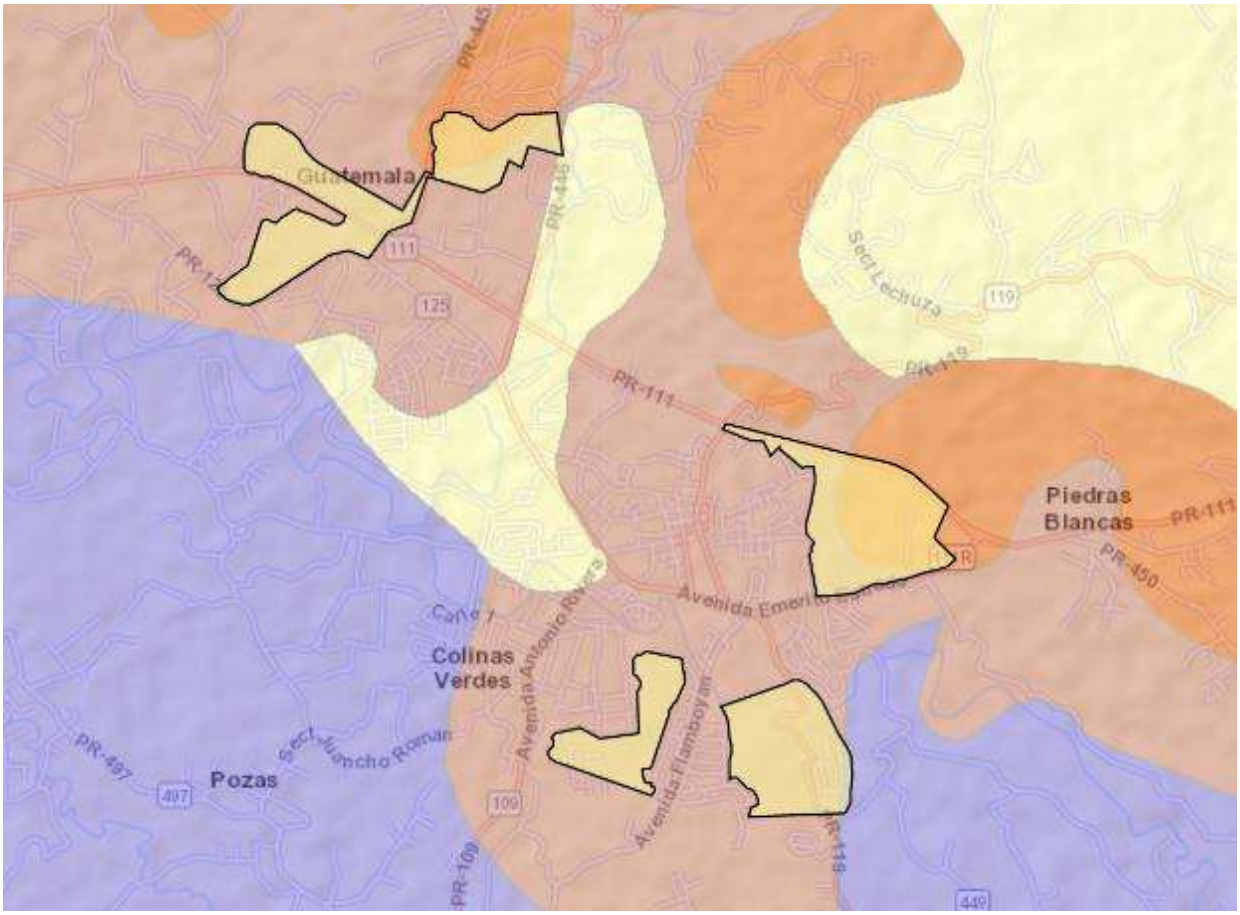

Figure 4-38 Potential New Development and Rainfall Induced Landslide Hazard Areas in Municipality of San Sebastián

Table 4-41
Potential New Development Located in Rain-Induced Landslide Susceptible Areas

	Facility Name	Rain-Induced Landslide Susceptible Areas			
		Low	Moderate	High	Highest
1	Ensanche Sur - Suelo Urbanizable Programado			X	
2	Ensanche Oeste - Suelo Urbanizable Programado			X	X
3	Ensanche Noreste - Suelo Urbanizable No Programado			X	X
4	Ensanche Este - Suelo Urbanizable No Programado		X	X	

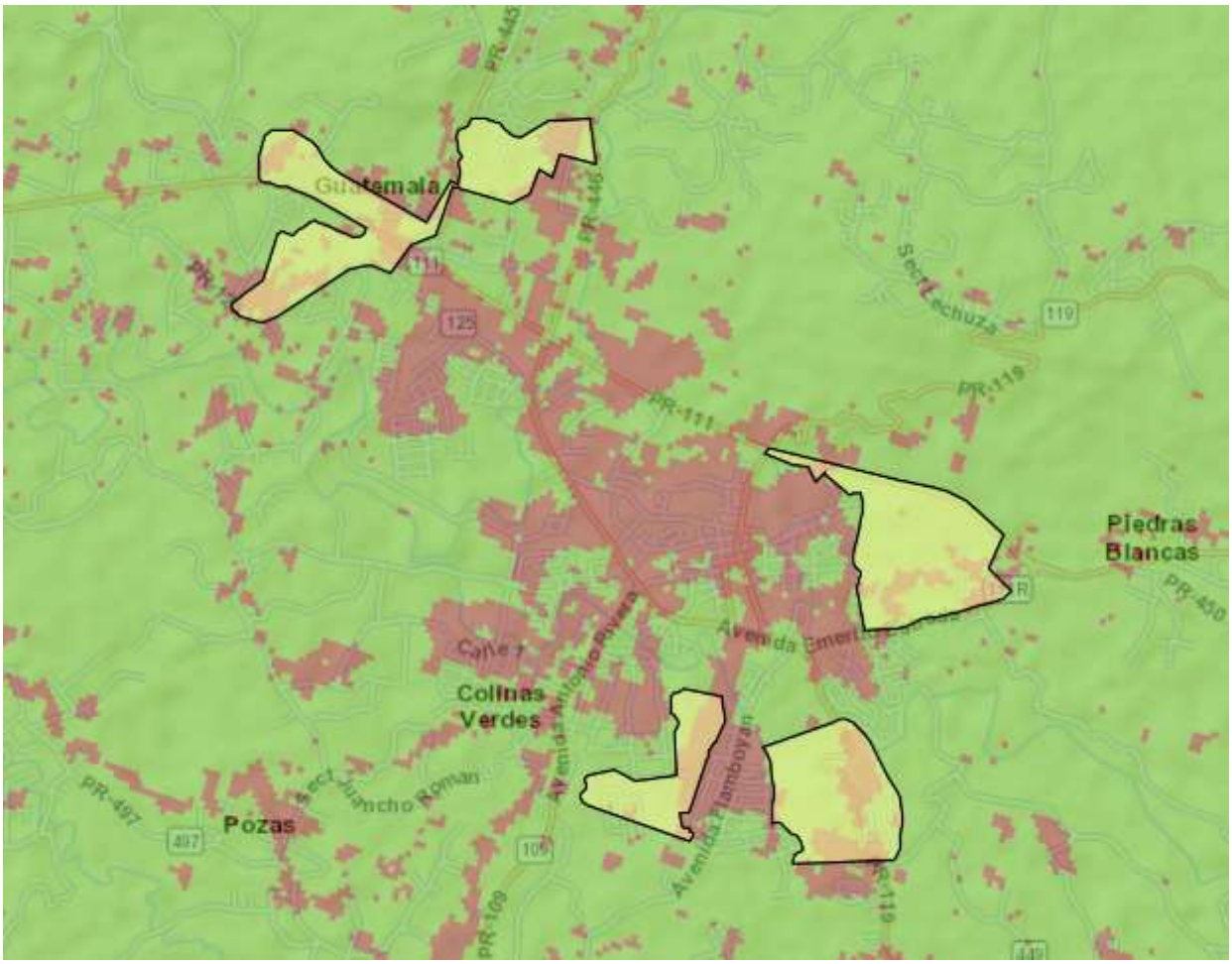

Figure 4-39 Potential New Development and Wildfire Hazard Areas in Municipality of San Sebastián

Table 4-42
New Development/Potential Development in the Municipality of San Sebastián and indication of its Presence in the Wildfire Area.

	Facility Name	Susceptibility level	
		0	1
1	Ensanche Sur - Suelo Urbanizable Programado	X	X
2	Ensanche Oeste - Suelo Urbanizable Programado	X	X
3	Ensanche Noreste - Suelo Urbanizable No Programado	X	X
4	Ensanche Este - Suelo Urbanizable No Programado	X	X

Potential development (for example, development planned or under consideration by the Municipality)

As a Town, we have several Projects on the agenda, which will allow us to grow and above all, to help our citizens. The following list represents the most important projects planned or under consideration by the municipality:

1. Demolition of two (2) low cross structures and bridge: Disposal of waste and replacement in the Sector Tamarindo, Barrio Robles, Highway # 446, KM 3.5 Int

2. Installation of windows shields: "Roll Up" concept of windows shields to avoid possible damage to the structure and facilities in the City Hall building, located in Calle Padre Feliciano # 3, San Sebastián

3. Bridge Replacement in Abrahonda Sector

4. Bridge Replacement in Old Bridge Sector

5. Canalization of the Culebrinas River

6. Canalization of the Guatemala River

7. Connection of three buildings: These buildings constitute critical facilities to install a common emergency power generator; these are the City Hall Building, the Historical Archive and the Finance Department, located at Calle Padre Feliciano # 3, San Sebastián.

8. Public Transportation Terminal: This building is in an advanced deterioration condition, showing cracks in the beams and columns, causing detachment of concrete fragments. To avoid future incidents, it was determined to close the facility. The FTA (Federal Transit Administration) required the Municipality to conduct a feasibility study to determine if the structure should be demolished and another building constructed or if the existing building should be rehabilitated with the amount of approved funds. To carry out the study, the FTA pre-approved $26,000.00, once the final approval is given, the study will begin. The estimated cost of the final project is $2,005,250.00

How those changes increased/decreased the Municipality's vulnerability? - Recent Construction:

The first list of projects in this section were constructed in the expansion areas delimited in the Comprehensive Plan of San Sebastián. The Comprehensive Plan identified four expansion areas to consolidate the existing projects (by the time of the Comprehensive Plan development) and to contain the new development due to the urban growth. The extension area of developed land consists of developed and non-developed areas that will gradually be incorporated into urban land, in the medium and long term. The public policy followed by the San Sebastián Comprehensive Plan is to encourage compact development by limiting the amount of land to be developed and to locate areas of expansion in the lands areas adjacent to the developed area. Some sectors of the extensions are reserved for industrial uses, as well as for commercial activities and services.

The Comprehensive plan also classified sensitive areas to public safety. Areas that have characteristics susceptible to landslides and floods were identified to prevent them from continuing their urbanization while protecting human life. These identified areas respond to lands where the current risk is known.

Susceptible Landslides areas:

- Areas of PR-445, Saltos Ward
- Areas of PR-111, Piedras Blancas Ward

Susceptible Flood Zones:

- Zone I – Río Culebrinas
- Zone II – Río Guatemala, Río Culebrinas (area of Central La Plata) and Río Grande de Añasco, to the south of the municipality of San Sebastian.

Since the recent construction activity was completed inside the developed urban areas and represent improvements to existing facilities, they did not change (increased/decreased) the Municipality's vulnerability. The activity occurred in the development classified zones, their construction did not alter the vulnerability in the areas. This Section includes the maps of the four areas for new potential development (were the projects were completed), and their corresponding vulnerability to the different hazards prone areas. The results are summarized in **Table 4-43**:

Table 4-43 Susceptibility Summary of the Four Development Areas in the Comprehensive Plan to the Different Prone Areas in the Municipality of San Sebastián

Development Areas	Hazard Areas						
	Earth-quake	Lique-faction	Earthquake-Induced Landslide	High Wind	Riverine Flooding	Rain-Induced Landslide	Wildfire
Ensanche Sur - Suelo Urbanizable Programado	M	M	M	OA	OA	H	0 to 1
Ensanche Oeste - Suelo Urbanizable Programado	M	M	M	OA	OA	H to VH	0 to 1
Ensanche Noreste - Suelo Urbanizable No Programado	M	M	M	OA	OA	H to VH	0 to 1
Ensanche Este - Suelo Urbanizable No Programado	M	M	VL to L	OA	In 100- and 500-yr DFIRM area	M to H	0 to 1

Very Low (VL), Low (L), Moderate (M), Hight (H), Very High (VH); Outside Area (OA)

How those changes increased/decreased the Municipality's vulnerability? - Potential development
The Municipality is immersed in the inspections of damaged public assets as part of the Project Formulation Process of the Public Assistance Program with FEMA and the COR[3]. The purpose of this effort is to reconstruct those damages due to the pass of Hurricane Maria and construct a resilient community. These objectives lead us to decrease the vulnerability of our municipality in the future.

Vulnerability refers to the characteristics of community assets that make them **susceptible** to damage from a given hazard. Section 4.8 of the HMP establishes that the general characteristics of the built environment are expected to change over time due to:

1. **Building Code** - Puerto Rico Codes 2018 repeals the Regulation No. 8222 of June 20, 2012, known as the "Puerto Rico Building Code". The Puerto Rico Codes 2018 were approved on November 15, 2018. The Puerto Rico Codes 2018 include the complete set of codes published under the name of Puerto Rico and each of the 10 ICC adopted codes. Act 161-2009, as amended, established that the codes will be revised every three (3) years, from the date of adoption.

2. **Code enforcement** - although formal building codes have been adopted by the central government in Puerto Rico, code enforcement continues to be poorly implemented in rural municipalities. The lack of regulatory control in rural municipalities is directly related to the comprehensive planning process in which municipalities must first complete and adopt a Plan Territorial to obtain regulatory responsibilities. Once adopted, it is expected that code enforcement will gradually improve throughout the municipality. A code enforcement multiplier was used to approximate improvements in the built environment.

3. **Improvements in the construction material and practices** - it is assumed that construction practices, in terms of workmanship and materials, will improve over time. Therefore, the risk projection model holds that vulnerability in the municipality will decrease over time (i.e., building performance for a given hazard type and intensity will improve over time).

All the projects in agenda mentioned before will be completed inside the developed urban areas and represent improvements to existing facilities. The demolition of two (2) low cross structures and bridge will provide a better water flow avoiding or reducing the vulnerability of flood hazard. The installation of windows shields reduces the vulnerability of the City Hall against heavy winds. The bridge replacements projects provide a better condition for water flow reducing the vulnerability to riverine floods. The canalization of the two rivers should provide a better condition to the water flow reducing the vulnerability of the communities in the area. The connection of the three critical facilities to a one common energy source is an energy project included in the priority list of the state. The demolition (or rehabilitation) Project address the safety concern associated to strong winds and earthquakes, minimizing the vulnerability to those hazards.

4.8.3 IMPACT OF CLIMATE CHANGE AND RESILIENCE

Earthquake Ground Shaking

Impact of Climate Change (Risk). The impacts of global climate change on earthquake probability are unknown. Some scientists say that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity per research into prehistoric earthquakes and volcanic activity. NASA and USGS scientists found that retreating glaciers in southern Alaska may be opening the way for future earthquakes (NASA 2004).

Secondary impacts of earthquakes could be magnified by climate change. Soils saturated by repetitive storms could experience liquefaction during seismic activity due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events. There are currently no models available to estimate these impacts.

Resilience and Earthquakes. Strong earthquakes can lead to structure collapse, injuries, fatalities, disruption to infrastructure, and business interruption. The immediate impacts of earthquakes can be devastating to a community and bring challenges (launching rescue efforts, restore essential services, and initiate the recovery process). A community's ability to recover from a disaster reflects its resilience (NEHRP 2011). A community has options to mitigate the impact of earthquakes. This includes the following:

- Avoid active fault zones and unstable ground through land use practices;
- Identify and enforce earthquake-resistant building codes and practices that can reduce damage and casualties;
- Assistance from insurance companies and government entities to facilitate recovery and ease economic impacts;
- Rapid emergency response which can save lives and restore essential services (NEHRP 2011).

Effect of Climate Change on Vulnerability. Providing projections of future climate change for a specific region is challenging. Some scientists feel that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the Earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity per research into prehistoric earthquakes and volcanic activity. National Aeronautics and Space Administration (NASA) and USGS scientists found that retreating glaciers in southern Alaska might be opening the way for future earthquakes. Secondary impacts of earthquakes could be magnified by future climate change. Soils saturated by repetitive storms could experience liquefaction during seismic activity because of the increased saturation. Dams storing increased volumes of water from changes in the hydrograph could fail during seismic events. There are currently no models available to estimate these impacts.

Next Steps. Additional data needed to further refine and enhance the San Sebastian's vulnerability assessment include NEHRP soils to be integrated into the HAZUS-MH model. Identifying un-reinforced masonry critical facilities and privately-owned buildings (i.e., residences) using local knowledge and/or pictometry/orthophotos would be valuable as these buildings may not withstand earthquakes of certain magnitudes. This information will facilitate developing plans to provide emergency response/recovery efforts for these properties. Further mitigation actions include training of municipal personnel to provide post-hazard event rapid visual damage assessments, increase of local debris management and logistic capabilities, and revised regulations to prevent additional construction of non-reinforced masonry buildings.

Liquefaction

Impact of Climate Change (Risk). The impacts of global climate change on earthquake / liquefaction probability are unknown. Some scientists say that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity according to research into prehistoric earthquakes and volcanic activity. NASA and USGS scientists found that retreating glaciers in southern Alaska may be opening the way for future earthquakes (NASA 2004).

Secondary impacts of earthquakes / liquefaction could be magnified by climate change. Soils saturated by repetitive storms could experience liquefaction during seismic activity due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events. There are currently no models available to estimate these impacts.

Resilience and Liquefaction. Liquefaction is a result of earthquake events. Please refer to the Earthquake hazard profile for information regarding resilience.

Effect of Climate Change on Vulnerability. Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of extremes such as flood events. While predicting changes of flood events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (U.S. Environmental Protection Agency [EPA], 2006).

Next Steps. Over time, the municipality will obtain additional data to support the analysis of this hazard. Data that will support the analysis would include additional detail on past hazard events and impacts. For a more accurate exposure analysis, as parcel or structure spatial data becomes available, the liquefaction-hazard areas can be overlaid upon the new data for updated exposure estimates. In addition, the development of maps of soil conditions affecting ground shaking, liquefaction and land sliding potential could be incorporated into HAZUS for evaluation of the effects of the local conditions upon damages and losses.

Earthquake Induced Landslide

Impact of Climate Change (Risk). The impacts of global climate change on earthquake (induced landslides) probability are unknown. Some scientists say that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity per research into prehistoric earthquakes and volcanic activity. NASA and USGS scientists found that retreating glaciers in southern Alaska may be opening the way for future earthquakes (NASA 2004).

