

gobierno de PUERTO RICO

PRESIDENCIA I AUTORIDAD DE ACUEDUCTOS Y ALCANTARILLADOS Ing. Luis R. González Delgado I Presidente Ejecutivo I luis.gonzalez@acueductospr.com

20 de marzo de 2025

Vía correo electrónico: secretaria@senado.pr.gov

Sra. Jenniffer Martínez Heyer Secretaria Secretaría del Senado Senado de Puerto Rico San Juan, PR

Petición de Información 2025-0034 – Proyecto en la Comunidad de El Condado, San Juan

Estimada secretaria Martínez Heyer:

Reciba un cordial saludo de parte de los que laboran en la Autoridad de Acueductos y Alcantarillados de Puerto Rico (en adelante, "AAA" o "Autoridad") y del mío propio. Acusamos el recibo de la Petición de Información 2025-0034 (en adelante, Petición de Información) presentada por la senadora Álvarez Conde y aprobada por el Senado de Puerto Rico el 13 de marzo de 2025.

Mediante la Petición de Información se solicita el estado del proyecto de mejoras y reparación de tuberías y desagües, y para el control de inundaciones en la comunidad de El Condado en San Juan.

En respuesta a la Petición de Información le indicamos lo siguiente:

La Autoridad para el Financiamiento de la Infraestructura (AFI), el Municipio Autónomo de San Juan, el Departamento de Recursos Naturales y Ambientales (DRNA) y la Autoridad de Acueductos y Alcantarillados de Puerto Rico (AAA) formalizaron un acuerdo interagencial para el desarrollo del proyecto denominado: "Diseño y Construcción de Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario y Sistema de Protección Contra Inundaciones por Mareas en Condado, Municipio de San Juan". Dicho acuerdo fue firmado el 5 de agosto de 2024 (Anejo A). Petición de Información 2025-0034 – Proyecto en la Comunidad de El Condado, San Juan 20 de marzo de 2025 Página 2

En este proyecto, la AFI funge como desarrollador y administrador, con la asistencia de la AAA, el Municipio y el DRNA. El mismo se compone de dos fases principales:

Fase 1:

- Rehabilitación de la infraestructura de agua potable y alcantarillado sanitario en las calles Delcasse, Marseilles, Mariano Ramírez Baiges, Piccioni, Joffre, Barranquitas, Mayagüez, Clemenceau, Aguadilla y la Ave. Ashford.
- El proyecto fue subastado por AFI el 7 de octubre de 2024 bajo la solicitud de propuesta # AFI-BP-24-069 y adjudicado el 25 de febrero de 2025 a DFM Contractors, LLC (Contrato #2025-000124) por la suma de \$8,259,903.13, con una inversión total de \$10,117,770.83 (incluye construcción, inspección, administración y contingencias) (Anejo B).
- La obra tiene una duración de 400 días, con fecha de inicio el 5 de marzo de 2025 y Terminación Sustancial el 9 de abril de 2026, proyectando la Terminación Final el 9 de mayo de 2026.
- La reunión de pre-construcción se llevó a cabo el 5 de marzo de 2025, y actualmente se trabaja en la fase de trámites administrativos como el itinerario base, Plan de Salud y Seguridad, pagos de patentes y arbitrios, obtención de permisos y la elaboración del 30% de los diseños.

Fase 2:

- Consiste en el diseño e implementación del Sistema de Protección Contra Inundaciones por Mareas, la cual incluye la coordinación y obtención de los permisos necesarios, especialmente del Cuerpo de Ingenieros del Ejército de los Estados Unidos (USACE).
- Basado en un estudio preliminar de CA Engineering, PSC, se propone la rehabilitación del muro estructural existente y la instalación de un sistema de bombeo para el manejo de aguas pluviales.
- Las medidas buscan mitigar las inundaciones por lluvias intensas y marejadas en las calles Delcasse, Piccioni, Joffre, Barranquitas, Mayagüez y Aguadilla.
- Además, el USACE desarrolla un Estudio de Manejo de Riesgos de Tormentas Costeras en el Área Metropolitana de San Juan (Anejos C y D), cuyo costo preliminar asciende a \$365,190,000. Este incluye la construcción de bermas elevadas con vegetación para reducir el riesgo de inundación costera en El Condado.

AFI posee más detalles del proyecto, así que recomendamos sean consultados, de existir dudas adicionales.

Petición de Información 2025-0034 – Proyecto en la Comunidad de El Condado, San Juan 20 de marzo de 2025 Página 3

Sobre los planes de prevención de descargas de aguas residuales:

La rehabilitación de la infraestructura sanitaria en la Fase 1 está dirigida precisamente a minimizar riesgos de fallos y descargas hacia la laguna y la comunidad de El Condado, mediante la modernización del sistema existente, lo que complementa los esfuerzos de mitigación de la Fase 2.

Además, la AAA cuenta con un programa denominado S2OMP (Programa de Operación y Mantenimiento del Sistema Sanitario), el cual forma parte del Acuerdo por Consentimiento (*Consente Decree*) con la Agencia de Protección Ambiental (EPA). Mediante este programa se provee limpiezas programadas en diferentes sectores del Municipio de San Juan, incluyendo la comunidad del Condado. En este contexto, la AAA ha realizado trabajos de investigación y reconocimiento del sistema de alcantarillado sanitario hidráulicamente conectados al Sistema de Alcantarillados de la Planta de Tratamiento Regional de Puerto Nuevo correspondiente al área del Condado, y sectores aledaños.