Secondary impacts of earthquakes (induced landslides), could be magnified by climate change. Soils saturated by repetitive storms could experience liquefaction during seismic activity due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events. There are currently no models available to estimate these impacts.

Resilience and Earthquake-Induced Landslides. Please refer to the Earthquake and Rainfall-Induced Landslide hazard profiles for information regarding a community's resiliency to those hazards.

Effect of Climate Change on Vulnerability. Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of extremes such as flood events. While predicting changes of flood events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (U.S. Environmental Protection Agency [EPA], 2006).

Next Steps. Obtaining historic damages to buildings and infrastructure incurred due to ground failure will help with loss estimates and future modeling efforts, given a margin of uncertainty. Generating a custom-building inventory using current tax data would provide a more detailed loss estimation at the structural level as opposed to the census block level. More detailed landslide susceptibility zones can be generated so that communities can more specifically identify high hazard areas.

High Wind

Impact of Climate Change (Risk). According to the Puerto Rico Climate Change Council (PRCCC), climate change will impact the social, economic, and ecological factors in Puerto Rico. It will affect key sectors such as economic development, tourism, services, natural resources and biodiversity, cultural and historic resources, security, and critical infrastructure. Global climate change is projected to increase the vulnerability of tropical islands, like Puerto Rico, to natural hazards. As shown in the 2001 National Climate Assessment, the average annual air temperatures in the Caribbean islands increased by more than 0.6°C over the 21st Century.

Over the next century, projected temperature increases for the Caribbean are projected to be between 2.5°C and 4°C by 2100. It is also projected that the Caribbean will see decreases in annual precipitation (PRCCC 2013).

Between 1948 and 2007, Puerto Rico experienced significant increases in annual average temperature. The Commonwealth has experienced a rise of 0.012 to 0.0.14°C each year. As for precipitation, past and future trends have shown a decrease of rainfall of -0.0012 to -0.0032 mm/day/year, which are projected to continue through 2050 (PRCCC 2013).

Caribbean Sea surface temperatures have warmed by 1.5°C over the last century. As for Puerto Rico, observed trends near the Commonwealth were assessed to be 0.008°C over the period 1900 to 2010. Projections for Puerto Rico indicated that an increase of 1.17°C over a 50-year period can be expected (PRCCC 2013).

Global sea level, on average, has risen by 120 meters over the last 18,000 years. The average rate during the last 3,000 years has been approximately one to two centimeters per century. Since 1961, the average global sea level has been rising at an average rate of 1.8 mm/year and at an increased rate of 3.1 mm/year since 1993. In the Caribbean, the current rate of sea level rise is 10 cm (3.9 inches) per century. In Puerto Rico, sea level rise can be expected to be 1.4 mm/year (PRCCC 2013).

As for extreme events for Puerto Rico, climate projections for extreme events show a probable increase in extreme heat days and cold events are expected to decrease. The projected rate of warming is most rapid in winter (December – February). Climate projections for the Commonwealth show a probable increase in regional downpours. Warmer sea surface temperatures around the North Atlantic, Caribbean, and Puerto Rico are likely to increases the intensity of rainfall, wind and storm surge events such as hurricanes and tropical storms. Intense hurricanes and associated extreme wind events have the potential to become more frequent due to the anticipated warming of the upper ocean (PRCCC 2013).

Resilience and High Wind. No community is immune from disasters or disaster-related loses. Natural hazards, like high wind events, can lead to large-scale consequences for a community. One way to reduce the impacts of disasters is to enhance a community's resilience. It allows better anticipation of disasters and better planning to reduce disaster losses. Ways for a community to become more resilient to disasters include:

- Provide access to risk and vulnerability information;
- Communities should design resilience strategies and operation plans based on risk and vulnerability information;
- Making proactive investments and policy decisions – by doing so can reduce loss of lives, costs and socioeconomic impacts of future disasters
- Expand public outreach and education programs for residents (Disaster Resilience: A National Imperative 2012)

Effect of Climate Change on Vulnerability. Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of events like hurricanes. While predicting changes to the prevalence or intensity of hurricanes and the events affects under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (U.S. Environmental Protection Agency [EPA], 2006).

Next Steps. Over time, San Sebastian can obtain additional data to support the analysis of this hazard. Data that will support the analysis would include additional detail on past hazard events and impacts, building footprints and specific building information such as details on protective features (for example, hurricane straps).

Riverine Flooding

Impact of Climate Change (Risk). According to the Puerto Rico Climate Change Council (PRCCC), climate change will impact the social, economic, and ecological factors in Puerto Rico. It will affect key sectors such as economic development, tourism, services, natural resources and biodiversity, cultural and historic resources, security, and critical infrastructure. Global climate change is projected to increase the vulnerability of tropical islands, like Puerto Rico, to natural hazards. As shown in the 2001 National Climate Assessment, the average annual air temperatures in the Caribbean islands increased by more than 0.6°C over the 21st century. Over the next century, projected temperature increases for the Caribbean are projected to be between 2.5°C and 4°C by 2100. It is also projected that the Caribbean will see decreases in annual precipitation (PRCCC 2013).

Between 1948 and 2007, Puerto Rico experienced significant increases in annual average temperature. The Commonwealth has experienced a rise of 0.012 to 0.0.14°C each year. As for precipitation, past and future trends have shown a decrease of rainfall of -0.0012 to -0.0032 mm/day/year, which are projected to continue through 2050 (PRCCC 2013).

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Global sea level, on average, has risen by 120 meters over the last 18,000 years. The average rate during the last 3,000 years has been approximately one to two centimeters per century. Since 1961, the average global sea level has been rising at an average rate of 1.8 mm/year and at an increased rate of 3.1 mm/year since 1993. In the Caribbean, the current rate of sea level rise is 10 cm (3.9 inches) per century. In Puerto Rico, sea level rise can be expected to be 1.4 mm/year (PRCCC 2013).

As for extreme events for Puerto Rico, climate projections for extreme events show a probable increase in extreme heat days and cold events are expected to decrease. The projected rate of warming is most rapid in winter (December – February). Climate projections for the Commonwealth show a probable increase in regional downpours. Warmer sea surface temperatures around the North Atlantic, Caribbean, and Puerto Rico are likely to increases the intensity of rainfall, wind and storm surge events such as hurricanes and tropical storms. Intense hurricanes and associated extreme wind events have the potential to become more frequent due to the anticipated warming of the upper ocean (PRCCC 2013).

Resilience and Riverine Flooding. Over the last 10 years, on average, 250 million people have been affected by floods each year. Floods are the single most widespread and increasing disaster risk to all municipalities. They cause extensive recurring risk which damages critical infrastructure (transport systems, roads, schools and healthcare facilities). Building or enhancing community resilience has become an important part of disaster risk reduction efforts.

Due to its location, Puerto Rico is exposed to the effects of hurricanes and other tropical systems from June to November. Many of the most severe and damaging flood events that occurred in the Commonwealth resulted from hurricanes and tropical storms. Other weather systems can also bring intense rains to Puerto Rico at any time of the year. Puerto Rico has used mitigation strategies, structural and non-structural, since the 1970s. More recently, the Commonwealth's Hazard Mitigation Plan identifies non-technical and proactive flood management practices: development and redevelopment of policies, floodplain regulations, public education and outreach, and flood forecasts and warnings. Building community resilience to floods in the HMP are considered essential elements of effective hazard mitigation strategies (López-Marrero et al. 2011). A study was conducted in the urban communities of Mansión del Sapo and Maternillo, located in the northeastern municipality of Fajardo to identify flood vulnerabilities to their residents and develop ways for those communities to become more resilient to flooding. These findings can be incorporated all over the Puerto Rico, including San Sebastian (López-Marrero et al. 2011). The findings of the study suggested that increasing resilience to floods requires:

- Promoting social learning by building on existing knowledge about floods, which refers to combining different types of knowledge, with explicit recognition of local knowledge;
- Stressing the importance of developing a diverse set of flood management options that overtly acknowledges the complementary nature of technical and non-technical strategies; and
- Promoting effective linkages and partnerships between community members and emergency managers to encourage collaborative flood management (López-Marrero et al. 2011).

Lastly, in order for a community to enhance their resilience to floods, the findings from the study suggest the need to:

- Build upon existing knowledge about floods, particularly in relation to the multiple types of floods and to the potential influences of human activity on floods;
- Increase awareness of the potential risks associated with technical measures in the area and emphasize the importance of developing and implementing non-technical strategies for flood management to complement technical ones; and
- Develop partnerships and collaborations for flood management (López-Marrero et al. 2011).

Effect of Climate Change on Vulnerability. Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of extremes such as flood events. While predicting changes of flood events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (U.S. Environmental Protection Agency [EPA], 2006).

Next Steps. A HAZUS-MH flood analysis was conducted for the Municipality using the most current and best available data including updated building and critical facility inventories, and DFIRM. For future plan updates, more accurate loss estimates can be produced by replacing the national default demographic inventory with 2010 U.S. Census data when it becomes available in the HAZUS-MH model.

Wildfire

Impact of Climate Change (Risk). According to the Puerto Rico Climate Change Council (PRCCC), climate change will impact the social, economic, and ecological factors in Puerto Rico. It will affect key sectors such as economic development, tourism, services, natural resources and biodiversity, cultural and historic resources, security, and critical infrastructure. Global climate change is projected to increase the vulnerability of tropical islands, like Puerto Rico, to natural hazards. As shown in the 2001 National Climate Assessment, the average annual air temperatures in the Caribbean islands increased by more than 0.6°C over the 21st century. Over the next century, projected temperature increases for the Caribbean are projected to be between 2.5°C and 4°C by 2100. It is also projected that the Caribbean will see decreases in annual precipitation (PRCCC 2013).

Fire is determined by climate variability, local topography, and human intervention. Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Hot dry spells create the highest fire risk. With the increasing temperatures occurring in Puerto Rico, wildfire danger may intensify by warming and drying out vegetation. When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

Resilience and Wildfire. No community is immune from disasters or disaster-related loses. Natural hazards, like wildfires, can lead to large-scale consequences for a community. One way to reduce the impacts of disasters is to enhance a community's resilience. It allows better anticipation of disasters and better planning to reduce disaster losses. Ways for a community to become more resilient to disasters include:

- Provide access to risk and vulnerability information;
- Communities should design resilience strategies and operation plans based on risk and vulnerability information;
- Making proactive investments and policy decisions – by doing so can reduce loss of lives, costs and socioeconomic impacts of future disasters
- Expand public outreach and education programs for residents (Disaster Resilience: A National Imperative 2012)

Some ways to enhance wildfire resiliency within a community includes:

- Risk identification
- Stakeholder alignment
- Investment in mitigation
- Public engagement for preparedness and planning
- Sustainable financing (Swiss RE 2015)

Effect of Climate Change on Vulnerability. According to the U.S. Fire Service (USFS), climate change will likely alter the atmospheric patterns that affect fire weather. Changes in fire patterns will, in turn, impact carbon cycling, forest structure, and species composition. Climate change associated with elevated greenhouse gas concentrations may create an atmospheric and fuel environment that is more conductive to large, severe fires (USFS, 2011). Under a changing climate, wildfires are expected to increase by 50% across the U.S. (USFS, 2013).

Fire interacts with climate and vegetation (fuel) in predictable ways. Understanding the climate/fire/vegetation interactions is essential for addressing issues associated with climate change that include:

- Effects on regional circulation and other atmospheric patterns that affect fire weather
- Effects of changing fire regimes on the carbon cycle, forest structure, and species composition, and
- Complications from land use change, invasive species and an increasing wildland-urban interface (USFS, 2011).

It is projected that higher summer temperatures will likely increase the high fire risk by 10 to 30%. Fire occurrence and/or area burned could increase across the U.S. due to the increase of lightning activity, the frequency of surface pressure and associated circulation patterns conductive to surface drying, and fire-weather conditions, in general, which is conductive to severe wildfires. Warmer temperatures will also increase the effects of drought and increase the number of days each year with flammable fuels and extending fire seasons and areas burned (USFS, 2011).

Future changes in fire frequency and severity are difficult to predict. Global and regional climate changes associated with elevated greenhouse gas concentrations could alter large weather patterns, thereby affecting fire-weather conducive to extreme fire behavior (USFS, 2011).

Next Steps. Creating a custom-building inventory including tax assessor data and additional building attributes regarding the construction of structures, such as roofing material, fire detection equipment, structure age, etc. may be incorporated as available. As stated earlier, buildings constructed of wood or vinyl siding are generally more likely to be impacted by the fire hazard than buildings constructed of brick or concrete. The proximity of these building types to the fuel hazard areas should be identified for further evaluation. Development and availability of such data would permit a more detailed estimate of potential vulnerabilities, including loss of life and potential structural damages.

5.0 MITIGATION STRATEGY

This section of the Hazard Mitigation Plan for the Municipality of San Sebastián describes the strategy for reducing the island's vulnerability to the effects of natural hazards. The mitigation strategy is built upon a framework of goals, objectives and actions. These mitigation strategies are based on community input, the risk assessment, and an assessment of technical and administrative capabilities. Section Five is divided into the following eight subsections:

- 5.1 Requirements for Mitigation Strategies
- 5.2 Mitigation Strategy
- 5.3 Mitigation Action Plan
- 5.4 Administration of Actions
- 5.5 Assessing Cost Effectiveness of Mitigation Actions
- 5.6 Mitigation Actions that Address Future Development
- 5.7 Prioritized List of Mitigation Actions
- 5.8 Broad Recommendations and Actions for Plan Update

5.1 REQUIREMENTS FOR MITIGATION STRATEGIES

44 CFR section 201.6(c)(3) states that "[t]he plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools"

- **Local Hazard Mitigation Goals** per **Requirement** §201.6(c)(3)(i): [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.
- **Identification and Analysis of Mitigation Actions** per **Requirement** §201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with emphasis on new and existing buildings and infrastructure.
- **Implementation of Mitigation Actions** per **Requirement:** §201.6(c)(3)(iii): [The mitigation strategy section shall include] an action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

5.2 MITIGATION STRATEGY

The mitigation strategy is intended to provide a clearly defined set of policies and projects based on a rational hierarchal framework for action. This framework consists of the following:

- **Goals:** Goals represent broad statements that are achieved through the implementation of a range of more specific objectives. Goals are usually expressed as broad policy statements and provide the framework for achieving the desired results over the long-term planning horizon.

- **Objectives:** Objectives describe more specific steps that would lead to implementation of the identified goals. They are intended to support, correspond and define a path on how to attain the desired goals.
- **Mitigation Techniques:** A range of mitigation techniques was identified to reduce hazard vulnerability and achieve established community goals and objectives. Mitigation techniques include prevention, property protection, natural resource protection, structural projects, emergency services, and public information and awareness activities.
- **Mitigation Action Plan:** The Mitigation Action Plan presents the short-term, specific actions to be undertaken in order to achieve identified objectives. For each action, the Mitigation Action Plan identifies the objective(s) it is intended to achieve, provides general background information to justify the proposed action, and provides measures to ensure successful and timely implementation, including task assignments and appropriate funding sources, if applicable. A simple voting technique was used by the Hazard Mitigation Committee to rank all of the proposed mitigation actions.

5.2.1 GOALS AND OBJECTIVES

The following goals and objectives represent a comprehensive approach taken by the Municipality of San Sebastián to reduce the impacts of natural hazards. Each goal and objective was approved by the Hazard Mitigation Committee and was based on public input gathered during public meeting. The goals and objectives are intended to guide both the day-to-day operations and the long-term approach taken by the Municipality of San Sebastián to reduce potential losses from future hazard events. The Committee reviewed the goals and objectives during this 2018 update process one by one, and determined to keep all of them as they are. The Hazard Mitigation Plan for San Sebastián contains four (4) broad based goals and eight (8) objectives.

- GOAL #1 REDUCE THE IMPACT OF NATURAL DISASTERS ON RESIDENTS AND PROPERTY

  Objective 1.1 Protect existing development from future disaster events

  Objective 1.2 Reduce the vulnerability of future development

- GOAL #2 STRENGTHENS THE CAPABILITIES OF MUNICIPAL AGENCIES TO IMPLEMENT AND MAINTAINS HAZARD MITIGATION PROGRAMS

  Objective 2.1 Identify and develop policies, regulations, and training necessary to support an effective hazard mitigation program in the Municipality

- GOAL #3 INCREASE THE AWARENESS AND UNDERSTANDING OF THOSE LIVING AND WORKING IN SAN SEBASTIÁN TO NATURAL HAZARDS AND TO THE PRINCIPLES OF HAZARD MITIGATION

  Objective 3.1 Develop outreach programs focused on increasing public awareness of hazards and their associated risks

  Objective 3.2 Support local businesses and industries in becoming more disaster resistant

- GOAL #4 IMPROVE LOCAL ABILITY TO RESTORE CRITICAL FACILITIES, ESSENTIAL INFRASTRUCTURE, AND ENSURE THE CONTINUITY OF MUNICIPAL OPERATIONS FOLLOWING NATURAL DISASTERS

  Objective 4.1 Enhance municipal capabilities to support emergency response and recovery operations

  Objective 4.2 Undertake planning to maximize governmental coordination and communication between municipality, central government and federal agencies

  Objective 4.3 Reduce the vulnerability of critical facilities, infrastructure and essential municipal facilities

5.2.2 MUNICIPALITY OF SAN SEBASTIAN CAPABILITY ASSESSMENT

According to FEMA 386-3, a capability assessment is an inventory of a community's missions, programs and policies; and an analysis of its capacity to carry them out. This assessment is an integral part of the planning process. It identifies, reviews and analyzes local and state programs, polices, regulations, funding and practices currently in place that may either facilitate or hinder mitigation.

The Municipality prepared a capability assessment for this updated version 2018. By completing this assessment, the Municipality learned how or whether they would be able to implement certain mitigation actions by determining the following:

- Types of mitigation actions that may be prohibited by law;
- Limitations that may exist on undertaking actions; and
- The range of local and/or state administrative, programmatic, regulatory, financial and technical resources available to assist in implementing their mitigation actions.
- Action is currently outside the scope of capabilities (e.g., funding)

Table 5-1 presents legal and regulatory capabilities. **Table 5-2** presents the administrative and technical capabilities. **Table 5-3** presents fiscal capabilities, and **Table 5-4** presents the community classifications for the Municipality.

Table 5-1
Legal and Regulatory Capabilities

Regulatory Tools (Codes, Ordinances, Plans)	**Local Authority (Y or N)**	**Prohibitions (State or Federal) (Y or N)**	**Higher Jurisdictional Authority (Y or N)**	**State Mandated (Y or N)**	***Code Citation*** *(Section, Paragraph, Page Number, date of adoption)*
1) Puerto Rico Codes 2018	N	N	Y	Y	Regulation No. 9049 of November 15, 2018 known as Puerto Rico Codes 2018.
2) Land Zoning and Use Plan (Local Comprehensive Plan)	Y	N	Y	Y	The Municipality has completed the four phases of the Land Plan. The Calification Map (use map) was approved on October 28, 1998. Until then, Puerto Rico Planning Board and Permitting Management Office process is follow.
3) Stormwater Management Plan/Ordinance	Y	N	Y	Y	NPDES Small MS4 General Permit for the Phase 2 Stormwater Program. The Permit number is: PRR040073. The NOI was submitted on September 2, 2009 and the date of coverage is June 7, 2010.
4) Comprehensive Plan / Master Plan	Y	N	Y	Y	In progress as part to become an Autonomous Municipality. Until then, Puerto Rico Planning Board and Permitting Management Office process is follow.
5) Habitat Conservation Plan	N	Y	Y	Y	Conservation Plan of Sensitive Areas for Adjuntas and Adjacent Municipalities (October 27, 2004).
6) Economic Development Plan	Y	N	N	N	Ordinance Num. 20 – PON-16 (26-08) Serie 2008-09): Ordinance to establish a municipal tax incentive program to companies and industries to be located or to improve the existing conditions in the Municipality of San Sebastián; to adopt the applicable regulations to promote the economic, social, and urban development, and other purposes.

Table 5-2
Administrative and Technical Capabilities

Staff/ Personnel Resources	Available (Y or N)	Department/ Agency/Position
1) Planner(s) or Engineer(s) with knowledge of land development and land management practices	N	Municipality Planner, Municipality Engineer
2) Engineer(s) or Professional(s) trained in construction practices related to buildings and/or infrastructure	Y	Director of Planning and Engineering
3) Planners or engineers with an understanding of natural hazards	N	Municipality Engineer
4) NFIP Floodplain Administrator	N	-
5) Surveyor(s)	N	-
6) Personnel skilled or trained in "GIS" applications	N	-
7) Scientist(s) familiar with natural hazards in the Municipality of San Sebastián.	N	-
8) Emergency Manager	Y	Director of OMME
9) Grant Writer(s)	Y	Director of Federal Funds Department
10) Staff with expertise or training in benefit/cost analysis	N	-

Table 5-3
Fiscal Capabilities

Financial Resources	Accessible or Eligible to use (Yes/No/Don't know)
1) Community development Block Grants (CDBG)	Yes
2) Capital Improvements Project Funding	Yes
3) Authority to Levy Taxes for specific purposes	Yes
4) User fees for water, sewer, gas or electric service	NO
5) Impact Fees for homebuyers or developers of new development/homes	Yes
6) Incur debt through general obligation bonds	Yes
7) Incur debt through special tax bonds	DK
8) Incur debt through private activity bonds	No
9) Withhold public expenditures in hazard-prone areas	No
10) State mitigation grant programs	Yes
11) Other	-

TBD = To be determined.

Table 5-4
Community Classifications

Program	Classification
Community Rating System (CRS)	NP
Building Code Effectiveness Grading Schedule (BCEGS)	NP
Public Protection (DCJS, CALEA)	NP
Storm Ready	NP
Firewise	NP
ISO	NP

The classifications listed above relate to the community's effectiveness in providing services that may impact it's vulnerability to the natural hazards identified. These classifications can be viewed as a gauge of the community's capabilities in all phases of emergency management (preparedness, response, recovery and mitigation) and are used as an underwriting parameter for determining the costs of various forms of insurance. The CRS class applies to flood insurance while the BCEGS and Public Protection classifications apply to standard property insurance. CRS classifications range on a scale of 1 to 10 with class one (1) being the best possible classification, and class 10 representing no classification benefit. Firewise classifications include a higher classification when the subject property is located beyond 1000 feet of a creditable fire hydrant and is within 5 road miles of a recognized Fire Station. Criteria for classification credits are outlined in the following documents:

- The Community Rating System Coordinators Manual
- The Building Code Effectiveness Grading Schedule
- The ISO Mitigation online ISO's Public Protection website at http://www.isomitigation.com/ppc/0000/ppc0001.html
- The National Weather Service Storm Ready website at http://www.weather.gov/stormready/howto.htm
- The National Firewise Communities website at http://firewise.org/

5.2.3 MITIGATION TECHNIQUES

A range of mitigation techniques were presented to the Hazard Mitigation Committee for consideration in implementing the goals and objectives. The Techniques may be added or subtracted as this Plan evolves, considering the effectiveness of chosen actions, their completion, or in response to the changing vulnerabilities found in San Sebastián.

Range of Available Mitigation Techniques

Prevention

Preventative activities are intended to keep hazard-related problems from getting worse. They are particularly effective in reducing a community's vulnerability, especially in areas where development has not occurred or capital improvements have not been substantial. Examples of preventative activities include:

- Planning and zoning
- Open space preservation
- Stormwater management
- Drainage system maintenance
- Capital improvements programming
- Riverine setbacks

Property Protection

Property protection measures "harden" existing structures to better withstand hazard events, remove them from hazard prone areas, or provide insurance to cover potential losses. Examples include:

- Acquisition
- Relocation
- Building elevation
- Critical facilities protection or "hardening"
- Retrofitting (i.e., wind proofing, flood proofing, seismic retrofits)
- Insurance
- Construction of Safe room (room protected from hurricane strength winds)

Natural Resource Protection

Natural resource protection activities reduce the impact of hazards by preserving or restoring the function of environmental systems such as floodplains and wetlands. In many cases, environmentally sensitive areas are also high hazard areas. Thus, natural resource protection measures can serve the dual purpose of protecting lives and property while enhancing environmental goals such as improved water quality or enhancing recreational opportunities. Parks, recreation or conservation agencies and organizations often implement these measures. Examples include:

- Floodplain protection
- Riparian buffers (establishing no disturbance, no development zoning setbacks along streams, rivers or coastline)
- Fire resistant landscaping
- Erosion and sediment controls
- Wetland preservation and restoration
- Habitat preservation and restoration
- Slope stabilization

Structural Projects

Structural mitigation projects are intended to lessen the impact of a hazard by physically modifying the environment. They are usually designed by engineers and managed or maintained by public works staff. Examples include:

- Flood control reservoirs
- Levees/dikes/floodwalls
- Storm water management ponds
- Channel modification
- Storm drains and culverts

Emergency Services

Although not typically considered a "mitigation technique," emergency services minimize the impact of a hazard event on people and property. These actions are typically taken immediately prior to, during, or in response to a hazard event. Examples include:

- Search and rescue
- Evacuation planning and management
- Flood "fighting" methods (i.e., sandbagging, use of temporary flood walls, etc.)
- Warning systems
- Emergency Operation Center (EOC)
- Retrofitting critical facilities to better withstand disaster events

Public Information and Awareness

Public information and awareness activities are used to advise residents, business owners, potential property buyers and visitors about hazards, hazardous areas and mitigation techniques they can use to protect themselves and their property. Examples of measures to educate and inform the public include:

- Outreach
- Speaker series/demonstration events
- Hazard map information
- Real estate disclosure
- Education
- Training

Mitigation Techniques Applicable to the Municipality of San Sebastián

In considering the appropriate mitigation techniques for the Municipality of San Sebastián, the Hazard Mitigation Committee reviewed the findings of the *Hazard Identification and Risk Assessment.* The following natural hazards evaluated in the risk assessment are presented in descending order of estimated disaster damages (highest loss estimate to the lowest).

- Earthquake Ground Shaking
- Hurricane (high wind damage)
- Earthquake Landslide
- Wildfire
- Rainfall-Landslide
- Riverine Flooding
- Earthquake liquefaction

The northwest portion of Puerto Rico is most at risk to a major earthquake and fact is reflected in the loss estimates for the Municipality of San Sebastián. The loss estimates for a major earthquake are approximately 10 times greater than those for hurricane and flood losses combined. Several specific mitigation actions included in this Plan address the need for seismic retrofits for critical and essential public facilities. However, the cost of extensive seismic retrofits to residential and commercial structures would be prohibitively expensive and potential funding sources quite limited. The most cost effective way to address the Municipality's vulnerability to earthquakes is to reduce the vulnerability of future development by training the building community and through stricter compliance with the building codes. Many the mitigation actions proposed address the need to reduce the vulnerability of future development (listed as earthquake or all hazards).

The lack of potential funding sources to implement seismic retrofits for many highly vulnerable structures in the Urban Center, should not be interpreted as a lack of concern for the seismic risk by the study contractors or the Municipality of San Sebastián. Many of older, two to four-story masonry structures in the Urban Center were constructed prior to the advent of the building code and are extremely prone to collapse, even in an earthquake of moderate intensity. The destructive 1918 earthquake occurred and it is not a question of whether such an earthquake will occur but when. Although many these structures are commercial, many are residential, especially on the upper floors. A moderate intensity earthquake in the near future could result in a substantial loss of life for residents in these vulnerable structures. For some of the older structures that do have historic designation potential, demolition and reconstruction should be considered. A gradual phase out of residential use of some of the most vulnerable structures should be considered, with relocation to areas outside of the Urban Center that are not as susceptible to ground shaking and liquefaction attenuation. New residential construction in the Urban Center needs scrutiny to ensure that design and construction meets all seismic standards in the building code. Many the mitigation actions proposed address repetitive flooding events (riverine and coastal) that may or not be associated with a Hurricane event. Although these mitigation actions address natural hazards that do not have the highest loss estimates (calculated for the 100-year occurrence interval), they are regarded by San Sebastián residents as deserving serious attention because of the disruption and property damages that occur repeatedly (several times a year for minor flooding events and on the order of one or twice every five to ten years for major flood events). The following matrix (**Table 5-5**) summarizes the mitigation techniques considered.

Table 5-5
Mitigation techniques for one or more natural hazards

Mitigation Technique	Ground Shaking	Liquefaction	Earthquake Landslide	Riverine Flooding	Rainfall Landslide	High Wind Hurricane	Wildfire
Prevention	X					X	
Property Protection	X			X		X	
Natural Resource Protection	X					X	
Structural Projects				X		X	
Emergency Services				X		X	
Public Information & Awareness	X	X	X	X	X	X	X

5.3 MITIGATION ACTION PLAN

The mitigation actions listed on the pages that follow have been designed to achieve the goals and objectives identified in the Hazard Mitigation Plan. A series of draft mitigation actions was presented to the Hazard Mitigation Committee for their consideration. Each mitigation action was evaluated and, where necessary, modified, deleted from consideration, and several new mitigation actions were proposed by the Committee. A simple voting technique was used to prioritize each mitigation action.

Each proposed mitigation action includes:

- The categorization of the mitigation technique;
- The hazard it is designed to mitigate;
- The objective(s) it is intended to achieve;
- General background information;
- Priority Ranking (Low, Medium, High)
- Funding sources, if applicable;
- The department or person assigned responsibility for carrying out the action; and
- A target completion date.

The mitigation actions are short-term, specific measures to be undertaken by the Municipality of San Sebastián and will be used as the primary measure of the Plan's progress over time. This approach is intended to facilitate the quick review and update of the Plan as described in Section Six, *Plan Implementation*.

5.4 ADMINISTRATION OF ACTIONS

The Municipality of San Sebastián established the Hazard Mitigation Monitoring and Evaluation Committee to implement and administer actions in 2012. Unlike the Hazard Mitigation Committee, which was responsible for the update of the Plan, this Committee oversaw the administration and implementation of the actions defined in the 2012 version of the HMP. Specific actions were assigned to specific individuals, municipal departments, and/or organizations.

The Municipality decided to leave active the HMP Planning Committee to comply with the monitoring and evaluation process during the next period 2018-2023. The Committee will be responsible for overseeing the progress made on the implementation of action items and updating the Plan, as needed, to reflect changing conditions. It will also be responsible for identifying opportunities to integrate findings of the Hazard Mitigation Plan into existing municipal plans and programs.

The municipality of San Sebastián provided the following status of the projects (Mitigation Actions 1-23) included in 2012 Mitigation Plan. Some of these mitigations were completed, others postpone waiting for funds. The "2018 status" provides information based on the changes that the municipality have had during the last five years and reflects the progress the Municipality had on mitigation area during the last five years. The impact of Hurricane María on the Municipality re-focused the priorities of the municipality to perform more mitigation actions to minimized or avoid impact in the future. The HMP Committee also recognized weakness in the planning process and re-focus of projects to include more public participation, educational programs, and regulatory update to support mitigation planning in the municipality. Those projects that were completed, are not included on **Table 5-6**.

Mitigation Action 1	**Identify "special needs" citizens and develop rescue and evacuation procedures**
Goal and Objective Addressed:	Goal #2 Strengthen the capabilities of municipal agencies to implement and maintain hazard mitigation programs and evaluate prior plans Objective 2.1 Identify and develop policies, regulations, and specialized training necessary to support an effective hazard mitigation program in the Municipality.
Category:	Emergency Services
Hazard:	All Hazards
Background:	A database can be developed on populations with special needs (age, disability, illness) and kept on file in the emergency management office. The compilation of this information is an important step in facilitating evacuation for special needs population.
Priority:	Low
Potential Funding Sources:	External $150,000

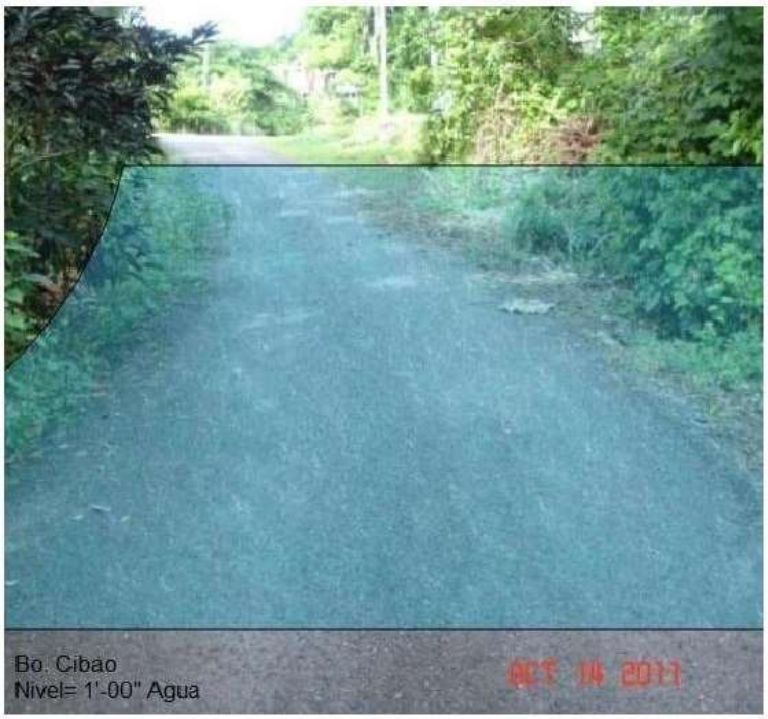
Hazard Mitigation Committee Action Lead:	Mr. Elio Rivera
Department Responsibilities:	Municipal Office of Emergency Management
Estimated Timeframe:	12 months
2018 Status:	The current OMME Director is Mr. Félix Avilés. This project was completed 100%. OMME prepared a database with bed patients, handicaps, and elderly homes. The rescue and evacuation procedures are detailed in a printed document title: *Plan Operacional de Emergencia 2018*. OMME required patients' care keepers to provide emergency plans and how they would survive during an emergency (e.g. if they have emergency plants, oxygen tanks). Since the project was completed, it will not be included in the 2018-2023 actions list.

Mitigation Action 2	**Flood Control Project for Cibao Ward road 455 interior, Bruscal Street, Cuartelillo Area**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objectives 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Flood
Background:	No drainage in the area, no sewerage. In addition, there is a wooded dare higher than the road. In event of rain flooded easily.
Priority:	Low
Potential Funding Sources:	External through USACE cost-sharing requirements. Federal contrition is $2.4 million and non-Federal cost share is $2.14 million. NFIP, Total estimated cost $75,000.
Hazard Mitigation Committee Action Lead:	Mr. Carlos Rosario
Department Responsibility:	Director Public Works
Estimated Timeframe:	3 months
Cibao Ward:	18.21.68 N - 66.54.03 W
2018 Status:	The current Director of Public Works is Mr. Guillermo Nieves. This project has not been done due to lack of funds. This project remains in the 2018 HMP version.

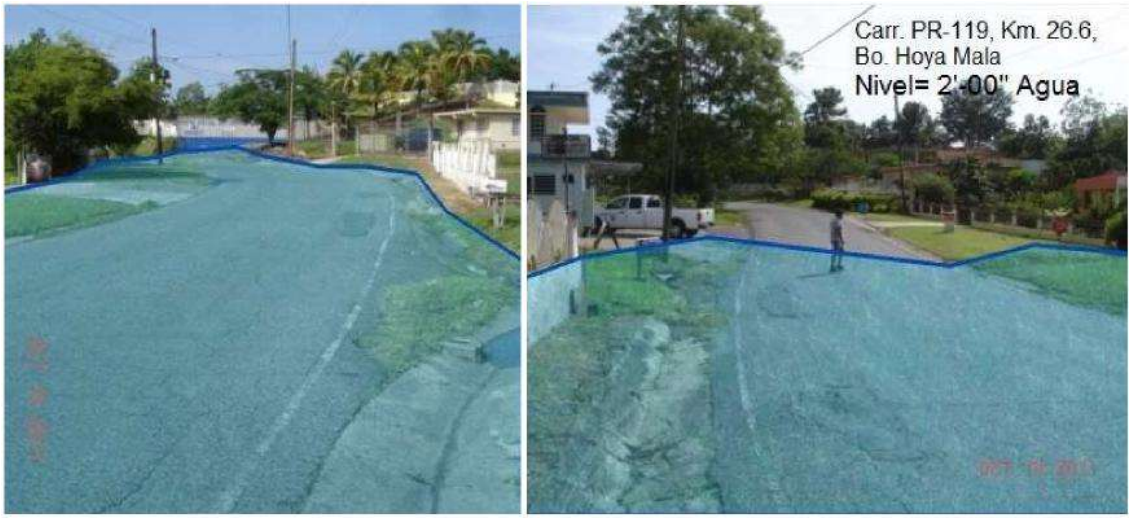

Carr. PR-445, Interior
Bo. Cibao, Area Cuartelillo
Nivel= 1'-00" de Agua

Mitigation Action 3	**Flood Control Project for Cibao Ward Moca Street Salvador Velez sector San Sebastián**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objectives 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Flood / High Winds
Background:	In area has no drainage, and sewage that shows a neighbor said: " the pipe it's clogged ". This street is at a high level and is the only access to an entire community. In the event of heavy rain the low layers of the pipe causes the water level rises quickly and cover the road with over 8" inches of water. The large amount of vegetation makes the community vulnerable to high winds events.
Priority:	Low
Potential Funding Sources:	National Flood Insurance Program. Municipality Funds. Total estimate $35,000 dollars
Hazard Mitigation Committee Action Lead:	Mr. Carlos Rosario
Department Responsibility:	Director of Public Works
Estimated Timeframe:	3 Months
Cibao Ward:	18.21.50 N – 66.53.95 W
2018 Status:	The current Director of Public Works is Mr. Guillermo Nieves. This project has not been done due to lack of funds. This project remains in the 2018 HMP version.