Además, la Autoridad está en proceso de formalizar un acuerdo con la corporación del Estuario de la Bahía de San Juan, mediante el cual se propone automatizar 15 estaciones de bomba de alcantarillado sanitario, entre las cuales está la Estación de Bombas Joffre. Esta estación ubica en la calle Joffre de la Comunidad El Condado. Con esta automatización de la estación la Autoridad recibirá alertas en tiempo real en caso de que esta salga de operación por cualquier motivo, de manera que podamos atender la situación de forma inmediata, evitando que ocurra desbordes de aguas residuales.

Finalmente, deseamos informar que la AAA ha establecido un Programa de Control de Aceites y Grasas que forma parte de los elementos del Programa de Pretratamiento aprobado por la Agencia de Protección Ambiental (EPA por sus siglas en inglés) en el 1985 bajo el Código de Regulación Federal 40 Parte 403, el cual prohíbe la descarga de contaminantes sólidos o viscosos que puedan causar obstrucción en el sistema de alcantarillado. A tales efectos, la AAA estableció los controles y guías necesarias para establecimientos que manejan aceites y grasas de forma que su descarga no cause impacto adverso al sistema de alcantarillado sanitario, plantas de tratamiento de aguas residuales y el ambiente. Esto, mediante la implementación de un programa abarcador de Inspecciones que permita:

- Reducción de desbordes por obstrucción de grasas.
- Cumplimiento con normas regulatorias.

Petición de Información 2025-0034 – Proyecto en la Comunidad de El Condado, San Juan 20 de marzo de 2025 Página 4

- Cultura de cumplimiento por parte de los comercios.
- Protección al medio ambiente y la salud pública.

Esperamos que la información brindada le sea de utilidad. Nos hacemos disponibles para cualquier colaboración adicional que requieran de nuestra agencia.

Cordialmente,

2-R. Ing. Luis González Delgado. P.E.

Presidente Ejecutivo

Anejos



PUERTO RICO INFRASTRUCTURE FINANCING AUTHORITY GOVERNMENT OF PUERTO RICO

AGREEMENT FOR DESIGN AND BUILD

BETWEEN

PUERTO RICO INFRASTRUCTURE FINANCING AUTHORITY,

AND

DFM CONTRACTORS (DYNAMIC FERRIOUS+CONCRETE MANUFACTURE) L.L.C.

AND

SPEC ENGINEERING SERVICES, PSC ("DB TEAM")

FOR

"DISEÑO Y CONSTRUCCIÓN PARA LA REHABILITACIÓN DE LA INFRAESTRUCTURA DE AGUA POTABLE, ALCANTARILLADO SANITARIO, MUNICIPIO DE SAN JUAN CONDADO, CALLES BARRANQUITAS, MAYAGÜEZ, AGUADILLA, JOFFRE, MARIANO RAMÍREZ BAIJES, DELCASSE, MARSELLES, CLEMENCEAU, PICCIONI Y AVE. ASHFORD"

CONTRACT No. 2025-000124

CONTRACT BOOK

- CONTRACT: PRIFA-Design/Build/ DB Team Agreement
- SUPLEMENTARY CONDITIONS
- UNIFORM GENERAL CONDITIONS

PRIFA- DESIGN AND BUILD DB TEAM AGREEMENT CONTRACT No. 2025-000124

This **PRIFA- DESIGN AND BUILD DB TEAM AGREEMENT** (this "<u>Agreement</u>") is made and entered into in San Juan, Puerto Rico as of the <u>25</u> /b day of <u>FUDYUQN</u>, 2025 ("The Effective Date") by and between:

FOR THE FIRST PARTY: The **PUERTO RICO INFRASTRUCTURE FINANCING AUTHORITY** ("**PRIFA**"), an instrumentality and public corporation of the Government of Puerto Rico, created and existing under Public Law Number 44 of June 21, 1988, as amended, represented herein by its Legal Director, Brenda A. Virella Crespo, of legal age, married, an attorney, and a resident of Bayamón, Puerto Rico; hereinafter referred to as "PRIFA" and duly authorized by resolution No. 2022-19; and

FOR THE SECOND PARTY: DFM CONTRACTOR (DYNAMIC FERROUS+CONCRETE MANUFACTURE), L.L.C. (the "Contractor", and together with the "Designer", the "Design Build Team or DB Team"), a corporation created and existing under the laws of The Government of Puerto Rico, and authorized to do business in Puerto Rico, represented herein by its Secretary, Leonardo Rivera-Jaca, of legal age, married and resident of Rio Grande, Puerto Rico, duly authorized by a Corporate Resolution issued on May 2, 2024.

FOR THE THIRD PARTY: SPEC ENGINEERING SERVICES, PSC (the "**Designer**", and together with the "Contractor", the "Design Build Team or DB Team"), a corporation created and existing under the laws of The Government of Puerto Rico, and authorized to do business in Puerto Rico, represented herein by its, president, Roberto J. Marte De La Mota of legal age, married, engineer and a resident of San Juan, Puerto Rico, duly authorized by a Corporate Resolution issued on <u>February 4, 2021</u>.

In consideration of the mutual covenants and agreements set forth below, the parties agree as follows:

Terms used herein which are not defined in this Agreement shall have the meanings assigned to them in the Contract Document entitled "Uniform General Conditions" (the "<u>General Conditions</u>"), which is attached hereto and made a part hereof.

The term "Design Build Team" or "DB Team" are the Contractor and the Designer, as one entity, responsible to design and complete the Work, as defined below.

The term Contractor for the purposes of the Contract Documents, including the Uniform General Conditions and Suplementary Conditions, is the DB Team as one sole contractor.

ARTICLE 1 – BACKGROUND

1.1 Preamble

The Parties acknowledge that the following facts constitute the background for this Agreement:

- **1.1.1** In accordance with the Regulations for Bids, Reg. No. 5853, PRIFA executed Bid Process No. **AFI-BP-24-069** for the design & build of the Project, resulting in the selection of the DB Team.
- **1.1.2** The DB Team agrees to design and build the Project, as more particularly described in the Contract Documents.
- **1.1.3** PRIFA and the DB Team agree to perform all of their respective obligations set forth in the Contract and to be bound by all of the terms and conditions of the Contract as stated below and in the Contract Documents.

ARTICLE 2 – CONTRACT

2.1 Scope of Contract

The DB Team shall complete the design for the construction of the Project. These services include any inspections, evaluations, experiments, analyses, briefings, and presentations that are, or may be, required by AFI in connection with the performance of such Services. DB Team shall fully execute all the Work described in the Contract documents.

The DB Team shall furnish all labor, materials, supervision, tools, and equipment required for the construction of the Project in strict accordance with the provisions of the Contract Documents, all of which are hereby made a part hereof. On or before the expiration or termination of the Contract, as part of its obligations thereunder, the DB Team shall deliver to AFI a true and exact copy of all diagrams, plans, sketches, maps and other documents used in the performance of the Work and for which a third-party copyright or patent right would not be an impediment to such delivery.

If the entity constituting the DB Team is a joint venture, each principal member of the DB Team is and shall be jointly and severally responsible and liable for all obligations, responsibilities, and liabilities of the DB Team under the Contract.

The abovementioned services (the "Work") are set forth in further detail in **Exhibit A**. AFI and the DB Team each agree to perform all their respective obligations set forth in the Contract and to be bound by all of the terms and conditions of the Contract.

2.2 Contract Documents

The Contract consists of each of the Contract Documents identified in Article 1.1.1.14 of the Uniform General Conditions.

ppr 8 1

2.3 Contract Attachments

The Contract Attachments are identified in Article 9 – Attachments.

2.4 Permits and Approvals

The DB Team shall timely perform all of its obligations mentioned in the General Conditions, including, without limitation, securing and maintaining all Permits and Approvals legally required or imposed in connection with the performance of the Contract and the proper execution and completion of the Work, including compliance with the disposal of solid waste as stated in **Attachment C**.

2.5 Preliminary Design

por H f (A) Time For Preliminary Design: DB Team shall prepare and submit to the AFI's Representative a Preliminary Design for the Project not later than the date called for in the Design Schedule,

(B) Contents Of Preliminary Design: The Preliminary Design shall address all requirements of the Project and shall include, without limitation, the following:

(1) preliminary drawings which illustrate each of the basic components of the Project including the size, scale, location, dimensions, and character of each building structure;

(2) preliminary drawings which illustrate each exterior view of the Project;

(3) preliminary drawings which illustrate a floor plan for each room, office, and functional area of the Project and the dimensions thereof;

(4) preliminary drawings and specifications illustrating and describing the architectural, electrical, mechanical, structural, and manufacturing systems of the Project;

(5) a written description of the materials and equipment to be incorporated into the Project and the location of same; and

(6) any other documents or things required to illustrate, describe or depict the Preliminary Design and the conformity of same with the requirements of the Design Scope Specification and this Contract.

(C) To Be Reviewed With AFI: DB Team shall review the Preliminary Design with AFI and AFI's Representative and shall incorporate any changes ordered by AFI and AFI's Representative in regard to the Preliminary Design or the requirements of the Project. When the changes are approved by AFI, an increase in the Contract price equal to the approved change may be performed. Said increase in the Contract may be performed only when the required documents have been submitted and approved by AFI and AFI's Representative. (D) Authorization To Proceed With Detailed Design: After review of the Preliminary Design and incorporation of any changes ordered by AFI's Representative, AFI's Representative shall authorize DB Team in writing to commence preparing the Detailed Design, or such part thereof as directed by AFI's Representative.

2.6 Detailed Design

(A) Time For Preparation: DB Team shall prepare and submit to AFI's Representative the complete Detailed Design not later than the date called for in the Design Schedule, after AFI's Representative has authorized DB Team to commence with the Detailed Design as provided in Paragraph 2.5(D) above.

(B) The Detailed Design: The Detailed Design shall include all Design Documents which shall describe with specificity all elements, details, components, materials, and other information necessary for the complete construction of the Project and the rendering of the Project fully operational for its intended including satisfaction of all testing. permitting. qualifications. purposes. certifications, validations, and obtaining regulatory approvals by all applicable regulatory authorities required to render the Project and all its components operational and functionally and legally usable for their intended purpose. Subject to the provisions of this Agreement, AFI shall review and approve, where appropriate, the Design Documents, or any portion thereof.

(C) Design Documents: Design Documents means all the design documents provided by DB Team and approved by AFI pursuant to the Contract including, without limitation, those for use in constructing the Project, performing the Work, and the rendering of the Project fully operational, and shall include, without limitation, detailed plans, drawings, specifications, manuals, and related materials prepared by or on behalf of DB Team.

2.7 Construction Services

pour Th z

(A) General Intent: DB Team shall perform all Work necessary to construct the Project in accordance with this Contract, and to render the Project and all its components operational and functionally and legally usable for their intended purpose.