2 Cibao


Bo. Cibao
Nivel= 1'-00" Agua

Mitigation Action 4	**Flood Control Project Hoya Mala Ward Road 119 Km 26.6 Rio Sector San Sebastián**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objectives 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Flood / Earthquake Liquefaction
Background:	With rain the road is impassable. The area affected is more than 90 meters long (325') and 2 feet deep. The water gets into the yard of the neighbors. There are two culverts with little capacity for falling water. This street is one of the main in San Sebastián. In developed areas, storm water management improvements (ponds, new or larger culverts, increased drainage channel capacity) are often necessary. This strategy represents an action that will reduce flooding impacts in surrounding neighborhoods in addition to eliminating repetitive flooding. There are 2 large car parts shops in this community. In case of Earthquake Liquefaction the enormous teats of these workshops will be affected and will affect the community. There are underground rivers throughout this area. The affected area has more than 325 feet long when is flooded, this cause the closure of the road for many hours. (view of the picture on the left north to south, right side view south to north.
Priority:	High
Potential Funding Sources:	External through, Local estate funds Total estimated cost $400,0000 dollars
Hazard Mitigation Committee Action Lead:	Mr. Rogelio Rivera
Department Responsibility:	Director of Emergency Management Offices
Estimated Timeframe:	8-10 Months
Hoya Mala Ward:	18.21.40 N – 66.56.33W
Status 2018:	The current OMME Director is Mr. Félix Avilés. This project is in a state road. The project has not been done due to lack of funds. It remains in the 2018 HMP version.


Carr. PR-119, Km. 26.6,
Bo. Hoya Mala
Nivel= 2'-00" Agua

Mitigation Action 5	**Flood Control Project Guajataca Ward, Road 448 Km 1.3 Las Vegas Sector San Sebastián.**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objectives 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Flood / Earthquake Liquefaction/ Urban fire
Background:	In developed areas, storm water management improvements (ponds, new or larger culverts, increased drainage channel capacity) are often necessary. This strategy represents an action that will reduce flooding impacts in surrounding neighborhoods in addition to eliminating repetitive flooding causes a huge flood of over 500 feet long. Two large car parts shops in this community. In case of Earthquake Liquefaction the enormous teats of these workshops will be affect the entire community. There are underground rivers throughout this area. In event of fire in the workshops, burning metal parts and the chemicals would be of great risk to the community.
Priority:	High
Potential Funding Sources:	External through. Total estimated cost $2.0 million dollars
Hazard Mitigation Committee Action Lead:	Mr. Carlos Rosario
Department Responsibility:	Federal Program Offices
Estimated Timeframe:	1 year
Guajataca Ward:	18.20.36 N – 66.56.35 W
Status 2018:	The current Director of Public Works is Mr. Guillermo Nieves. This project has not been done due to lack of funds. The former District Representative searched state funds without success. This is a state road however, the Municipality performed some improvements but did not revolve the existing problem. This project remains in the 2018 HMP version.


Bo. Guajataca
Sector Las Vegas
Nivel= 1'-02" Agua

Mitigation Action 6	**Flood Control Project Hoya Mala Ward, vicinal road, Julio Lugo Sector**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objectives 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Flood / Earthquake Ground Shaking
Background:	This area does not need heavy rain to flood. The river passes easily over the bridge and this is the only access they have the ten families who use the bridge daily. Replace and elevation of the bridge. In the event of earthquake, the bridge will suffer serious structural damage and this is the only vehicular access to the community.
Priority:	Medium
Potential Funding Sources:	Federal funds. Total estimated cost $400,000 dollars
Hazard Mitigation Committee Action Lead:	Mr. Claudio Cardona
Department Responsibility:	Federal Program Offices
Estimated Timeframe:	1 year
Hoya Mala:	18.21.46 N – 66.57.86 W
Status 2018:	The current Director of Federal Funds Programs is Ms. Maritza Ruiz. This project is in a municipal road. The project has not been done due to lack of funds. It remains in the 2018 HMP version.


S H Mala


Bo. Hoya Mala
Sector Julio Lugo
Nivel= 1'00" Agua

Mitigation Action 7	**Flood Control Project for Hoya Mala Road 119 Km31.2 La Tosca sector San Sebastián**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objectives 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Flood / High Winds
Background:	This area is flooded with too little rain. There is no drainage and no sewage system, besides the road level difficult the water flows. There is also a little river which prevents the flow of rainfall into the river as this also has plenty of water and overflows over the street. The large amount of vegetation makes the community vulnerable to high winds events.
Priority:	High
Potential Funding Sources:	Total estimated cost $450,000 dollars
Hazard Mitigation Committee Action Lead:	Mr. Claudio Cardona
Department Responsibility:	Federal Program Offices
Estimated Timeframe:	2 years
Hoya Mala:	18.20.83 N – 66.58.53 W
Status 2018:	The current Director of Federal Funds Programs is Ms. Maritza Ruiz. This project is in a state road. This project has not been done due to lack of funds. GAR representatives performed a site visit to evaluate and identify fund sources. NFIP requires that most residents have flood insurance but the community does not have such product. This project remains in the 2018 HMP version.


Carr. PR-119, Km. 31.2
Bo. Hoya Mala
Sector La Tosca
Nivel= 10" Agua

Mitigation Action 8	**Flood Control Project Perchas 1 ward road 4455 Quebradas Las Cañas sector San Sebastián**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objectives 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Flood / Earthquake Ground Shaking / High Winds
Background:	To reach this community, it necessary to cross three bridges. These bridges area too low level almost touching the river. With little rainfall the river level rises and passes on the road keeping the community completely isolated. The river levels raise 2 feet. Replace and raise the height of the bridges. In the event of earthquake those bridges will suffer serious structural damage. This is the only vehicular access to the community. Perchas 1 Ward 18.16.86 N – 66.56.64 W First bridge
Priority:	High
Potential Funding Sources:	Total estimated cost of 1.5 million dollars
Hazard Mitigation Committee Action Lead:	Mr. Carlos Rosario
Department Responsibility:	Director of Public Works
Estimated Timeframe:	2 years
Status 2018:	The current Director of Public Works is Mr. Guillermo Nieves. The Department of Agriculture (DA), GAR, and FEMA visited this Project site. DA included this Project on their high priority list. DA received funds form FEMA to remove debris from waterways after Hurricane María. The bid for this Project will be hold in June 2018 and the fieldwork should be completed in 120 days. The other components of this project remain in the 2018 HMP version.


7 Perchas A


Carr. PR-4435,
Bo. Perchas 1
Sector Quebrada Las Cañas
Nivel= 2'-00" Agua

Perchas 1 Ward second Bridge 18.16.67 N – 66.56.62 W

Perchas 1 Ward third bridge 18.16.60 N –66.56.55 W

Mitigation Action 9	**Landslide Control Project for Perchas 1 Ward road 4433**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objective 1.1 Protect existing development from future disaster event.
Category:	Structural Projects
Hazard:	Landslide / Earthquake
Background:	This area falls with regularity on rain periods. Perchas 1 ward 18.16.48 N – 66.56.97 W
Priority:	Medium
Potential Funding Sources:	Municipality funds, Total estimated cost $50,000 dollars
Hazard Mitigation Committee Action Lead:	Mr. Carlos Rosario
Department Responsibility:	Director of Public Works
Estimated Timeframe:	1 year
Status 2018:	The current Director of Public Works is Mr. Guillermo Nieves. This project is in a state road. The project has not been done due to lack of funds. It remains in the 2018 HMP version.


8 Perchas


Carr. PR-4433
Bo. Perchas 1

Mitigation Action 10	**Landslide Control Project for the Perchas 1 Ward**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objective 1.1 Protect existing development from future disaster event.
Category:	Structural Projects
Hazard:	Landslide / Earthquake
Background:	With the passage of time and periodic landslide into this area. The foundation of the fence has been affected. Perchas 1 Ward 18.16.70 N – 66.57.21 W
Priority:	Low
Potential Funding Sources:	Municipality funds and NFIP. Total estimated cost $25,000 dollars
Hazard Mitigation Committee Action Lead:	Mr. Carlos Rosario
Department Responsibility:	Director of Public Works
Estimated Timeframe:	6 months
Status 2018:	The current Director of Public Works is Mr. Guillermo Nieves. This project is in a municipal road. The project has not been done due to lack of funds. It remains in the 2018 HMP version.


9 Perchas


Carr. PR-4433
Bo. Perchas 1
OCT 14 2011

Mitigation Action 11	**Landslide Control Project for Guacio Ward Boquerón sector San Sebastián**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objectives 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Landslide / Earthquake
Background:	On this road landslides occur frequently along the way. Here also caused landslides that affect the foundations of the neighborhood community center. Occur on both sides of the road. From the mountains, down into the road and from the road into the ravine. Guacio Ward 18.17.03 N – 67.00.14 W
Priority:	High
Potential Funding Sources:	Total estimated cost $700,000 dollars
Hazard Mitigation Committee Action Lead:	Mr. Claudio Cardona
Department Responsibility:	Federal Program Offices
Estimated Timeframe:	1 years
Status 2018:	The current Director of Federal Funds Programs is Ms. Maritza Ruiz. This project has been completed in 10% due to lack of funds. The ditches were installed using $22,736.95 from Disaster Declaration FEMA-4004-DR, Puerto Rico, but the amount was not enough to construct the concrete wall. The scope of work included scarification, shaping, and compacting, bituminous overlay (2 inches thick), codes and standards, and direct administrative costs. This project remains in the 2018 HMP version.


10 Guacio


OCT 14 2011


Bo. Guacio
Sector Boquerón


Bo. Guacio
Sector Boquerón
OCT 14 2011

Mitigation Action 12	**Landslide Control Project for Guacio Ward Road 119 Km42.3**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objectives 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Landslide / Earthquake / Wildfire / High Winds
Background:	This is a state road and one of the main accesses San Sebastián and Las Marias. When landslide occurs, block the road every time at this point. Guacio 18.17.22 N – 66.59.61 W
Priority:	Medium
Potential Funding Sources:	State Funds, DTOP and Municipality Funds, Total estimated cost $350,000 dollars
Hazard Mitigation Committee Action Lead:	Mr. Rogelio Rivera
Department Responsibility:	Director of Emergency Management Offices
Estimated Timeframe:	2 years
Status 2018:	The current OMME Director is Mr. Félix Avilés. This project is in a state road. The project has not been done due to lack of funds. It remains in the 2018 HMP version.


11 Guacio


Carr. PR-119, Km. 42.3

Mitigation Action 13	**Landslide Control Project for Hato Arriba ward Paseo Central Sector**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objectives 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Landslide / Earthquake
Background:	This road collapse. According to neighbors fell two feet deep; they believed that there is a sink that passes under this road which is a safety hazard. This is the first time that occurs.
Priority:	Medium
Potential Funding Sources:	Municipality funds, Total estimated cost $200,000 dollars
Hazard Mitigation Committee Action Lead:	Mr. Rogelio Rivera
Department Responsibility:	Director Emergency Management Offices
Estimated Timeframe:	1 year
Hato Arriba ward:	18.21.24 N – 67.01.23W
Status 2018:	The current OMME Director is Mr. Félix Avilés. This project located in a state road was completed 100% in 2017. This project was performed two times after technical field studies since the first attempt did not resolved the problem. The project cost was $33,472.75 (FEMA-4004-DR, Puerto Rico). No additional problems have been reported. Since the project was completed, it will not be included in the 2018-2023 actions list.


12 H Arriba


Hato Arriba 12/16/13
Hato Arriba 12/16/13

Mitigation Action 14	**Landslide Control Project for Hato Arriba road 423 concrete wall.**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objectives 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Landslide / Earthquake
Background:	Collapse road
Priority:	High
Potential Funding Sources:	State funds. Total estimated cost $75,000 dollars
Hazard Mitigation Committee Action Lead:	Mr. Claudio Cardona
Department Responsibility:	Federal Program Offices
Estimated Timeframe:	1 year
Hato Arriba ward:	18.21.09 N – 67.02.36 W
Status 2018:	The current Director of Federal Funds Programs is Ms. Maritza Ruiz. This project is in a state road. The project has not been done due to lack of funds. It remains in the 2018 HMP version.


13 H Arriba


Carr. PR-423,
Bo. Hato Arriba

Mitigation Action 15	**Landslide Control Project for Robles Ward, road 446 intersection road 457**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objectives 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Landslide / Earthquake
Background:	Road 446 complete collapse at the intersection with 457 roads. At first glance can see groundwater flows (sinks) The road was completely collapse over a hundred feet long.
Priority:	High
Potential Funding Sources:	State and Federal Funds Total estimated cost $2.0 million dollars
Hazard Mitigation Committee Action Lead:	Mr. Claudio Cardona
Department Responsibility:	Federal Program Offices
Estimated Timeframe:	2 years
Robles Ward:	18.23.04N – 66.58.67 W
Status 2018:	The current Director of Federal Funds Programs is Ms. Maritza Ruiz. This project was completed 100% by the DTOP. A total of $12,496.35 from Disaster Declaration FEMA-4004-DR-Puerto Rico were used. No additional problems have been reported. Since the project was completed, it will not be included in the 2018-2023 actions list.


14 Robles

Gelo Esteves

1) Remover 49.5 m^2 de asfalto
2) Escarificar 62 m^2 de asfalto
3) Construir un muro de gabiones de 75 pies de largo por 6 pies de alto.
4) Rellenar 8.5 m^3 de material selecto.
5) Depositar 15 truckloads de asfalto
6) Remover e instalar 84 pies de valla de seguridad.
7) Construir 84 pies de cuneton a un lado de la calle.

Mitigation Action 16	**Landslide Control Project for Robles ward road 4446 Km 1.5**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objectives 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Landslide / Earthquake
Background:	In this road occurs landslide in every rain event.
Priority:	High
Potential Funding Sources:	Total estimated cost $150,000 dollars
Hazard Mitigation Committee Action Lead:	Mr. Carlos Rosario
Department Responsibility:	Director of Public Works
Estimated Timeframe:	1 year
Robles Ward:	18.23.14 N – 66.59.12 W
Status 2018:	The current Director of Public Works is Mr. Guillermo Nieves. The project has not been done due to lack of funds. It remains in the 2018 HMP version.


15 Robles


Carr. PR-4446, Km. 1.5
Bo. Robles

Mitigation Action 17	**Flood Control Project for San Sebastián town (Pueblo)**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objectives 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Flood / Urban fire
Background:	Historically, residential houses in San Sebastián down town area have had repetitive flooding problems. In the area is a pump (to pumped water out of the area) but is useless, causing flood in the area, the waste water flooding the area and causes plague, makes it impossible to live there according to the neighbors. Once resolved the water pump, must also enable a fire pump. Highly populated neighborhood with houses and wooden structures. San Sebastián Pueblo 18.20.37 N – 66.59.58 W
Priority:	High
Potential Funding Sources:	FEMA Competitive, Municipal funds, potentially other State funding $150,000 dollars
Hazard Mitigation Committee Action Lead:	Mr. Carlos Rosario
Department Responsibility:	Director of Publics Works
Estimated Timeframe:	1 year
Status 2018:	The current Director of Public Works is Mr. Guillermo Nieves. This project has not been done due to lack of funds. GAR representatives performed a site visit to evaluate and identify fund sources. NFIP requires that most residents have flood insurance but the community does not have such product. Some residents have illicit wastewater discharge connections to the abandoned pump station (an incomplete PRASA's project). The Municipality is waiting an answer from the PR Housing Department for funds. This project remains in the 2018 HMP version.


15 San Seb Pueblo

Mitigation Action 18	**Flood Control Project for Sonador Ward road 109 Cain sector San Sebastián**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objective 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Flood / Earthquake Ground Shaking / High Winds
Background:	With heavy rain the water goes over the bridge. It can be seen passing a strong current of water that the bridge has the foundations in the air.
Priority:	High
Potential Funding Sources:	Total estimated cost $525,000 dollars
Hazard Mitigation Committee Action Lead:	Mr. Carlos Rosario
Department Responsibility:	Director Public Works
Estimated Timeframe:	1 year
Sonador Ward:	18.18.64 N – 67.00.49 W
Status 2018:	The current Director of Public Works is Mr. Guillermo Nieves. The Department of Agriculture (DA), GAR, and FEMA visited this Project site. DA included this Project on their high priority list. DA received funds form FEMA to remove debris from waterways after Hurricane María. The bid for this Project will be hold in June 2018 and the fieldwork should be completed in 120 days. The other components of this project remain in the 2018 HMP version.


17 Sonador


Carr. PR-109,
Bo. Sonador
Sector Cain
Nivel= 1'.00" Agua

Mitigation Action 19	**Landslide Control Project for Alto Sano ward road 109 La Palma sector San Sebastián**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objective 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Landslide
Background:	Always with landslide the road is closed. Alto Sano Ward 18.17.96 N – 67.01.27 W
Priority:	Medium
Potential Funding Sources:	Total estimated cost $700,000 dollars
Hazard Mitigation Committee Action Lead:	Mr. Carlos Rosario
Department Responsibility:	Director of Public Works
Estimated Timeframe:	8 Months
Status 2018:	The current Director of Public Works is Mr. Guillermo Nieves. This project is in a state road. The project has not been done due to lack of funds. It remains in the 2018 HMP version.


18 A Sano


Carr. PR-109,
Bo. Alto Sano
Sector La Pluma

Mitigation Action 20	**Flood Control Project for Alto Sano ward road 109 Los Alvarez sector San Sebastián**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objectives 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Flood
Background:	With heavy rain the water goes over the bridge. It can be seen passing a strong current of water that the bridge has the foundations in the air.
Priority:	High
Potential Funding Sources:	Total estimated cost $150,000 dollars
Hazard Mitigation Committee Action Lead:	Mr. Rogelio Rivera
Department Responsibility:	Director Emergency Management Offices
Estimated Timeframe:	1 years
Alto Sano Ward:	18.17.90N – 67.01.84 W
Status 2018:	The current OMME Director is Mr. Félix Avilés. This project is in a state road. The project has not been done due to lack of funds. It remains in the 2018 HMP version


19 A Sano


Carr. PR-109 Interior
Bo. Alto Sano
Sector Los Alvarez
Nivel= 1'-00" Agua

Mitigation Action 21	**Landslide Control Project for Alto Sano ward road 423 El Tunel Sector, San Sebastián**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objectives 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Landslide / Earthquake
Background:	The is another area with frequent landslide
Priority:	High
Potential Funding Sources:	Total estimated cost $150,000 dollars.
Hazard Mitigation Committee Action Lead:	Mr. Carlos Rosario
Department Responsibility:	Director of Public Works
Estimated Timeframe:	1 year
Alto Sano ward:	18.18.42 N – 67.01.70 W
Status 2018:	The current Director of Public Works is Mr. Guillermo Nieves. This project is in a state road. The project has not been done due to lack of funds. It remains in the 2018 HMP version.