(B) Work Defined: The term "Work" shall mean whatever is done by or required of DB Team to perform and complete its duties relating to the construction of the Project under the Contract, including, without limitation, the following:

(1) construction of the whole and all parts of the Project in full and strict conformity with this Contract;

(2) the provision and furnishing, and prompt payment therefore, of all labor, supervision, services, materials, supplies, equipment, fixtures, appliances, facilities,

tools, transportation, storage, power, fuel, heat, light, cooling, other utilities and things required for the construction of the Project;

(3) the procurement and furnishing of all necessary building permits and other permits required for the construction of the Project;

(4) the creation and submission to AFI of detailed as-built drawings depicting all as-built construction;

(5) the furnishing of any required surety bonds and insurance as required by the Contract;

(6) the furnishing of all equipment and product warranties, manuals, test results and user guides required by the Contract or otherwise reasonably available to DB Team;

(7) the furnishing of all other services and things required or reasonably inferable from the Contract Documents;

2.8 Additional Duties and Responsibilities of the DB Team

(1) Supervision Of The Construction Work: The Construction Work shall be strictly supervised by a duly licensed engineer or architect. DB Team shall bear full responsibility for any and all acts or omissions of those engaged in the Construction Work on behalf of DB Team.

(2) Warranty Of Construction Workmanship And Materials: DB Team warrants and guarantees to AFI that all labor furnished to perform the Construction Work under the Contract will be competent to perform the tasks undertaken and is the best quality obtainable, that the product of such labor will yield only first-class results in strict compliance with the Contract, that materials and equipment furnished will be of high quality and new unless otherwise permitted by the Contract, and that the Construction Work will be of high quality, free from faults and defects and in strict conformance with the Contract. Any and all Construction Work not strictly conforming to these requirements shall be considered defective and shall constitute a breach of DB Team's warranty.

(3) As-Built Drawings: DB Team shall prepare and provide to the Owner's Representative a complete set of all as-built drawings which shall be complete and, except as specifically noted, shall reflect performance of the Construction Work in strict compliance with the requirements of this Contract.

(4) Compliance With Labor Laws: DB Team shall assume all labor responsibility for all personnel assigned to or contracted for the performance of the Construction Work and agrees to strictly comply with all its obligations as employer with respect to said personnel under all applicable labor laws.

(5) Testing, Inspections, And Approvals: DB Team shall be responsible for procuring all tests and inspections required by sound professional practices and by

por B 8 governmental authorities having jurisdiction over the Project. DB Team shall submit certified results of such tests to AFI. If the laws, ordinances, rules, regulations or orders of any public authority having jurisdiction require any Construction Work to be specifically inspected, tested, or approved, DB Team shall assume full responsibility therefore, pay all costs in connection therewith and furnish to AFI the required certificates of inspection, testing or approval.

(6) AFI's Regulations And Applicable Laws: DB Team shall, during the course of the Construction Work, comply with any regulations or guidelines prescribed by AFI. DB Team warrants that it will comply with all public laws, ordinances, rules and regulations applicable to the services to be performed under the Contract, including without limitation, those relating to the terms and conditions of the employment of any person by DB Team in connection with the Construction Work to be performed under the Contract.

(7) Compliance With Construction Regulations: DB Team shall perform the Construction Work in accordance with all construction codes, laws, ordinances or regulations applicable to the design and execution of the Construction Work. Any fine or penalty which may be imposed as consequence of any violation of this provision shall be paid by DB Team, and DB Team shall fully indemnify and hold AFI harmless from all loss, damage, and expense, including attorney's fees, resulting from any such violation or alleged violation of codes, laws, ordinances, or regulations, regardless of a concurrent contribution by AFI, through negligence or other wrongful act, to such loss, damage, or expense, except that such indemnity shall not apply if the violation is solely and directly caused by a negligent or willful act or omission of AFI, its officers, agents, or employees.

And Notices: All construction (8) Permits. Licenses and building permits, licenses and authorizations necessary for the construction of the Project shall be secured and paid for by DB Team. DB Team shall notify the Owner's Representative when it has received said permits, licenses, and authorizations, and upon receipt shall supply the Owner's Representative with copies of same. The originals of permits, licenses and authorizations shall be delivered to the Owner's Representative upon completion of the Construction Work, and receipt of these documents by AFI shall be a condition precedent to final payment. DB Team shall also give and maintain any and all notices required by applicable laws pertaining to the construction of the Construction Work.

(9) Cleaning The Site: DB Team shall keep the site reasonably clean during performance of the Construction Work. Upon Final Completion of the Construction Work, DB Team shall thoroughly clean the site and the Project and remove all waste, debris, trash and excess materials or equipment, together with DB Team's property therefrom.

(10) Fiduciary Relationship: DB Team recognizes and accepts a fiduciary relationship of trust and confidence hereby established between DB Team and AFI and agrees that it shall at all times in good faith use its best efforts to advance

Par 8

AFI's interests and agrees to perform the Design Services and the Construction Work in the highest professional manner.

ARTICLE 3 – CONTRACT PRICE, WITHHOLDING, AND LIQUIDATED DAMAGES

3.1 Contract Price

- **3.1.1 Contract Price.** In accordance with the Contract Documents, PRIFA agrees to pay and the DB Team accepts, as full payment for the complete and proper performance of the Contract, the amount of **Eight Million Two Hundred Fifty-Nine Thousand Nine Hundred Three Dollars and Thirteen Cents** (\$8,259,903.13) (the "Contract Price"), subject to any authorized increase or decrease by means of Change Orders, in accordance with Subsection 3.1.3 of this Agreement and in the General Conditions.
- 3.1.2 Submission of Applications for Payment. Prior to the submission of the first Application for Payment by the DB Team, PRIFA's Representative and the DB Team shall agree upon a date each month (the "Invoice Submission Date"), which shall be the same date each month, on or prior to which the DB Team shall submit, on a monthly basis, an Application for Payment in accordance with the General Conditions. Except as provided in the succeeding paragraph, in the event the DB Team fails to submit, on or prior to the 15th day following the Invoice Submission Date for any month, an Application for Payment for such month that complies with the requirements of the General Conditions, the amount of such Application for Payment shall be automatically reduced by one percent (1%) of the amount of such Application for Payment, without further act by PRIFA or the DB Team. Such reduction in the amount of any Application for Payment shall not be recoverable by the DB Team and shall constitute instead an automatic adjustment in the Contract Price binding on the DB Team.