20 A Sano


Carr. PR-423,
Bo. Alto Sano
Sector El Tunel

Mitigation Action 22	**Landslide Control Project for Sonador ward road 4423**
Goal and Objective Addressed:	Goal #1 Reduce the impact of natural disasters on residents and property Objectives 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Landslide / High Winds
Background:	There are two areas very close to each other with landslides. The first one is that part of the road collapse, and the second area has continuing landslide with heavy rain.
Priority:	High
Potential Funding Sources:	Total estimated cost $350,000 dollars
Hazard Mitigation Committee Action Lead:	Mr. Claudio Cardona
Department Responsibility:	Federal Program Offices
Estimated Timeframe:	1 year
Sonador Ward:	18.18.69 N – 67.01.65 W
Status 2018:	The current Director of Federal Funds Programs is Ms. Maritza Ruiz. This project was completed 50%. The site to the baseball park was completed resolving the problem to that area. The site to the landslide source has not been completed due to lack of funds. This project remains in the 2018 HMP version.


21 Sonador
21 Sonador


Carr. PR-4423
Bo. Sonador


Carr. PR-4423
Bo. Sonador

Mitigation Action 23	**Flood Control Project for Sonador ward road 497 Flores Rivera sector San Sebastián**
Goal and Objective Addressed:	Goal #1Reduce the impact of natural disasters on residents and property Objectives 1.1 and 1.2 Protect existing development from future disaster events, reduce the vulnerability of future development.
Category:	Structural Projects
Hazard:	Flood
Background:	This community is affected very much each time that the river passes over the bridge in flood event. Sonador is a very populated ward and this road is critical infrastructure and the only access for the entire community.
Priority:	High
Potential Funding Sources:	Total estimated cost $2.0 million dollars
Hazard Mitigation Committee Action Lead:	Mrs. Emily Masters
Department Responsibility:	Federal Program Offices
Estimated Timeframe:	5 years
Status 2018:	The Department of Agriculture (DA), GAR, and FEMA visited this Project site. DA included this Project on their high priority list. DA received funds form FEMA to remove debris from waterways after Hurricane María. The bid for this Project will be hold in June 2018 and the fieldwork should be completed in 120 days. The other components of this project remain in the 2018 HMP version.


22 Sonador


Carr. PR-497,
Bo. Sonador
Sector Flores Rivera
Nivel= 1'-00" Agua

5.5 ASSESSING COST EFFECTIVENESS OF MITIGATION ACTIONS

The Municipality and the Hazard Mitigation Committee considered cost effectiveness during the development and prioritization of the mitigation actions presented in this section. Actions were identified based on administrative, technical and financial capabilities of the municipality. Many of prioritized mitigation actions presented in Section 5.6 concern programmatic actions that the Municipality of San Sebastián can take to reduce the impact of future development (i.e. new structures) while others involve mitigation actions that provide solutions to existing hazards, primarily flooding, but also address the significant seismic risk posed by some sectors of the existing development, and in critical facilities.

5.6 PRIORITIZED LIST OF MITIGATION ACTIONS 2018 - 2023

Table 5-6 provides the updated list of mitigation actions proposed for the HMP updated version 2018-2023. The list includes projects presented in previous HMP versions that are in progress or have not been initiated due to lack of funds. It also includes new projects addressing hazards areas identified by the community and Projects that are of the administration interest. The Projects that were completed since the last HMP version have been removed from the list. The Action Numbers have been re-written for period 2018-2023. The table also indicates the objectives that will be met, the project category, the hazard it addresses for new and or existing buildings / infrastructure. It also provides a summary background of the problem, priority, cost estimate and found source. The table shows who is the action leader, the expected timeframe for the project and additional comments.

Most of the mitigations actions included in the updated mitigation action list (**Table 5-6)** refers to floods and landslides hazards in existing developed areas with buildings and infrastructure. Most of these projects were identified due to the experience of Hurricane María. The estimated costs are presented as a broad idea of project costs. Proper cost estimated shall be performed when requesting funds from municipal, state or federal sources. The HMP Planning Committee added new mitigation projects to address new buildings and infrastructure for first time. The following specific mitigations actions where took from "Mitigation Ideas[21]". These ideas shall be considered and selected as mitigation action during specific evaluation of each proposed action after the specific field, geotechnical or required study is performed to determine the best action to mitigate the hazard.

Flood

- Incorporate Flood Mitigation in Local Planning
  - Developing a floodplain management plan and updating it regularly.
  - Adopting a post-disaster recovery ordinance based on a plan to regulate repair activity, generally depending on property location.
  - Passing and enforcing an ordinance that regulates dumping in streams and ditches.

- Limit or Restrict Development in Floodplain Areas
  - Prohibiting or limiting floodplain development through regulatory and/or incentive-based measures.
  - Limiting the density of developments in the floodplain.
  - Requiring that floodplains be kept as open space.
  - Limiting the percentage of allowable impervious surface within developed parcels.
  - Developing a stream buffer ordinance to protect water resources and limit flood impacts.
  - Prohibiting any fill in floodplain areas.

[21] FEMA, 2013. Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards.

- Adopt and Enforce Building Codes and Development Standards
  - Adding or increasing "freeboard" requirements (feet above base flood elevation) in the flood damage ordinance.
  - Prohibiting all first-floor enclosures below base flood elevation for all structures in flood hazard areas.
  - Considering orientation of new development during design (e.g., subdivisions, buildings, infrastructure, etc.).
  - Setting the design flood elevation at or above the historical high water mark if it is above the mapped base flood elevation.
  - Requiring standard tie-downs of propane tanks.

- Improve Stormwater Management Planning
  - Completing a stormwater drainage study for known problem areas.
  - Update and adopting a stormwater drainage plan and ordinance.
  - Preparing and adopting a community-wide stormwater management master plan.
  - Regulating development in upland areas to reduce stormwater run-off through a stormwater ordinance.
  - Linking flood hazard mitigation objectives with EPA Stormwater Phase II initiatives.
  - Developing engineering guidelines for drainage from new development.
  - Requiring a drainage study with new development.
  - Encouraging the use of Low Impact Development techniques.

- Adopt Policies to Reduce Stormwater Runoff
  - Requiring more trees be preserved and planted in landscape designs to reduce the amount of stormwater runoff.
  - Requiring developers to plan for on-site sediment retention.
  - Requiring developers to construct on-site retention basins for excessive stormwater and as a firefighting water source.
  - Encouraging the use of porous pavement.
  - Conforming pavement to land contours so as not to provide easier avenues for stormwater.
  - Encouraging the use of permeable driveways and surfaces to reduce runoff and increase groundwater recharge.
  - Adopting erosion and sedimentation control regulations for construction.

- Join or Improve Compliance with NFIP
  - Participating in NFIP.
  - Adopting ordinances that meet minimum Federal and state requirements to comply with NFIP.
  - Conducting NFIP community workshops to provide information and incentives for property owners to acquire flood insurance.
  - Designating a local floodplain manager and/or CRS coordinator who achieves CFM certification.

- Participate in the CRS
    - Advising the public about the local flood hazard, flood insurance, and flood protection measures.
    - Enacting and enforcing regulations that exceed NFIP minimum standards so that more flood protection is provided for new development.
    - Implementing damage reduction measures for existing buildings such as acquisition, relocation, retrofitting, and maintenance of drainageways and retention basins.
    - Acting to minimize the effects of flooding on people, property, and building contents through measures including flood warning, emergency response, and evacuation planning.

- Remove Existing Structures from Flood Hazard Areas

- Improve Stormwater Drainage System Capacity
    - Installing, re-routing, or increasing the capacity of a storm drainage system.
    - Increasing drainage or absorption capacities with detention and retention basins, relief drains, spillways, drain widening/dredging or rerouting, logjam and debris removal, extra culverts, bridge modification, dike setbacks, flood gates and pumps, or channel redirection.
    - Increasing capacity of stormwater detention and retention basins.
    - Increasing dimensions of drainage culverts in flood-prone areas.
    - Using stream restoration to ensure adequate drainage and diversion of stormwater.
    - Requiring developers to construct on-site retention basins for excessive stormwater and as a firefighting water source.
    - Providing grassy swales along roadsides.

- Conduct Regular Maintenance for Drainage Systems and Floor Control Structures
    - Performing regular drainage system maintenance, such as sediment and debris clearance, as well as detection and prevention of discharges into stormwater and sewer systems from home footing drains, downspouts, or sewer pumps.
    - Implementing an inspection, maintenance, and enforcement program to help ensure continued structural integrity of dams and levees.
    - Routinely cleaning debris from support bracing underneath low-lying bridges.
    - Routinely cleaning and repairing stormwater drains.
    - Regularly clearing sediment build-up on riverbanks near aerial lines.
    - Inspecting bridges and identifying if any repairs or retrofits are needed to prevent scour.

- Educate Property Owners about Flood Mitigation Techniques

Landslide

- Manage Development in Landslide Hazard Areas
    - Creating a plan to implement reinforcement measures in high-risk areas.
    - Defining steep slope/high-risk areas in land use and comprehensive plans and creating guidelines or restricting new development in those areas.
    - Creating or increasing setback limits on parcels near high-risk areas.

- Prevent Impacts to Roadways
    - Applying soil stabilization measures, such as planting soil-stabilizing vegetation on steep, publicly-owned slopes.
    - Using debris-flow measures that may reduce damage in sloping areas, such as stabilization, energy dissipation, and flow control measures.
    - Establishing setback requirements and using large setbacks when building roads near slopes of marginal stability.
    - Installing catch-fall nets for rocks at steep slopes near roadways.