In the event the DB Team fails to submit, on or prior to the 30th day following the Invoice Submission Date for any month, an Application for Payment for such month that complies with the requirements of the General Conditions, the amount of such Application for Payment shall be automatically reduced by two (2%) of the amount of such Application for Payment, without further act by PRIFA or the DB Team. Such reduction in the amount of any Application for Payment (a) shall be in lieu of, and not in addition to, the reduction provided in the preceding paragraph, and (b) shall not be recoverable by the DB Team and shall constitute instead an automatic adjustment in the Contract Price binding on the DB Team.

All Applications for Payments shall be subject to review and approval by PRIFA's Representative and the Contracting Officer in accordance with the General Conditions. Any determination by PRIFA's Representative whether or not to recommend the issuance of a Certificate of Payment, in whole or in

part, with respect to any Application for Payment shall be made in accordance with the General Conditions.

Each Application for Payment must include a written certification stating that:

"We certify under penalty of nullity that no public servant of PRIFA will derive or obtain any benefit or profit of any kind from the contractual relationship which is the basis of this invoice. If such benefit or profit exists, the required waiver has been obtained prior to entering into the Agreement. The only consideration to be received in exchange for the delivery of goods or for services provided is the agreed-upon price that has been negotiated with an authorized representative from PRIFA. The total amount shown on this invoice is true and correct. The professional services have been rendered, and no payment has been received".

3.1.3 Allowances. See Attachment H.

3.1.4 In accordance with the Contract Documents, the amount of retainage with respect to progress payments is five percent (5%) of each partial payments made to the DB Team.

3.2 Withholding

ph.

κ

3.2.1 Resident Individual or Entity DB Teams. PRIFA, in compliance with Law No. 1 of January 31, 2011, The Internal Revenue Code for a New Puerto Rico, as amended, shall deduct, and withhold the applicable percent of amounts payable to the DB Team for services performed under this Contract.

3.3 Liquidated Damages

3.3.1 Measure of Damages. In the event that Substantial Completion is not achieved on or prior to the Scheduled Substantial Completion Date (as such date may be adjusted by means of a Change Order in accordance with the Contract Documents), whether or not the Contract is terminated pursuant to the General Conditions, the DB Team acknowledges that (a) PRIFA will suffer losses and damages on account of such delay, and (b) the amount of such losses or damages would be difficult, if not impossible, to ascertain and prove. The liquidated damage amount specified below shall be considered not as a penalty, but as fixed and agreed liquidated damages due to PRIFA from the DB Team by reason of interference with business, increased engineering, inspection and administrative costs to PRIFA and other items which would result in an expenditure of public funds due to the delay in achieving Substantial Completion on or prior to the Scheduled Substantial Completion Date. PRIFA and the DB Team, having considered the nature and types of losses or damages that would be suffered by PRIFA, hereby agree for purposes of the Contract that, instead of requiring proof of actual damages, the amount of such damages is fairly and reasonably established as the liquidated amount of **Three Thousand Dollars (\$3,000.00)** per day for each and every day of delay:

- **3.3.1.1** In achieving Substantial Completion on or prior to the Scheduled Substantial Completion Date (as adjusted in accordance with the Contract Documents); or
- **3.3.1.2** In the event of termination of the Contract pursuant to the General Conditions and PRIFA's replacement of the DB Team with another DB Team to complete the Work, in achieving Substantial Completion measured from the Scheduled Substantial Completion Date.

The damages described in Clauses .1 and .2 above are referred to herein as "Liquidated Damages".

3.3.2 Recovery of Damages. The DB Team agrees to pay to PRIFA, upon demand, the full amount of the Liquidated Damages due under Subsection 3.3.1 and authorizes PRIFA to deduct the amount of such Liquidated Damages due from retainage or any other amounts otherwise due the DB Team under the Contract. Nothing contained in this Section 3.3 shall be interpreted to limit the damages otherwise recoverable by PRIFA or any other remedies of PRIFA under the Contract Documents, at law or in equity. The amount of Liquidated Damages payable to PRIFA pursuant to this Subsection 3.3.1 shall not be subject to reduction, adjustment or offset for any reason (including, without limitation, that the circumstances giving rise to such Liquidated Damages were caused by any action or inaction of PRIFA other than any action or inaction constituting willful misconduct or gross negligence on the part of PRIFA).

3.4 Collection Remedies

All amounts due to PRIFA from the DB Team pursuant to Section 3.3 or any other provisions of the Contract ("<u>Owed Amounts</u>") shall be due and payable on the tenth (10th) day after demand therefore, and, if not paid when due, shall bear interest from such due date at the Repayment Rate on the amount outstanding. PRIFA shall be entitled, at any time, to recover any Owed Amount (plus interest) from the DB Team by reducing any payments due to the DB Team from PRIFA by all or any portion of such Owed Amount (plus interest) and crediting the amount of such reduction (excluding interest for such purpose) against the Owed Amount. If any such offset is made, PRIFA shall so notify the DB Team. PRIFA's rights under this Section 3.4 are in addition to its right to receive direct payment of Owed Amounts (plus interest) from the DB Team.