- Remove Existing Buildings and Infrastructure from Landslide Hazard Areas

Table 5-6
Mitigation Action List 2018-2023

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
1	Flood control project for Cibao Ward road 455 interior, Bruscal Street, Cuartelillo Area	1.1 1.2	Structural Projects	Flood	No drainage in the area, no sewerage. In addition, there is a wooded dare higher than the road. In event of rain flooded easily	Low	External through USACE cost-sharing requirements. Federal contrition is $2.4 million and non-Federal cost share is $2.14 million. NFIP, Total estimated cost $75,000	Mr. Guillermo Nieves	3 months	The current Director of Public Works is Mr. Guillermo Nieves. This project has not been done due to lack of funds. This project remains in the 2018 HMP version.
2	Flood control project for Cibao Ward, Moca Street, Salvador Vélez Sector	1.1 1.2	Structural Projects	Flood / High Winds	In area has no drainage, and sewage that shows a neighbor said: " the pipe it's clogged ". This street is at a high level and is the only access to an entire community. In the event of heavy rain the low layers of the pipe causes the water level rises quickly and cover the road with over 8" inches of water. The large amount of vegetation makes the community vulnerable to high winds events.	Low	National Flood Insurance Program. Municipality Funds. Total estimate $35,000 dollars	Mr. Guillermo Nieves	3 Months	The current Director of Public Works is Mr. Guillermo Nieves. This project has not been done due to lack of funds. This project remains in the 2018 HMP version.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
3	Flood control project Hoya Mala Ward, Road 119 Km 26.6, Río Sector	1.1 1.2	Structural Projects	Flood / Earthquake Liquefaction	With rain the road is impassable. The area affected is more than 90 meters long (325') and 2 feet deep. The water gets into the yard of the neighbors. There are two culverts with little capacity for falling water. This street is one of the main in San Sebastián. In developed areas, storm water management improvements (ponds, new or larger culverts, increased drainage channel capacity) are often necessary. This strategy represents an action that will reduce flooding impacts in surrounding neighborhoods in addition to eliminating repetitive flooding. There are 2 large car parts shops in this community. In case of Earthquake Liquefaction the enormous teats of these workshops will be affected and will affect the community. There are underground rivers throughout this area	High	External through, Local estate funds Total estimated cost $400,0000 dollars	Mr. Félix Avilés.	8-10 Months	The current OMME Director is Mr. Félix Avilés. This project is in a state road. The project has not been done due to lack of funds. It remains in the 2018 HMP version.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
4	Flood control project Guajataca Ward, Road 448 Km 1.3, Las Vegas Sector	1.1 1.2	Structural Projects	Flood / Earthquake Liquefaction / Urban fire	In developed areas, storm water management improvements (ponds, new or larger culverts, increased drainage channel capacity) are often necessary. This strategy represents an action that will reduce flooding impacts in surrounding neighborhoods in addition to eliminating repetitive flooding causes a huge flood of over 500 feet long. Two large car parts shops in this community. In case of Earthquake Liquefaction, the enormous teats of these workshops will be affect the entire community. There are underground rivers throughout this area. In event of fire in the workshops, burning metal parts and the chemicals would be of great risk to the community.	High	External through. Total estimated cost $2.0 million dollars	Mr. Guillermo Nieves	1 year	The current Director of Public Works is Mr. Guillermo Nieves. This project has not been done due to lack of funds. The former District Representative searched state funds without success. This is a state road however, the Municipality performed some improvements but did not revolve the existing problem. This project remains in the 2018 HMP version.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
5	Flood control project Hoya Mala Ward, vicinal road, Julio Lugo Sector	1.1 1.2	Structural Projects	Flood / Earthquake Ground Shaking	This area does not need heavy rain to flood. The river passes easily over the bridge and this is the only access they have the ten families who use the bridge daily. Replace and elevation of the bridge. In the event of earthquake, the bridge will suffer serious structural damage and this is the only vehicular access to the community.	Medium	Federal funds. Total estimated cost $400,000 dollars	Ms. Maritza Ruiz	1 year	The current Director of Federal Funds Programs is Ms. Maritza Ruiz. This project is in a municipal road. The project has not been done due to lack of funds. It remains in the 2018 HMP version.
6	Flood control project for Hoya Mala, Road PR-119 Km 31.2, La Tosca Sector	1.1 1.2	Structural Projects	Flood / High Winds	This area is flooded with too little rain. There is no drainage and no sewage system, besides the road level difficult the water flows. There is also a little river which prevents the flow of rainfall into the river as this also has plenty of water and overflows over the street. The large amount of vegetation makes the community vulnerable to high winds events.	High	Total estimated cost $450,000 dollars	Ms. Maritza Ruiz	2 years	The current Director of Federal Funds Programs is Ms. Maritza Ruiz. This project is in a state road. This project has not been done due to lack of funds. GAR representatives performed a site visit to evaluate and identify fund sources. NFIP requires that most residents have flood insurance but the community does not have such product. This project remains in the 2018 HMP version.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
7	Flood control project Perchas 2 ward, state road PR-4455, Quebradas Las Cañas Sector	1.1 1.2	Structural Projects	Flood / Earthquake Ground Shaking / High Winds	To reach this community, it necessary to cross three bridges. These bridges area too low level almost touching the river. With little rainfall, the river level rises and passes on the road keeping the community completely isolated. The river levels raise 2 feet. Replace and raise the height of the bridges. In the event of earthquake those bridges will suffer serious structural damage. This is the only vehicular access to the community. Hurricane María caused the following additional damages: • Bridge • Scour and damage. • Vegetative debris obstructing the flow of water.	High	Total estimated cost of 1.5 million dollars	Mr. Guillermo Nieves	2 years	The current Director of Public Works is Mr. Guillermo Nieves. The Department of Agriculture (DA), GAR, and FEMA visited this Project site. DA included this Project on their high priority list. DA received funds form FEMA to remove debris from waterways after Hurricane María. The bid for this Project will be hold in June 2018 and the fieldwork should be completed in 120 days. The other components of this project remain in the 2018 HMP version.
8	Landslide control project for Perchas 1 Ward, Road 4433	1.1	Structural Projects	Landslide / Earthquake	This area falls with regularity on rain periods	Medium	Municipality funds, Total estimated cost $50,000 dollars	Mr. Guillermo Nieves	1 year	The current Director of Public Works is Mr. Guillermo Nieves. This project is in a state road. The project has not been done due to lack of funds. It remains in the 2018 HMP version.
9	Landslide control project for Perchas 1 Ward	1.1	Structural Projects	Landslide / Earthquake	With the passage of time and periodic landslide into this area. The foundation of the fence has been affected	Low	Municipality funds and NFIP. Total estimated cost $25,000 dollars	Mr. Guillermo Nieves	1 year	The current Director of Public Works is Mr. Guillermo Nieves. This project is in a municipal road. The project has not been done due to lack of funds. It remains in the 2018 HMP version.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
10	Landslide control project for Guacio Ward, Boquerón Sector	1.1 1.2	Structural Projects	Landslide / Earthquake	On this road landslides occur frequently along the way. Here also caused landslides that affect the foundations of the neighborhood community center. Occur on both sides of the road. From the mountains, down into the road and from the road into the ravine	High	Federal funds. Total estimated cost $700,000 dollars	Ms. Maritza Ruiz	1 years	The current Director of Federal Funds Programs is Ms. Maritza Ruiz. This project has been completed in 10% due to lack of funds. The ditches were installed using $22,736.95 from Disaster Declaration FEMA-4004-DR, Puerto Rico, but the amount was not enough to construct the concrete wall. The scope of work included scarification, shaping, and compacting, bituminous overlay (2 inches thick), codes and standards, and direct administrative costs. This project remains in the 2018 HMP version.
11	Landslide control project for Guacio Ward, Road 119 Km 42.3	1.1 1.2	Structural Projects	Landslide / Earthquake / Wildfire / High Winds	This is a state road and one of the main accesses San Sebastián and Las Marias. When landslide occurs, block the road every time at this point	Medium	State Funds, DTOP and Municipality Funds, Total estimated cost $350,000 dollars	Mr. Félix Avilés	2 years	The current OMME Director is Mr. Félix Avilés. This project is in a state road. The project has not been done due to lack of funds. It remains in the 2018 HMP version.
12	Landslide control project for Hato Arriba ward, Road 423 Concrete wall	1.1 1.2	Structural Projects	Landslide / Earthquake	Collapse road	High	Federal funds. Total estimated cost $75,000 dollars	Ms. Maritza Ruiz	1 year	The current Director of Federal Funds Programs is Ms. Maritza Ruiz. This project is in a state road. The project has not been done due to lack of funds. It remains in the 2018 HMP version.
13	Landslide control project for Robles ward, Road 4446 Km 1.5	1.1 1.2	Structural Projects	Landslide / Earthquake	In this road occurs landslide in every rain event	High	State funds. Total estimated cost $150,000 dollars	Mr. Guillermo Nieves	1 year	The current Director of Public Works is Mr. Guillermo Nieves. The project has not been done due to lack of funds. It remains in the 2018 HMP version.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
14	Flood control project for San Sebastián downtown ward (Barrio Pueblo)	1.1 1.2	Structural Projects	Flood / Urban fire	Historically, residential houses in San Sebastián down town area have had repetitive flooding problems. In the area is a pump (to pumped water out of the area) but is useless, causing flood in the area, the waste water flooding the area and causes plague, makes it impossible to live there according to the neighbors. Once resolved the water pump, must also enable a fire pump. Highly populated neighborhood with houses and wooden structures	High	FEMA Competitive, Municipal funds, potentially other State funding $150,000 dollars	Mr. Guillermo Nieves	1 year	The current Director of Public Works is Mr. Guillermo Nieves. This project has not been done due to lack of funds. GAR representatives performed a site visit to evaluate and identify fund sources. NFIP requires that most residents have flood insurance but the community does not have such product. Some residents have illicit wastewater discharge connections to the abandoned pump station (an incomplete PRASA's project). The Municipality is waiting an answer from the PR Housing Department for funds. This project remains in the 2018 HMP version.
15	Flood control project for Sonador Ward municipal road PR109 int., Chain Sector	1.1 1.2	Structural Projects	Flood / Earthquake Ground Shaking / High Winds	With heavy rain the water goes over the bridge. It can be seen passing a strong current of water that the bridge has the foundations in the air. Hurricane María caused the following additional damages: • Bridge • Scour and damage • Vegetative debris obstructing the flow of water. • Damage to security trial - approx. length 27'.	High	State Funds, DNER. Total estimated cost $525,000 dollars	Mr. Guillermo Nieves	1 year	The current Director of Public Works is Mr. Guillermo Nieves. The Department of Agriculture (DA), GAR, and FEMA visited this Project site. DA included this Project on their high priority list. DA received funds form FEMA to remove debris from waterways after Hurricane María. The bid for this Project will be hold in June 2018 and the fieldwork should be completed in 120 days. The other components of this project remain in the 2018 HMP version.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
16	Landslide control project for Alto Sano ward, Road 109, La Pluma Sector	1.1 1.2	Structural Projects	Landslide	Always with landslide the road is closed.	Medium	State Funds, DTOP. Total estimated cost $700,000 dollars	Mr. Guillermo Nieves	8 Months	The current Director of Public Works is Mr. Guillermo Nieves. This project is in a state road. The project has not been done due to lack of funds. It remains in the 2018 HMP version.
17	Flood control project for Alto Sano ward, Road 109, Los Álvarez Sector	1.1 1.2	Structural Projects	Flood	With heavy rain the water goes over the bridge. It can be seen passing a strong current of water that the bridge has the foundations in the air	High	Federal funds USACE; State Funds DRNA. Total estimated cost $150,000 dollars	Mr. Félix Avilés	1 years	The current OMME Director is Mr. Félix Avilés. This project is in a state road. The project has not been done due to lack of funds. It remains in the 2018 HMP version.
18	Landslide control project for Alto Sano ward, Road 423, El Túnel Sector	1.1 1.2	Structural Projects	Landslide / Earthquake	The is another area with frequent landslide	High	State Funds, DTOP. Total estimated cost $150,000 dollars.	Mr. Guillermo Nieves	1 year	The current Director of Public Works is Mr. Guillermo Nieves. This project is in a state road. The project has not been done due to lack of funds. It remains in the 2018 HMP version.
19	Landslide control project for Sonador ward, Road 423 Interior	1.1 1.2	Structural Projects	Landslide / High Winds	There are two areas very close to each other with landslides. The first one is that part of the road collapse, and the second area has continuing landslide with heavy rain	High	State Funds, DTOP. Total estimated cost $350,000 dollars	Ms. Maritza Ruiz.	1 year	The current Director of Federal Funds Programs is Ms. Maritza Ruiz. This project was completed 50%. The site to the baseball park was completed resolving the problem to that area. The site to the landslide source has not been completed due to lack of funds. This project remains in the 2018 HMP version.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
20	Flood control project for Sonador ward bridge on state road PR-497, Flores Rivera Sector	1.1 1.2	Structural Projects	Flood	This community is affected very much each time that the river passes over the bridge in flood event. Sonador is a very populated ward and this road is critical infrastructure and the only access for the entire community. Hurricane María caused the following additional damages: • Bridge structure • Damage on the road - approx. area 150' x 18' area. • Vegetative debris obstructing the flow of water. • Damage to the fence - approx. long 52'.	High	Federal Funds USACE. Total estimated cost $2.0 million dollars	Ms. Maritza Ruiz	1.5 years	The Department of Agriculture (DA), GAR, and FEMA visited this Project site. DA included this Project on their high priority list. DA received funds form FEMA to remove debris from waterways after Hurricane María. The bid for this Project will be hold in June 2018 and the fieldwork should be completed in 120 days. The other components of this project remain in the 2018 HMP version.
21	Landslide control project for municipal road PR-119 Km 44.7 int., Parcelas de Guacio, Guacio ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Land and road slide - approx. area 65’ x 3’ (22 yd^2). • Damage to security trial – approx. length of 80’. • Ditch damaged.	High	State Funds, DTOP. Total estimated cost $667,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
22	Landslide control project for state road PR-433 Km 4.7, ward limit between Guacio and Mirabales	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Land and road slide - approx. area 75' x 6' (50 yd^2).	High	State Funds, DTOP. Total estimated cost $150,000 dollars	Mr. Guillermo Nieves	1 year	This is a new Project for the 2018 HMP version.
23	Landslide control project for state road PR-438 (Km 1.0 to 1.1), La Cuadra Sector, Juncal Ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Land and road slide - approx. area 180' x 3' (60 yd^2). • Damage to security trial – approx. length of 180'.	High	State Funds, DTOP. Total estimated cost $360,000 dollars	Mr. Guillermo Nieves	1 year	This is a new Project for the 2018 HMP version.
24	Landslide control project for state road PR-445 Km 5.2, Angelmo Rosado Sector, Saltos ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Failure of the base of the road and detachment of the asphalt layer - approx. area of 210' x 22'6" (525 yd^2).	High	State Funds, DTOP. Total estimated cost $420,000 dollars	Mr. Guillermo Nieves	1 year	This is a new Project for the 2018 HMP version. The municipality re-cover the road with new asphalt. The next step is to perform a geological study to develop a final or long term solution taking into consideration the geological fault in the area.
25	Landslide control project for state road PR-111 Km 13.3, Hato Arriba ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Collapse of pipes through where Quebrada El Salto passes caused the road collapsed - approx. length of 46' x 60' (307 yd^2).	High	State Funds, DTOP. Total estimated cost $94,000 dollars	Mr. Guillermo Nieves	1 year	This is a new Project for the 2018 HMP version. A temporary bridge was constructed in the site. The project would cover the pipes as part of the road. The ACT is working with the improvements plans to discuss the project with the Municipalities of San Sebastián and Moca.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
26	Landslide control project for municipal road PR-446 Km 1.5 int., El Barandillo Sector, Bahomamey ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Landslide – approx. area of 70' x 1' (8 yd^2).	High	State Funds, DTOP. Total estimated cost $140,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version.
27	Flood / Landslide control project for state road PR-446 from Km 1.4 to Km 1.6, Guatemala ward	1.1 1.2	Structural Projects	Flood / Landslide	Hurricane María caused the following additional damages: • Detachment of asphalt layers on the road - approx. length of 500'x 22' (1,223 yd^2).	High	State Funds, DTOP. Total estimated cost $1,000,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version. The municipality will negotiate a collaborative agreement with state government agency.
28	Landslide control project for state road PR-445 from Km 0.8 to Km 1.5, Saltos ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Landslide and collapse of soil and rocks - approx. stretch 700 m. • Damage to the layer of asphalt on the road- approx. stretch 100 m. • Damage to the fence - approx. stretch 100 m.	High	State Funds, DTOP. Total estimated cost $750,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version. The municipality will negotiate a collaborative agreement with state government agency.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
29	Landslide control project for state road PR-119 from Km 35.8 to Km 44.7, Calabazas, Culebrinas and Guacio wards	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Collapse at various sites - stretch approx. 2.5 Km. • Landslide and damage on the road in several sections - approx. total 350 yd^2. • Damage to the fences of security - long approx. 500'. • Damage to retaining wall of reinforced block - approx. long 100'.	High	State Funds, DTOP. Total estimated cost $1,350,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version. It covers additional area from previous project.
30	Landslide control project for municipal road PR-435 int., Parcelas de Calabazas, Calabazas and Perchas 1 wards	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Land and road slide - approx. area 120' x 15' (200 yd^2) • Damage to retaining wall that separates road residence.	High	State Funds, DTOP. Total estimated cost $240,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
31	Landslide control project for municipal road PR-119 Km 42.3 int., Sector Boquerón, Guacio ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Land and road slide - approx. area 40' x 13' (58 yd^2). • Collapse of land on the highway - approx. stretch 260 linear feet. • Damage to security trial - approx. length 31'. • Damage on the road - approx. area 432 yd^2.	High	State Funds, DTOP. Total estimated cost $240,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version.
32	Landslide control project for municipal road PR-119 Km 44.7 int., Brisas del Guacio neighborhood, Guacio ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Collapse of land on highway - approx. stretch 500 linear feet.	High	State Funds, DTOP. Total estimated cost $800,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version.
33	Landslide control project for state road PR-119 Km 32.1, Hoyamala ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Land and road slide - area approx. 50' x 9' (50 yd^2). • Damage to security - approx. long 80 feet of fence. • Damage to the curb - approx. stretch 50 linear feet.	High	State Funds, DTOP. Total estimated cost $200,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
34	Landslide control project for municipal road PR-497 int., Jun González house entrance, Pozas ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Landslide and collapse of road - approx. area 25' x 9' (25 yd^2).	High	State Funds, DTOP. Total estimated cost $50,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version.
35	Landslide control project for municipal road PR-497 int., Urb. Pozas Hills, Pozas ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Collapse of soil and rocks on the road and a private parcel - approx. stretch 200 linear feet.	High	State Funds, DTOP. Total estimated cost $400,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version.
36	Landslide control project for state road PR-111 from Km 27.0 to 27.2, Juncal ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Increase the problem of land and road - approx. area 165' x 20' (367 yd^2). • Damage to fence - approx. long 165 feet.	High	State Funds, DTOP. Total estimated cost $320,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version. The Municipality completed geometric improvements and new asphalt. The project is included for long term solution project.
37	Landslide control project for state road PR-438 from Km 0.2 to 0.7, Magos ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Landslide and landslide on highway - approx. stretch 400 m. • Damage to security trial.	High	State Funds, DTOP. Total estimated cost $750,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
38	Landslide control project for municipal road PR-424 int., Marco Antonio Sector, Guacio ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Land and road slide - approx. long 225 linear feet. • Landslides in several sections of municipal road - approx. total 685 linear feet.	High	State Funds, DTOP. Total estimated cost $450,000 dollars	Mr. Guillermo Nieves	1 year	This is a new Project for the 2018 HMP version.
39	Landslide control project for municipal road PR-111 Km 28.0 int., Nolo González Sector, Cidral ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Land and road slide - approx. area 200' x 3' (67 yd^2).	High	State Funds, DTOP. Total estimated cost $375,000 dollars	Mr. Guillermo Nieves	1.5 year	This is a new Project for the 2018 HMP version.
40	Landslide control project for state road PR-423 Km 1.6, Sonador ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Land and road slide - approx. area 90' x 2' (20 yd^2).	High	State Funds, DTOP. Total estimated cost $180,000 dollars	Mr. Guillermo Nieves	1.5 year	This is a new Project for the 2018 HMP version.
41	Landslide control project for municipal road PR-111 Km 15.2 int., Campo Alegre Sector, Hato Arriba ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Land and road slide - approx. area 260' x 16' (463 yd^2). • Damage to the curb - approx. stretch 230 linear feet.	High	State Funds, DTOP. Total estimated cost $520,000 dollars	Mr. Guillermo Nieves	1 year	This is a new Project for the 2018 HMP version.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
42	Landslide control project for state road PR-119 desde Km 21.0 al 22.1, Hoyamala ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Land and road slide - approx. area 930 yd^2. • Damage to security trial - approx. length 125 ft. • Damage to the curb on approx. stretch of 120 linear feet.	High	State Funds, DTOP. Total estimated cost $300,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version.
43	Landslide control project for municipal road PR-119 Km 42.3 int., Sector Fondo del Saco, Guacio ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Land and road slide – approx. area 40' x 4' (18 yd^2).	High	State Funds, DTOP. Total estimated cost $80,000 dollars	Mr. Guillermo Nieves	1.5 year	This is a new Project for the 2018 HMP version.
44	Landslide control project for municipal road PR-119 Km 43.7 int., Camino de León, Guacio ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Collapse of land - approx. stretch 320 linear feet. • Land and road slide - approx. area 125' x 5' (70 yd^2).	High	State Funds, DTOP. Total estimated cost $250,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version. This Project includes additional damages compared to previous project.
45	Landslide control project for municipal road PR-109 int., Sector Francisco Rosado, Altozano ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Collapse of land - approx. stretch 125 linear feet. • Land and road slide - approx. area 85' x 12' (114 yd^2).	High	State Funds, DTOP. Total estimated cost $170,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
46	Flood / Landslide control project for municipal road PR-447 int., Siquito López Sector, Aibonito ward	1.1 1.2	Structural Projects	Flood / Landslide	Hurricane María caused the following additional damages: • Damage on the road - approx. area 100' x 8' (90 yd^2).	High	State Funds, DTOP. Total estimated cost $200,000 dollars	Mr. Guillermo Nieves	1.5 year	This is a new Project for the 2018 HMP version.
47	Landslide control project for municipal road PR-423 Km 1.7 int., La Mona Sector, Sonador ward	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Land and road slide - approx. area 43' x 1' (5 yd^2).	High	State Funds, DTOP. Total estimated cost $86,000 dollars	Mr. Guillermo Nieves	1.5 year	This is a new Project for the 2018 HMP version.
48	Landslide control project for municipal road PR-111 Km 13.5 int., Los Medina Sector, Hato Arriba	1.1 1.2	Structural Projects	Landslide	Hurricane María caused the following additional damages: • Land and road slide - area approx. 300' x 2' (76 yd^2). • Damage to security trial - approx. length 300'.	High	State Funds, DTOP. Total estimated cost $700,000 dollars	Mr. Guillermo Nieves	1.5 year	This is a new Project for the 2018 HMP version.
49	Flood control project for Bridge on municipal road PR-435 int., Rancho Grande Sector, Calabazas ward	1.1 1.2	Structural Projects	Flood	Hurricane María caused the following additional damages: • Detachment the layer of asphalt - approx. area 50 yds^2.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 year	This is a new Project for the 2018 HMP version.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
50	Flood control project for bridge on municipal road PR-438 int., ward limit Magos and Calabazas wards	1.1 1.2	Structural Projects	Flood	Hurricane María caused the following additional damages: • Scour around the foundations of the bridge pillars • Vegetative debris obstructing the flow of water.	High	State Funds, DTOP. Total estimated cost $400,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version. The Department of Agriculture (DA), GAR, and FEMA visited this Project site. DA included this Project on their high priority list. DA received funds form FEMA to remove debris from waterways after Hurricane María. The bid for this Project will be hold in June 2018 and the fieldwork should be completed in 120 days. The other components of this project remain in the 2018 HMP version.
51	Flood control project for bridge on municipal road PR-125 int., Urb. El Culebrinas, Culebrinas ward	1.1 1.2	Structural Projects	Flood	Hurricane María caused the following additional damages: • Scour around the foundations of the bridge and on the slopes of the river.	High	State Funds, DTOP. Total estimated cost $400,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version.
52	Flood control project for bridge on municipal road PR-446 Km 1.5 int., El Barandillo Sector, Bahomamey ward	1.1 1.2	Structural Projects	Flood	Hurricane María caused the following additional damages: • Vegetative debris obstructing the flow of water. • Scour around the foundations of the retaining wall.	High	State Funds, DTOP. Total estimated cost $400,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version. The Department of Agriculture (DA), GAR, and FEMA visited this Project site. DA included this Project on their high priority list. DA received funds form FEMA to remove debris from waterways after Hurricane María. The bid for this Project will be hold in June 2018 and the fieldwork should be completed in 120 days. The other components of this project remain in the 2018 HMP version.
53	Flood control project for bridge on municipal road PR-446 Km 1.5 int., El Barandillo Sector, Carretera ward	1.1 1.2	Structural Projects	Flood	Hurricane María caused the following additional damages: • Damage to security trial - approx. stretch 45-ft.	High	State Funds, DTOP. Total estimated cost $90,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
54	Flood control project for bridge on municipal road PR-111 int., Evaristo Carril Sector, Guatemala Ward. Rise the bridge	1.1 1.2	Structural Projects	Flood	Hurricane María caused the following additional damages: • Damage - approx. area 15 yds^2.	High	State Funds, DTOP. Total estimated cost $1,500,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version.
55	Flood control project for bridge on municipal road PR-125 int., Puente Viejo Sector, bridge between Pozas and Bahomamey wards	1.1 1.2	Structural Projects	Flood	Hurricane María caused the following additional damages: • Accumulation of sediment and debris on the bridge. • Damage to the steel elements of the bridge by continuous contact with water during the overflow of the river.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version.
56	Flood control project for bridge on municipal road PR-119 Km 35.5, bridge between Piedras Blancas and Calabazas wards	1.1 1.2	Structural Projects	Flood	Hurricane María caused the following additional damages: • Damage in the road. • Scour the ground and a section of the road - approx. 60 yd^2. • Accumulation of vegetative material in the bridge debris.	High	State Funds, DTOP. Total estimated cost $175,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version. The Department of Agriculture (DA), GAR, and FEMA visited this Project site. DA included this Project on their high priority list. DA received funds form FEMA to remove debris from waterways after Hurricane María. The bid for this Project will be hold in June 2018 and the fieldwork should be completed in 120 days. The other components of this project remain in the 2018 HMP version.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
57	Flood control project for bridge on municipal road PR-451 int., Abrahonda Sector, vado between Eneas and Cibao wards. Re-construction of the bridge	1.1 1.2	Structural Projects	Flood	Hurricane María caused the following additional damages: • Total collapse • Damage on the road	High	State Funds, DTOP. Total estimated cost $1,750,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version.
58	Flood control project for bridge on municipal road PR-125 Km 19.1 int., Sofrito Doña Yiya Sector, Pozas Ward	1.1 1.2	Structural Projects	Flood	Hurricane María caused the following additional damages: • Damage to the coating of asphalt - approx. area 6' x 15' (10 yd^2).	High	State Funds, DTOP. Total estimated cost $20,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version.
59	Landslide control project for landslide – fault in Salto ward (18°22'59.33"N; 67°00'45.92"W)	1.1 1.2	Structural Projects	landslide	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
60	Landslide control project for landslide in Salto ward (18°22'27.42"N; 67°02'01.14"W)	1.1 1.2	Structural Projects	landslide	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
61	Flood control project for flood area in Salto ward (18°22'18.49"N; 67°00'15.53"W)	1.1 1.2	Structural Projects	flood	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
62	Landslide control project for landslide in Salto ward (18°21'41.22"N; 67°00'06.69"W)	1.1 1.2	Structural Projects	landslide	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
63	Landslide control project for landslide in Robles ward (18°22'59.94"N; 66°58'51.89"W)	1.1 1.2	Structural Projects	landslide	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
64	Flood control project for three (3) small bridges (vados) in Robles war, Sector Tamarindo (18.371499, -66.992131); (18.372889, -66.996144); (18.371532, -66.999658)	1.1 1.2	Structural Projects	flood	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
65	Flood control project for bridge in Aibonito ward (18°22'06.31"N; 66°57'11.44"W)	1.1 1.2	Structural Projects	flood	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
66	Landslide control project for landslide in Guatemala ward (18°21'32.54"N; 67°00'01.01"W)	1.1 1.2	Structural Projects	landslide	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
67	Landslide control project for collapsed road in Guatemala ward (18°21'35.63"N; 66°59'38.36"W)	1.1 1.2	Structural Projects	landslide	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
68	Landslide control project for landslide in Guatemala ward (18°21'21.65"N; 66°59'47.52"W)	1.1 1.2	Structural Projects	landslide	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
69	Flood control project for flood in Guatemala ward (18°20'45.14"N; 67°00'37.95W)	1.1 1.2	Structural Projects	flood	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
70	Flood control project for flood in Guatemala ward (18°20'51.60"N; 67°00'58.60"W)	1.1 1.2	Structural Projects	flood	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
71	Flood control project for bridge in Guatemala ward (18°21'18.18"N; 67°00'47.96"W)	1.1 1.2	Structural Projects	flood	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
72	Flood control project for collapsed road in Ciabo ward (18°19'49.42"N; 67°54'57.10"W)	1.1 1.2	Structural Projects	flood	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
73	Landslide control project for landslide in Pozas ward (18°20'10.76"N; 67°01'56.54"W)	1.1 1.2	Structural Projects	landslide	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
74	Flood control project for flood in Pozas ward (18°20'42.27"N; 67°01'30.14"W)	1.1 1.2	Structural Projects	flood	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
75	Landslide control project for landslide in Pozas ward (18°20'23.25"N; 67°00'44.39"W)	1.1 1.2	Structural Projects	landslide	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
76	Flood control project for flood in Pozas ward (18°19'59.06"N; 66°59'59.95"W)	1.1 1.2	Structural Projects	flood	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
77	Flood control project for flood in Pozas ward (18°19'29.91"N; 67°01'18.89"W)	1.1 1.2	Structural Projects	flood	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
78	Flood control project for flood in San Sebastián ward (18°20'08.24"N; 66°59'13.69"W)	1.1 1.2	Structural Projects	flood	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
79	Landslide control project for landslide – fault in Piedras Blancas ward (18°20'07.46"N; 66°58'19.40"W)	1.1 1.2	Structural Projects	landslide	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
80	Landslide control project for landslide in Piedras Blancas ward (18°19'56.40"N; 67°56'57.13"W)	1.1 1.2	Structural Projects	landslide	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
81	Flood control project for flood in Culebrinas ward (18°19'52.63"N; 66°59'22.56"W)	1.1 1.2	Structural Projects	flood	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
82	Landslide control project for landslide / bridge in Culebrinas ward (18°19'42.62"N; 67°59'53.79"W)	1.1 1.2	Structural Projects	landslide	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
83	Landslide control project for landslide / bridge in Alto Sano ward (18°17'37.98"N; 67°02'28.33"W)	1.1 1.2	Structural Projects	landslide	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
84	Landslide control project for landslide in Guacio ward (18°17'37.48"N; 67°00'54.02"W)	1.1 1.2	Structural Projects	landslide	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
85	Flood control project for flood in Guacio ward (18°16'34.50"N; 66°58'45.16"W)	1.1 1.2	Structural Projects	flood	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
86	Landslide control project for landslide in Mirabales ward (18°17'08.56"N; 67°57'23.01"W)	1.1 1.2	Structural Projects	landslide	Project identified by community due to experience with Hurricane María and previous natural events.	High	State Funds, DTOP. Total estimated cost $100,000 dollars	Mr. Guillermo Nieves	1.5 years	This is a new Project for the 2018 HMP version as identified by the community.
87	Creation of one Education and Awareness Program to educate property and local business and industries owners regarding options for mitigating their properties from the natural hazards included in this HMP.	3.1 3.2	Public Information and Awareness	All Hazards	The mitigation actions included in previous HMP versions did not include initiatives to meet these objectives. This is a first step to develop efforts supporting all goals and objectives of the current HMP 2018-2023.	High	Local and Federal funds. Total estimated cost $140,000 dollars	Mrs. Maritza Ruiz	1 year	This is a new Project for the 2018 HMP version as identified by the HMP Planning Committee Coordinator and steering committee.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
88	Review local ordinances to develop policies, regulations, and provide specialized training to support effective hazard mitigation program.	2.1	Prevention	All Hazards	The mitigation actions included in previous HMP versions did not include initiatives to meet these objectives. This is a first step to develop efforts supporting all goals and objectives of the current HMP 2018-2023.	High	Local and Federal funds. Total estimated cost $75,000 dollars	Mrs. Maritza Ruiz	1 year	This is a new Project for the 2018 HMP version as identified by the HMP Planning Committee Coordinator and steering committee.
89	Review the HMP 2018 every 6 months to ensure the progress of mitigation actions by enhancing municipal capabilities to support resiliency, response, and communication with government entities.	4.1 4.2	Prevention	All Hazards	The mitigation actions included in previous HMP versions did not include initiatives to meet these objectives. This is a first step to develop efforts supporting all goals and objectives of the current HMP 2018-2023.	High	Local and Federal funds. Total estimated cost $50,000 dollars	Mrs. Maritza Ruiz	1 year	This is a new Project for the 2018 HMP version as identified by the HMP Planning Committee Coordinator and steering committee.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
90	Installation of Emergency power generator in City Hall and all the critical facilities (Police Stations, OME, etc.), as a retrofitting project to better withstand disaster events and ensure continuity essential services to citizens after natural events. The Project shall include a power assessment to relative close critical facilities to consider a micro-web power supply system as an alternative.	1.2 4.1 4.3	Emergency Services	All Hazards	Action identifies as needed after Hurrican due to experience with Hurricane María	High	FEMA and local government	Mrs. Maritza Ruiz	1 year	This is a new Project for the 2018 HMP version as identified by the HMP Planning Committee Coordinator and steering committee.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
91	Installation of wind shields in City Hall and all the critical facilities (Police Stations, OME, etc.), as a retrofitting project to better withstand disaster events and ensure continuity essential services to citizens after natural events.	1.2 4.1 4.3	Protection	High Wind	Action identifies as needed after Hurrican due to experience with Hurricane María	High	FEMA and local government	Mrs. Maritza Ruiz	1 year	This is a new Project for the 2018 HMP version as identified by the HMP Planning Committee Coordinator and steering committee.
92	Installation of wind shields in Historic Archives Building (Archivo Histórico) as a retrofitting project to preserve historic and important municipal documents during a natural event.	1.2 4.1 4.3	Protection	High Wind	Action identifies as needed after Hurrican due to experience with Hurricane María	High	FEMA and local government	Mrs. Maritza Ruiz	1 year	This is a new Project for the 2018 HMP version as identified by the HMP Planning Committee Coordinator and steering committee.