Contract Agreement

ARTICLE 4 – CONTRACT TIME

4.1 Contract Time

The Contract Time will be effective and enforceable against the parties for a period of no more than **Five Hundred Twenty (520) calendar days** from the effective date. This time period includes all administrative tasks, the project starts up, Design-Construction Period and final payment.

The Design-Construction Period for this Agreement, on the other hand, as offered by the DB Team and accepted by AFI, is for the total of **Four Hundred Thirty (430) calendar days** from the issuance of the Notice to Proceed by AFI, until the date on which the DB Team accepts Final Payment (the Contract Time), which time is included in the Contract Period. The Design-Construction Period will commence upon receipt and/or as specified on the Notice to Proceed from the AFI to DB Team. The Contract Period may be adjusted in accordance with, and subject to, the terms of the Contract Documents.

Substantial and Final Completion Dates

The DB Team shall commence the Work promptly upon receipt of the Notice to Proceed issued by PRIFA in accordance with the Contract Documents. The DB Team shall thereafter proceed to carry out the Work diligently in accordance with the schedule requirements set forth in the Contract Documents so as to ensure the substantial completion of the work. Substantial Completion is the stage in the progress of the Work when the work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or use the work or a portion thereof for its intended use.

Substantial Completion of the Work shall be achieved not later than the date that is **Four Hundred (400) calendar days** after the date of issuance of the Notice to Proceed (the "<u>Scheduled Substantial Completion Date</u>"). The Scheduled Substantial Completion Date shall be subject to adjustment by means of a Change Order in accordance with the Contract Documents.

The DB Team together with the Owner's Representative, will determine the itinerary for Partial Delivery of each building that are on the premises of each school. The Partial Delivery shall be achieved within the Substantial Completion Date.

The Final Completion of the Work shall be achieved not later than **Thirty (30)** calendar days following the date of achievement of the Substantial Completion Date.



The Administrative Closing shall be achieved within **Ninety (90) calendar days** from the date of Final Completion. Administrative Closing of the Project is part of the Contract Time and included in the same period of **Five Hundred Twenty (520) calendar days**.

Time is of the essence with respect to all of the obligations of the DB Team under the Contract. <u>The failure to complete the work within the time established by</u> <u>this "Scheduled Substantial Completion Date" will subject the DB Team to</u> <u>liquidated damages as set forth in Section 3.3 above.</u>

ARTICLE 5 – DB TEAM'S REPRESENTATIONS, WARRANTIES AND COVENANTS

5.1 Organization and Authority of DB Team

The DB Team represents and warrants to PRIFA that:

- **5.1.1** The DB Team is duly formed, validly existing and in good standing under the laws of The Government of Puerto Rico of the state of its formation.
- **5.1.2** The DB Team is duly registered before the Puerto Rico Department of State under identification no. <u>424020</u> (Contractor), <u>345932</u> (Designer) and duly authorized to do business in Puerto Rico.
- **5.1.3** The DB Team has full power, authority and capacity to (a) carry on its business, profession or craft, (b) execute, deliver and perform its obligations under the Contract and (c) perform the Work in full.
- **5.1.4** The DB Team has taken all necessary corporate or other action to authorize its execution, delivery and performance of its obligations under the Contract.
- **5.1.5** The Contract has been duly executed and delivered by the DB Team and constitutes the legal, valid and binding obligation of the DB Team enforceable in accordance with its terms, except as enforceability may be limited by bankruptcy, insolvency, reorganization, moratorium or similar laws of general application affecting the rights and remedies of creditors.
- **5.1.6** The DB Team's execution, delivery and performance of its obligations under the Contract does not and will not (a) conflict with, result in a breach of, or constitute a default under, any agreement or other instrument to which the DB Team is a party, or (b) violate any federal, state or local law of The Government of Puerto Rico, regulation, ordinance, judgment, decree or order to or by which the DB Team or any of its assets may be bound or affected (collectively, "Laws of The Government of Puerto Rico and Orders").
- **5.1.7** The DB Team and its employees and agents (a) have complied with all Laws of The Government of Puerto Rico and Orders that relate to or could affect

Balk Balk F

the DB Team's ability to perform the Work, (b) possess all necessary Permits and Approvals necessary to perform the Work, which Permits and Approvals are in full force and effect, and (c) are not aware of any legal, professional or ethical impediment of any kind to performing the Work.

5.2 Contract Documents, Site and Work

The DB Team further represents and warrants to PRIFA that:

- 5.2.1 The DB Team has examined and carefully studied the Contract Documents.
- **5.2.2** The DB Team has visited the Site and is familiar with, and is satisfied as to, the general, local and Site conditions that may affect cost, progress, performance or furnishing of the Work.
- **5.2.3** The DB Team is familiar with, and is satisfied as to, all Laws of The Government of Puerto Rico and Orders that may affect costs, progress, performance or furnishing of the Work.
- **5.2.4** The DB Team has carefully studied all reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site that have been made available by PRIFA.
- **'5.2.5** The DB Team is aware of the general nature of work to be performed by PRIFA and others at the Site that relates to the Work as indicated in the Contract Documents.
- **5.2.6** The DB Team has correlated (a) all information known to the DB Team, (b) all information and observations obtained from visits to the Site, (c) all reports and drawings identified in the Contract Documents, and (d) all additional examinations, investigations, explorations, tests, studies, and data, with the Contract Documents.
- **5.2.7** (a) The DB Team has given PRIFA written notice of all conflicts, errors, ambiguities, or discrepancies that the DB Team has discovered in the Contract Documents, (b) the written resolution thereof by PRIFA is acceptable to the DB Team, and (c) the Contract Documents are generally sufficient to indicate and convey an understanding of all terms and conditions for performance and furnishing of the Work.
- **5.2.8** The DB Team accepts the trust and confidence established between the DB Team and PRIFA by this Agreement and agrees to furnish reasonable skill and judgment and to cooperate with each other. The DB Team shall furnish procurement, construction, construction administration and management services, and shall use the DB Team's best efforts to perform the Project in an expeditious and economical manner consistent with the interests of PRIFA. PRIFA and the DB Team shall endeavor to promote harmony and

BIU D I

cooperation between PRIFA and the DB Team and other persons or entities employed by PRIFA for the Project or the DB Team for the Work.

- **5.2.9** The DB Team agrees that the Contract Price includes any and all home office overhead expenses that the DB Team may incur during the Contract duration, whatever the cause of that delay may be. The DB Team waives any claim for the office overhead expenses, arising out of or relating to this Contract.
- **5.2.10** The DB Team agrees that the Contract Price includes any and all job site and office overhead that the DB Team may incur, whatever the cause may be. The DB Team waives any type of claim of such job site and office overhead incurred during that period, arising out of, or relating to this Contract.
- **5.2.11** The DB Team will keep available all information relevant to the government contract and at no cost to the treasury.
- **5.2.12** The projects developed by PRIFA are works that are paid for with public funds. In order to be accountable for the work carried out on its projects, PRIFA requires that a representative of the DB Team be available, to assist and accompany PRIFA officials, to public and/or private forums that promote a public purpose, including but not limited to official citations from the legislative branch, the judicial branch, the media, among others; to report on matters related to the Scope of Services contracted for the Project.

Tax Matters

For L

Certifications. In compliance with the provisions of Act 73-2019, the DB Team has provided PRIFA the Certification of Eligibility of the Unique Registry of Professional Services Providers (known in Spanish as "*Certificado de Elegibilidad del Registro Único de Proveedores de Servicios Profesionales*)", hereinafter referred to as the "<u>RUP Certification</u>", if applicable; and the Unique Registry for Bidders (known in Spanish as "*Certificado de Elegibilidad del Registro Único de Servicios*").

For the purposes of this Agreement, 'tax debt' shall mean any debt that the DB Team, may have with the Government of Puerto Rico for income taxes, real or personal property taxes, including any special taxes levied, license rights, tax withholdings for payment of salaries and professional services, taxes for payment of interest, dividends and income to individuals, corporations and non-resident accounting firms, unemployment insurance premiums, workers' compensation payments, Social Security for chauffeurs, and the Administration for the Maintenance of Minors.

(12) Further, the Contractor hereby certifies, guarantees, acknowledges and agrees to the following:

- A. Department of Treasury of Puerto Rico: Pursuant to Executive Order Number OE-1991-24 of June 18, 1991 ("EO-1991-24") and Act No. 237-2004, as amended, the DB Team hereby certifies and guarantees that it has filed all the necessary and required income tax returns to the Government of Puerto Rico for the last five (5) years. The DB Team, further certifies that it has complied and is current with the payment of any and all income taxes that are or were due to the Government of Puerto Rico. During the term of this Agreement, the DB Team agrees to pay and/or to remain current with any repayment plan agreed to by the DB Team with the Government of Puerto Rico. For these purposes, absent a valid RUP Certification, the DB Team shall present to the Authority a debt certification issued by the Department of Treasury or a Single Debt Certification (as defined above), together with the last invoice to be submitted for Services rendered. The DB Team agrees to cancel any debt that cannot be clarified or cleared with the Department of the Treasury of Puerto Rico, by withholding from the payments entitled to receive under this Agreement. Executive Order 1991OE24.
- B. <u>Department of Labor and Human Resources of Puerto Rico</u>: Pursuant to Executive Order Number 1992-52 of August 28, 1992, which amends EO-1991-24, the DB Team hereby certifies and warrants that it has made and will continue to make all payments required for unemployment benefits, workmen's compensation and social security for chauffeurs, whichever is applicable, or that in lieu thereof, has subscribed a payment plan in connection with any such unpaid items and is in full compliance with the terms thereof. *Executive Order 1992OE52*.
- C. <u>Department of State of Puerto Rico</u>: If applicable, the DB Team certifies that it is duly authorized to do business in Puerto Rico and has complied with its annual filing obligations before the Department of State of Puerto Rico.
- D. <u>Municipal Revenue Collection Center (known in Spanish as "Centro</u> <u>de Recaudación de Ingresos Municipales", and hereinafter referred</u> <u>to by its acronym "CRIM"</u>): The DB Team hereby certifies and guarantees that it does not have any current debt with regards to real and personal property taxes that may be registered with CRIM. The DB Team further certifies that it is current with the payment of any and all property taxes that are or were due to the Government of Puerto Rico or any instrumentality thereof. The DB Team agrees to pay and/or to remain current with any payment plan agreed to by the DB Team with the Government of Puerto Rico with regards to its property taxes. 3 L.P.R.A. § 8611 et seq.; 21 L.P.R.A. § 5001 et seq.
- E. <u>Child Support Administration (known in Spanish as "Administración</u> <u>para el Sustento de Menores", and hereinafter referred to by its</u> <u>acronym, "ASUME")</u>: The DB Team certifies that neither the DB Team nor any of its owners, affiliates or subsidiaries, if applicable, have any debt

pan 195 1

or legal procedures to collect child support payments registered with ASUME. 3 L.P.R.A. § 8611 et seq.