Action Num.	Mitigation Action	Goal and Objective Met	Category	Hazard	Background	Priority	Potential Funding Sources	Action Lead	Estimated Timeframe	Comments 2018
93	Installation of wind shields in Department of Finance Building as a retrofitting project to better withstand disaster events and ensure continuity financial and agencies support services to citizens after natural events.	1.2 4.1 4.3	Protection	High Wind	Action identifies as needed after Hurrican due to experience with Hurricane María	High	FEMA and local government	Mrs. Maritza Ruiz	1 year	This is a new Project for the 2018 HMP version as identified by the HMP Planning Committee Coordinator and steering committee.

6.0 PLAN IMPLEMENTATION

This section of the Plan provides a framework for implementation, monitoring, evaluation, and updating of the Plan in accordance with the requirements of the Disaster Mitigation Act of 2000. It provides a framework based on the same level of participation of all involved in the development of the Plan, but with specific roles and responsibilities clearly defined for action implementation. One of the most important elements of this plan is the implementation of bi-annual meetings and reports. The Plan will be evaluated every six months (April, before the Major's budget message and September, before the Major's achievements message to the Municipal Assembly) to determine the effectiveness of the programs, and to reflect changes that may affect mitigation priorities or available funding.

Section Six consists of the following eight subsections:

- 6.1 Requirements for Plan Maintenance
- 6.2 Responsibilities
- 6.3 Monitoring
- 6.4 Plan Evaluation, Reporting, Revision and Updates
- 6.5 Implementation Through Existing Planning Mechanisms
- 6.6 Public Involvement

6.1 REQUIREMENTS FOR PLAN MAINTENANCE

44 CFR section 201.6(c)(4)(i) requires the Municipality to include a section that describes the Plan Maintenance Process. Specific language in the CFR states that the Local Mitigation Plan must include:

- **Monitoring, Evaluating, and Updating the Plan per Requirement §201.6(c)(4)(i):** [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.
- **Incorporation into Existing Planning Mechanisms per Requirement §201.6(c)(4)(ii):** [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.
- **Continued Public Involvement per Requirement §201.6(c)(4)(iii):** [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.

6.2 RESPONSIBILITIES

The Municipality of San Sebastián has developed a Hazard Mitigation Monitoring and Evaluation Committee. This committee will be responsible for the implementation of actions identified in the Plan. The Director of Federal Programs Office, Ms. Maritza Ruiz, will oversee the Hazard Mitigation Monitoring and Evaluation Committee. Ms. Ruiz has asked the following persons to work with her on implementing the actions defined in this Plan, they are:

Table 6-1
Hazard Mitigation Monitoring and Evaluation Committee

Department	Name
Hon. Javier Jiménez Pérez	Mayor
Director Federal Program Office	Maritza Ruiz
Vice-Major	Emily Ramos
Vice-President Municipal Legislature	Hon. Camilo Ortiz
Finance Director	Félix M. Irizarry
Director Emergency Management Offices	Félix Avilés
Director of Public Works	Guillermo Nieves
Engineering	TBD

The Hazard Mitigation Monitoring and Evaluation Committee will be in charge and responsible for the implementation of the actions defined in Section Five. The Committee has assigned specific actions to individuals, municipal departments, and/or organizations. **Figure 6-1** provides a conceptual framework for the administration and implementation of mitigation actions.

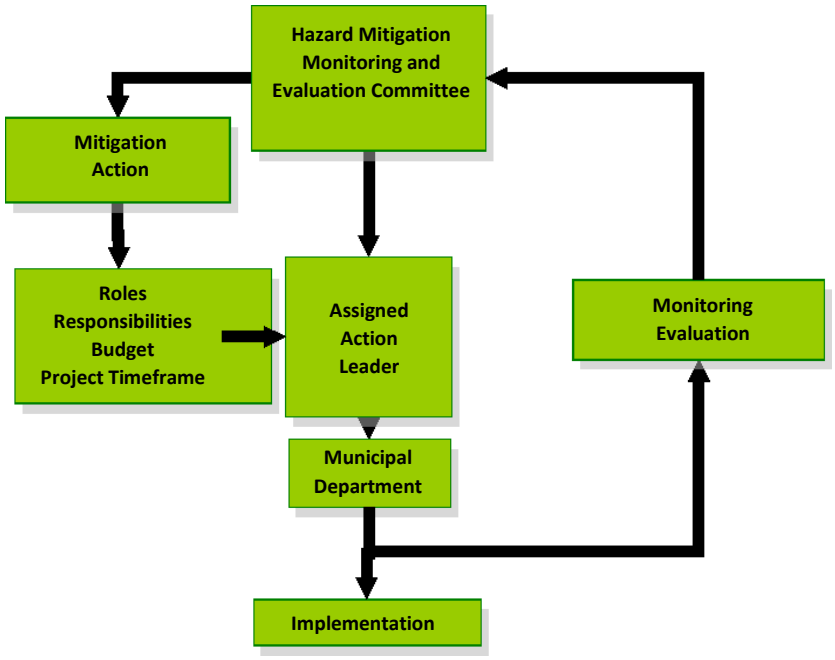


Figure 6-1 Conceptual framework for monitoring of mitigation actions

Implementation Framework

The Hazard Mitigation Monitoring and Evaluation Committee will be in charge of assigning action/project responsibilities to different members or municipal staff. Once actions/projects have been assigned, the Hazard Mitigation Monitoring and Evaluation Committee will be responsible for monitoring progress and ensuring that goals and objectives of the Hazard Mitigation Plan are obtained.

Mitigation Committee Action Leaders

The Hazard Mitigation Monitoring and Evaluation Committee will therefore need to have capable officers—called Action Leaders—to undertake the following responsibilities. Action Leaders will:

- Facilitate the formulation of actions/projects; and
- Provide reports to the Hazard Mitigation Monitoring and Evaluation Committee on success or shortfalls of project/action implementation.

An Action Leader will oversee working with each respective municipal department or organization that has been identified for implementation of the different actions.

6.3 MONITORING

The person in charge, Ms. Maritza Ruiz, will have the task of monitoring the implementation through a designated Action Leader. Successful implementation of the Hazard Mitigation Plan requires continuous monitoring of all defined actions:

- Ensure that appropriate resources (technical, financial, political and legal) are assigned to the action/project;
- Monitor the implementation of each action item; and
- Conduct status meetings, site visits and phone calls with implementing municipal department.

The Committee will request that the Action Leader, along with the implementing department, submit **bi-annual** reports (April and September) to provide adequate information to assess the status of each action.

6.4 PLAN EVALUATION, REPORTING, REVISION, AND UPDATES

As lessons learned from the 2012 Hazard Mitigation Plan, very little documentation was kept on file. The 2018 Updated Plan changed the procedures to improve the documentation process. To keep the progress of the mitigation action sites; a status report will be required from all action leaders designated. This section has been updated to clarify the evaluation process and includes specific topics that should be addressed.

The evaluation of the mitigation plan is an assessment of whether the planning process and actions have been effective, if the Plan goals are being reached, and whether changes are needed. The Plan will be evaluated every six months (April, before the Major's budget message and September, before the Major's achievements message to the Municipal Assembly) to determine the effectiveness of the programs, and to reflect changes that may affect mitigation priorities or available funding.

- The status of the HMP will be discussed and documented. In March and August, at least one month before the plan review meeting, the HMP Coordinator will advise HMP-PC members of the meeting date, agenda and expectations of the members. The HMP Coordinator will be responsible for calling and coordinating the plan review meeting, and assessing progress toward meeting plan goals and objectives. These evaluations will assess whether, including:

- Achievement of the goals and objectives
- The nature or magnitude of the risks has changed.
- Project evaluation based on current needs of the mitigation plan
- Project completion regarding progress of proposed or ongoing actions
- Outcomes have occurred as expected.
- Implementation problems, such as technical, political, legal or coordination issues with other agencies exist.
- Changes in municipal resources impacted plan implementation (e.g., funding, personnel, and equipment)
- Resource allocation to note if resources are required to implement mitigation activities
- Timeframes comment on whether proposed schedules are sufficient to address actions
- Budgets note if budget basis should be changed or is sufficient
- Under/over spending regarding proposed mitigation action budgets
- Actions were cost effective.
- Lead/support agency commitment note if there is a lack of commitment on the part of lead or support agencies
- Resources regarding whether resources are available to implement actions
- Feasibility comment regarding whether certain goals, objectives, or actions prove to be unfeasible

Finally, the HMP-PC will evaluate how other programs and policies have conflicted or augmented planned or implemented measures, and shall identify policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions (see the "Implementation of Mitigation Plan through Existing Programs" subsection later in this Section). Other programs and policies can include those that address:

- Economic Development
- Environmental Preservation & Permitting
- Historic Preservation
- Redevelopment
- Health and/or safety
- Recreation
- Land use/zoning
- Public Education and Outreach
- Transportation

The HMP-PC may refer to the evaluation forms, Worksheets #2 and #4 in the FEMA 386-4 guidance document to assist in the evaluation process.

The HMP-PC Coordinator shall be responsible for preparing the Progress Reports. These reports will provide data for the 5-year update of this HMP and will assist in pinpointing implementation challenges. By monitoring the implementation of the Plan on an annual basis, the HMP-PC will be able to assess which projects are completed, which are no longer feasible, and what projects may require additional funding. During the HMP-PC meeting, the planning partners shall establish a schedule for the draft development, review, comment, amendment and submission of the Annual HMP Progress Report to the GAR.

The Plan will also be evaluated and revised following any major disasters, to determine if the recommended actions remain relevant and appropriate. The risk assessment will also be revisited to see if any changes are necessary based on the pattern of disaster damages or if data listed in the Section 5.4 (Hazard Profiles) of this Plan has been collected to facilitate the risk assessment. This is an opportunity to increase the community's disaster resistance and build a better and stronger community.

6.5 IMPLEMENTATION THROUGH EXISTING PLANNING MECHANISM

It will also be the responsibility of the Committee to facilitate the integration of the recommended actions of the Hazard Mitigation Plan into other local planning documents, processes or mechanisms as opportunities may arise. Such opportunities to integrate the requirements of this Plan into other local planning mechanisms will be identified through future meetings of the Hazard Mitigation Monitoring and Evaluation Committee and through the review process described herein. Several specific mitigation actions address the objective of implementation of hazard mitigation through day-to-day and long-term planning responsibilities of the Permit and Planning Offices.

This Plan highlights several key planning principles that offer a foundation that may guide public policies and avoid a cycle of disaster-reconstruction-disaster:

- The Municipality of San Sebastián should limit intensive development in hazard-prone areas;
- The Municipality of San Sebastián should initiate a long-term transformational process to reduce the vulnerability of older two- to four-story masonry commercial and residential structures in the Urban Center, through demolition, adaptive reuse, seismic retrofits where technically feasible, urban park planning, and more stringent compliance with the building code for new construction;
- The Municipality of San Sebastián should promote information about hazards and sustainable ways of coping with them;
- The Municipality of San Sebastián must develop the political will and capacity to effectively manage the land development process and encourage sustainable development practices;
- The Municipality of San Sebastián should foster innovation and change in land use development practices;
- The Municipality of San Sebastián should integrate findings into the Land Use Plan by modifying its Program, Memorial and Land Use Regulations when these documents are scheduled for updating.

The implementation framework outlined in the sections above provide a vehicle for the Hazard Mitigation Monitoring and Evaluation Committee to develop a "voice" within the community and work directly with policymakers and planners to help them understand the costs of risk reduction, assumption or elimination.

The Municipality of San Sebastián views the development and maintenance of this stand-alone Plan as an effective tool to incorporate hazard mitigation into larger development processes. The Municipality also understands that its implementation will require some fundamental changes in the way the Municipality plans for and regulates new development.

Additional information on how planning mechanisms such as the comprehensive plan is updated

The Land Zoning Comprehensive Plan (Plan de Ordenamiento Territorial) of San Sebastián was adopted by the Puerto Rico Planning Board through Resolution JP-PT-30-1 on April 24, 1998 and was approved by the Governor of Puerto Rico through Executive Order No. 1998-38 on October 28, 1998.

The "Regulation" document of the Comprehensive Plan (Part IV, page 4), establishes that "the Plan will be reviewed in an integrated manner within a period of eight years (i.e. 2006)". The Governor of Puerto Rico approved an amendment to the Road Plan contained in the Comprehensive Plan through Executive Order No. 2002-04 on May 31, 2002. Since then, the Comprehensive Plan has not been amended.

The Comprehensive Plan (Part IV, page 4), also provides that it "can be revised if significant changes occur that affect the classification of the soil adopted". As said before, the Comprehensive Plan has not been amended, since no significant changes that affect the classification of the soil adopted have occurred after year 2002.

Due to the hit of hurricane María in 2017, the HMP Steering Committee will address the possibility to revise the Comprehensive Plan to determine if significant changes might be identified to encourage a new revision. If the Mayor, the municipal Head Directors and local Legislators agree to open the process for a new revision then, it will be done in accordance with Planning Regulation No. 24, Regulation on Municipal Planning Plans and Transfer and Administration of Faculties, Topic 6 - Review of the Comprehensive Plans. Regulation 24 requires the community participation trough Public Hearings. The data, information, and hazard mitigation goals and actions in the Hazard Mitigation Plan will be integrated in the update document draft of the Comprehensive Plan during review process and provided to the open community through the Public Hearing process and comments period.

Additional information on how planning mechanisms such as the capital improvement plan is updated

An integral part of the Territorial Plan is the Investment Projects Program certified by state agencies. This Investment Program is addressed in the "Program" document of the Comprehensive Plan (Section V, page 31). The document formalizes the investment commitment, through certification, between public agencies and the Municipality. These constitute the main source to provide the basic infrastructure of the municipalities. As established by Law 81, Article 13.011 "Once approved by the Governor, the Plan of Ordination will oblige public agencies to comply with the work and project programs included in the Program Section of Investment Projects certified by public agencies." The Municipality of San Sebastián identified the basic infrastructure projects of potable water, sanitary sewage and electricity as of greater importance for the population. For the municipal government, these works that were identified are meritorious and should be assigned financial resources for its execution. However, it has become difficult establish a formal agreement, through certification, to perform the projects programmed by public agencies due to budgetary reasons.

The municipal government continues its efforts to obtain the firm commitment to perform the works for the construction and infrastructure improvements, which constitutes the structural base of the municipality. The mitigation actions proposed in the updated version of the HMP as identified by the community during the open meeting will be added to the list of capital projects negotiation and included during the updated process of the Comprehensive Plan if the Mayor and Local Legislature agree to open the review process. In this way, the data, information, and hazard mitigation goals and actions in the Hazard Mitigation Plan will be integrated in the update document draft of the Comprehensive Plan during review process and provided to the open community through the Public Hearing process and comments period.

How hazard mitigation information can be incorporated:

The hazard mitigation information can be incorporated into others local plans through the "Plan Integration" process. The Municipality of San Sebastián will use this method as described in "Plan Integration: Linking Local Planning Efforts (FEMA, 2015), to look critically at our existing planning framework and align efforts with the goal of building a safer and smarter community. The process will involve the incorporation of hazard mitigation principles and actions into the Municipality of San Sebastián plans and municipal mechanisms into hazard mitigation plans.

The process will involve the local plans, policies, codes, and programs that guide development in our municipality and the roles of people and government in implementing these capabilities. The community and stakeholders will be invited to participate in the process to obtain a successful integration outcome. The Mayor shall appoint a steering committee to lead this effort. The team shall develop goals, objectives, and coordinate all the efforts to complete the integration process. The process itself shall include the following parts:

1. Integration of Hazard Mitigation Principles into Other Local Planning Mechanisms
2. Integration of Hazard Mitigation Principles into Comprehensive Plans
3. Integration Across Agencies and Departments
4. Putting It All Together

6.6 PUBLIC INVOLVEMENT

The Municipality of San Sebastián is committed to the continued involvement of the public in the hazard mitigation process. Therefore, copies of the Plan will be made available for review during normal business hours at the Municipality of San Sebastián Hall. The HMP Coordinator will be responsible for receiving, tracking, and filing public comments regarding this Plan. Contact information is:

Name:	Maritza Ruiz
Title:	Director of Federal Programs
Attn:	Mayor Office
Address:	Municipality of San Sebastán P.O. Box 1603 San Sebastián, P.R. 00685
Phone:	(787) 896-7110
e-mail:	federalesmss@gmail.com federales@munss.org

The public will have an opportunity to comment on the Plan at the review meeting for the HMP and during the 5-year plan update. The annual progress reports will attach to the Hazard Mitigation Plan.

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8.0 ACRONYMS

AEMEAD	Agencia Estatal para el Manejo de Emergencias y Administración de Desastres (Puerto Rico Emergency Management Agency)
BCA	Benefit Cost Analysis
BFE	Base Flood Elevation
CBSA	Core Based Statistical Area
CDERA	Caribbean Disaster Emergency Response Agency
CEMP	Comprehensive Emergency Management Program
CFR	Code of Federal Regulations
CRS	Community Rating System
DEM	Digital Elevation Models
DFIRM	Digital Flood Insurance Rate Maps
DMA 2000	Disaster Mitigation Act of 2000
DNER	Department of Natural and Environmental Resources
DRNA	Departamento de Recursos Naturales y Ambientales
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FIA	Flood Insurance Administration
FIRM	Flood Insurance Rate Maps
FMA	Flood Mitigation Assistance
ft	feet
GIS	Geographic Information System
HAZMAT	Hazardous Materials Facilities
HAZUS-MH	Hazards U.S. – Multi-Hazard
HAZUS-MH MR5	HAZUS-MH MR5 provides users with a streamlined and upgraded version of its world class methodology for estimating potential damages from natural disasters.
HMGP	Hazard Mitigation Grant Program
HMP COMMITTEE	Hazard Mitigation Planning Committee
HMP	Hazard Mitigation Plan
km	kilometer
km^2	square kilometer
m^3	Cubic Meters
MGD	million gallons per day
mi	miles
mi^2	square miles
MMI Scale	Modified Mercalli Intensity scale

MPC	Mitigation Planning Committee
MRP	Mean Return Period
NASA	National Aeronautics and Space Administration
NEHRP	National Earthquake Hazards Reduction Program
NFIP	National Flood Insurance Program
NHC	National Hurricane Center

9.0 GLOSSARY

This resource defines terms that are used in or support the risk assessment document. These definitions were based on terms defined in documents included in the reference section.

100-year flood – A flood that has a 1-percent chance of being equaled or exceeded in any given year. This flood event is also referred to as the base flood. The term "100-year flood" can be misleading; it is not the flood that will occur once every 100 years. Rather, it is the flood elevation that has a 1- percent chance of being equaled or exceeded each year. Therefore, the 100-year flood could occur more than once in a relatively short period. The 100-year flood, which is the standard used by most federal and state agencies, is used by the National Flood Insurance Program (NFIP) as the standard for floodplain management to determine the need for flood insurance.

500-year flood – A flood that has a 0.2-percent chance of being equaled or exceeded in any one year.

Aggregate Data – Data gathered together across an area or region (e.g. census tract or census block data).

Benefit – Net project outcomes, usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of conducting a benefit-cost analysis of proposed mitigation measures, benefits are limited to specific, measurable, risk reduction factors, including a reduction in expected property losses (building, content, and function) and protection of human life.

Benefit-cost analysis (BCA) – Benefit-cost analysis is a systematic, quantitative method of comparing the projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

Building – A structure that is walled and roofed, principally aboveground and permanently fixed to a site. The term includes a manufactured home on a permanent foundation on which the wheels and axles carry no weight.

Building Codes – Regulations that set forth standards and requirements for construction, maintenance, operation, occupancy, use, or appearance of buildings, premises, and dwelling units. Building codes can include standards for structures to withstand natural disasters.

Capability Assessment – An assessment that provides a description and analysis of a community or state's current capacity to address the threats associated with hazards. The capability assessment attempts to identify and evaluate existing policies, regulations, programs, and practices that positively or negatively affect the community or state's vulnerability to hazards or specific threats.

Community Rating System (CRS) – CRS is a program that provides incentives for National Flood Insurance Program communities to complete activities that reduce flood hazard risk. When the community completes specific activities, the insurance premiums of these policyholders in communities are reduced.

Comprehensive Plan – A document, also known as a "general plan", covering the entire geographic area of a community and expressing community goals and objectives. The plan lays out the vision, policies, and strategies for the future of the community, including all the physical elements that will determine the community's future development. This plan can discuss the community's desired physical development, desired rate and quantity of growth, community character, transportation services, location of growth, and

siting of public facilities and transportation. In most states, the comprehensive plan has no authority in and of itself, but serves as a guide for community decision-making.

Critical Facility – Facilities that are critical to the health and welfare of the population and that are especially important following a hazard. Critical facilities include essential facilities, transportation systems, lifeline utility systems, high-potential loss facilities, and hazardous material facilities. As defined for the Village of Scarsdale risk assessment, this category includes police stations, fire and/or EMS stations, major medical care facilities and emergency communications.

Disaster Mitigation Act of 2000 (DMA 2000) – Law that requires and rewards local and state predisaster planning, promotes sustainability as a strategy for disaster resistance, and is intended to integrate state and local planning with the aim of strengthening state-wide mitigation planning.

Essential Facility – A facility that is important to ensure a full recovery of a community or state following the occurrence of a hazard. These facilities can include: government facilities, major employers, banks, schools, and certain commercial establishments (such as grocery stores, hardware stores, and gas stations). For the Village of Scarsdale risk assessment, this category was defined to include schools, colleges, shelters, adult living and adult care facilities, medical facilities and health clinics, hospitals.

Extent – The size of an area affected by a hazard or the occurrence of a hazard.

Flood Hazard Area – Area shown to be inundated by a flood of a given magnitude on a map.

Flood Insurance Rate Map (FIRM) – Map of a community, prepared by the FEMA that shows both the special flood hazard areas and the risk premium zones applicable to the community.

Flood Mitigation Assistance (FMA) Program – A program created as a part of the National Flood Insurance Report Act of 1994. FMA provides funding to assist communities and states in implementing actions that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other NFIP insurance structures, with a focus on repetitive loss properties.

Floodplain – Any land area, including a watercourse, susceptible to partial or complete inundation by water from any source.

Frequency – A measure of how often events of a magnitude are expected to occur. Frequency describes how often a hazard of a specific magnitude, duration, and/or extent typically occurs, on average. Statistically, a hazard with a 100-year recurrence interval is expected to occur once every 100 years on average, and would have a 1-percent chance of happening in any given year. The reliability of this information varies depending on the kind of hazard being considered.

Goals – General guidelines that explain what you want to achieve. They are usually broad policy-type statements, long term in nature, and represent global visions.

Geographic Information Systems (GIS) – A computer software application that relates data regarding physical and other features on the earth to a database to be used for mapping and analysis.

Hazard – A source of potential danger or an adverse condition that can cause harm to people or cause property damage. For this risk assessment, priority hazards were identified and selected for the pilot project effort. A natural hazard is a hazard that occurs naturally (such as flood, wind, and earthquake). A man-made hazard is one that is caused by humans (for example, a terrorist act or a hazardous material spill). Hazards are of concern if they have the potential to harm people or property.

Hazards of Interest – A comprehensive listing of hazards that may affect an area.

Hazards of Concern – Those hazards that have been analytically determined to pose significant risk in an area, and thus the focus of the mitigation plan for that area (a subset of the Hazards of Interest).

Hazard Identification – The process of identifying hazards that threaten an area.

Hazard Mitigation Grant Program (HMGP) – Authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, HMGP is administered by FEMA and provides grants to states, tribes, and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster.

Hazard Mitigation Plan – A collaborative document in which hazards affecting the community are identified, vulnerability to hazards assessed, and consensus reached on how to minimize or eliminate the effects of these hazards.

Hazard Profile – A description of the physical characteristics of a hazard, including a determination of various descriptors including magnitude, duration, frequency, probability, and extent. In most cases, a community can most easily use these descriptors when they are recorded and displayed as maps.

Hazards U.S. – Multi-Hazard (HAZUS-MH) – A GIS-based nationally standardized earthquake, flood, and wind loss estimation tool developed by FEMA. The purpose of this pilot project is to demonstrate and implement the use of HAZUS-MH to support risk assessments.

Hydraulics – That branch of science, or of engineering, which addresses fluids (especially, water) in motion, its action in rivers and canals, the works and machinery for conducting or raising it, its use as a prime mover, and other fluid-related areas.

Hydrology – The science of dealing with the waters of the earth (for example, a flood discharge estimate is developed through conduct of a hydrologic study).

Infrastructure – The public services of a community that have a direct impact on the quality of life. Infrastructure includes communication technology such as phone lines or Internet access, vital services such as public water supplies and sewer treatment facilities, transportation system (such as airports, heliports; highways, bridges, tunnels, roadbeds, overpasses, railways, bridges, rail yards, depots; and waterways, canals, locks, seaports, ferries, harbors, dry docks, piers and regional dams).

Intensity – A measure of the effects of a hazard occurring at a place.

Lifelines – Critical facilities that include utility systems (potable water, wastewater, oil, natural gas, electric power facilities and communication systems) and transportation systems (airways, bridges, roads, tunnels and waterways).

Loss Estimation – The process of assigning hazard-related damage and loss estimates to inventory, infrastructure, lifelines, and population data. HAZUS-MH can estimate the economic and social loss for specific hazard occurrences. Loss estimation is essential to decision making at all levels of government and provides a basis for developing mitigation plans and policies. It also supports planning for emergency preparedness, response, and recovery.

Magnitude – A measure of the strength of a hazard occurrence. The magnitude (also referred to as severity) of a given hazard occurrence is usually determined using technical measures specific to the hazard. For example, ranges of wind speeds are used to categorize tornados.

Mitigation Actions – Specific actions that help you achieve your goals and objectives.

Mitigation Goals – General guidelines that explain what you want to achieve. They are usually broad policy-type statements, long term, and represent global visions.

Mitigation Objectives – Strategies or implementation steps to attain the identified goals. Unlike goals, objectives are specific and measurable.

Mitigation Plan – A plan that documents the process used for a systematic evaluation of the nature and extent of vulnerability to the effects of natural hazards typically present in a state or community. The plan includes a description of actions to minimize future vulnerability to hazards. This plan should be developed with local experts and significant community involvement.

National Flood Insurance Program (NFIP) – Federal program created by Congress in 1968 that makes flood insurance available in communities that enact minimum floodplain management regulations in 44 Code of Federal Regulations (CFR) §60.3.

Objectives – Objectives define strategies or implementation steps to attain the identified goals. Unlike goals, objectives are specific and measurable.

Ordinance – A term for a law or regulation adopted by local government.

Post-disaster mitigation – Mitigation actions taken after a disaster has occurred, usually during recovery and reconstruction.

Presidential Disaster Declaration – A post-disaster status that puts into motion long-term federal recovery programs, some of which are matched by state programs, and designed to help disaster victims, businesses, and public entities in the areas of human services, public assistance (infrastructure support), and hazard mitigation. If declared, funding comes from the President's Disaster Relief Fund and disaster aid programs of other participating federal agencies.

Preparedness – Actions that strengthen the capability of government, citizens, and communities to respond to disasters.

Priority Hazards – Hazards considered most likely to impact a community based on frequency, severity, or other factors such as public perception. These are identified using available data and local knowledge.

Public Education and Outreach Programs – Any campaign to make the public more aware of hazard mitigation and mitigation programs, including hazard information centers, mailings, public meetings, etc.

Recovery – The actions taken by an individual or community after a catastrophic event to restore order and lifelines in the community.

Regulation – Most states have granted local jurisdictions broad regulatory powers to enable the enactment and enforcement of ordinances that deal with public health, safety, and welfare. These include building codes, building inspections, zoning, floodplain and subdivision ordinances, and growth management initiatives.

Recurrence Interval – The average time between the occurrences of hazardous events of similar size in a given location. This interval is based on the probability that the given event will be equaled or exceeded in any given year.

Repetitive Loss Property – A property that is currently insured for which two or more National Flood Insurance Program losses (occurring more than ten days apart) of at least $1,000 each have been paid within any 10-year period since 1978.

Replacement Value – The cost of rebuilding a structure. This cost is usually expressed in terms of cost per square foot and reflects the present-day cost of labor and materials to construct a building of a size, type and quality.

Resolutions – Expressions of a governing body's opinion, will, or intention that can be executive or administrative in nature. Most planning documents must undergo a council resolution, which must be supported in an official vote by a majority of representatives to be adopted. Other methods of making a statement or announcement about an issue or topic include proclamations or declarations.

Resources – Resources include the people, materials, technologies, money, etc., required to implement strategies or processes. The costs of these resources are often included in a budget.

Risk – The estimated impact that a hazard would have on people, services, facilities, and structures in a community; the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate or low likelihood of sustaining damage above a threshold due to occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Risk Assessment – A methodology used to assess potential exposure and estimated losses associated with priority hazards. The risk assessment process includes four steps: (1) identifying hazards, (2) profiling hazards, (3) conducting an inventory of assets, and (4) estimating losses. This pilot project report documents this process for selected hazards addressed as part of the pilot project.

Risk Factors – Characteristics of a hazard that contribute to the severity of potential losses in the study area.

Riverine – Of or produced by a river (for example, a riverine flood is one that is caused by a river overflowing its banks).

Saffir-Simpson Scale – This scale categorizes or rates hurricanes from 1 (Minimal) to 5 (Catastrophic) based on their intensity. It is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the shape of the coastline, in the landfill region.

Scale – A proportion used in determining a dimensional relationship; the ratio of the distance between two points on a map and the actual distance between the two points on the earth's surface.

Stafford Act – The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law (PL) 100-107 was signed into law on November 23, 1988. This law amended the Disaster Relief Act of 1974, PL 93-288. The Stafford Act is the statutory authority for most Federal disaster response activities, especially as they pertain to FEMA and its programs.

Stakeholder – Stakeholders are individuals or groups, including businesses, private organizations, and citizens, that will be affected in any way by an action or policy.

State Hazard Mitigation Officer (SHMO) – The representative of state government who is the primary point of contact with FEMA, other state and Federal agencies, and local units of government in the planning and implementation of pre- and post-disaster mitigation activities.

Substantial Damage – Damage of any origin sustained by a structure in a SFHA, for which the cost of restoring the structure to its pre-hazard event condition would equal or exceed 50 percent of its pre-hazard event market value.

Topographic – Map that shows natural features and indicate the physical shape of the land using contour lines based on land elevation. These maps also can include man-made features (such as buildings and roads).

Appendix A: Plan Adoption

Appendix B: Applicable Federal and State Regulation

This appendix provides the following Federal and State Regulations related to the Hazard Mitigation Planning process.

Federal

Public Law 106-390 – October 30, 2000

Code of Federal Regulations (CFR) - Title 44 - Emergency Management and Assistance - Part 201- Mitigation Planning. February 26, 2002

CFR Title 44 – Emergency Management and Assistance - Part 201 – Mitigation Planning. September 13, 2004.

State

Law No. 20 of April 10, 2017, known as the Law of the Department of Public Security of Puerto Rico.

Appendix C: HMP Planning Committee and Community Workshop

This appendix provides meeting agendas, attendance lists, power point presentations, survey template, and monthly reports developed during the HMP updating process.