- F. <u>Social Security and Income Tax Withholdings</u>: In compliance with EO-1991-24 and C.F.R. Part 404 et. seq., the DB Team will be responsible for paying the Federal Social Security and Income Tax Contributions for any amount owed as a result of the income from this Agreement. *Executive Order 1991OE24*; C.F.R. Part 404 et. seq.
- G. Income Tax Withholdings Law: The DB Team is an independent contractor and, as such, agrees and acknowledges that it has sole responsibility and liability for any and all taxes, contributions, penalties, interest, licenses, fees or other sums payable in connection with the fees [and expenses] paid pursuant to this Agreement, including, without limitation, any Commonwealth, federal and local income taxes. tax withholdings, excise taxes, sales and use taxes, payroll taxes, municipal taxes and any other taxes applicable under the tax laws of Puerto Rico, the United States, or any other jurisdiction, as such laws may be amended from time to time. Notwithstanding the foregoing, unless the DB Team provides to the Authority a waiver or exemption certificate issued by the Department of the Treasury, the Parties hereby agree that the Authority shall withhold and submit to the Department of the Treasury all amounts required to be withheld pursuant to the Puerto Rico Internal Revenue Code of 2011, as amended from time to time, and any other taxes required to be withheld under any applicable laws, as amended from time to time. In addition to the foregoing, if applicable, the Authority shall also withhold the special contribution of one point five percent (1.5%) of the gross amounts paid under this Agreement as required by Act No. 48-2013, as amended, and shall forward such withholdings to the Department of Treasury. The Authority will also notify the Department of Treasury of all payments and reimbursements made to the DB Team. 2011 L.P.R. 232; 3 L.P.R.A. §8611.
- H. Enabling Act of the Office of Government Ethics of Puerto Rico, Act No. 1-2012, as amended: The DB Team certifies that it is in compliance with Act No. 1 of January 3, 2012, as amended, known as the Enabling Act of the Office of Government Ethics of Puerto Rico ("Act No. 1-2012").
- <u>Code of Ethics for Contractors, Suppliers, and Applicants for</u> <u>Economic Incentives of the Government of Puerto Rico, Chapter III of</u> <u>Act No. 2-2018</u>: The DB Team hereby recognizes and agrees that it shall be bound by and comply with all applicable provisions of the Code of Ethics for Contractors, Suppliers, and Applicants for Economic Incentives of the Government of Puerto Rico (known in Spanish as "Código de Ética para Contratistas, Suplidores y Solicitantes de Incentivos Económicos del Gobierno de Puerto Rico"), Chapter III of Act No. 2-2018. The DB Team acknowledges that it has received a copy of Act 2-2018 and agrees to abide and comply with its dispositions.

Þ

J. <u>Certification of other government agreements</u>: The DB Team hereby certifies that, at the time of execution of this Agreement, it does not have any other agreement with any agency, public corporation, municipality, or instrumentality of the Government of Puerto Rico, except for:

Contractor:

Contract No.	Entity
2024-000342	Municipality of Cataño
2025-000456	Municipality of Trijillo Alto
2025-000173	Municipality of Dorado
2024-000062	Municipality of Ceiba
2024-000584	Municipality of Dorado
2023-000169	Municipality of Dorado
W50S9324C002	Air National Guard
2024-000287	Municipality of Canóvanas
2025-000032	Municipality of Salinas
2025-000341	Municipality of Ponce

Designer:

Contract No.	Entity
2022-001113	Puerto Rico Medical Services
	Administration (ASEM)
2022-001114	Puerto Rico Medical Services
	Administration (ASEM)"
CSP-2024-000021	Institute of Puerto Rican Culture
2024-SA0130	Puerto Rico Departament of
	Education
2025-SA0026	Puerto Rico Departament of
	Education
2025-SA0029	Puerto Rico Departament of
	Education

The DB Team certifies that said agreements are not in conflict with the Services provided hereunder.

The DB team certify that the above are all entities of the Government of Puerto Rico with which it has a contractual relationship. In addition, the DB team acknowledges and agrees that failure to mention any government entity with which they have an existing contractual relationship may result in termination of this contract as required by PRIFA. If the DB team should obtain additional contracts from other instrumentalities and/or government agencies of Puerto Rico, had to inform PRIFA of such contracts immediately. The DB team certify that any contract will not affect the services provided to the PRIFA.

5.3.1 Representations

- **5.3.2** and Warranties. Each of the DB Team and, in the event the DB Team is a partnership, each partner of the DB Team who is a resident of Puerto Rico represents and warrants to PRIFA, as of the date of execution of the Contract by the DB Team, that each of them:
 - **5.3.2.1** Has filed all required income tax returns with the Puerto Rico Treasury Department during the five (5) years prior to the date of the Contract and does not owe any income taxes to Puerto Rico, or has entered into a payment plan to pay any delinquent income taxes (a copy of which payment plan the DB Team has submitted to PRIFA) and is in full compliance with the terms of such payment plan; and
 - **5.3.2.2** Has paid any required property taxes, unemployment security, temporary disability and chauffeurs social security taxes, and any other "tax debt" as defined in the aforementioned Puerto Rico Treasury Department Tax Circular Letter No. 1300-21-06, or has entered into a payment plan to pay any such tax debt which may be delinquent (a copy of which payment plan the DB Team has submitted to PRIFA) and is in full compliance with the terms of such payment plan.
 - Each submittal of an Application for Payment shall constitute a reaffirmation of the representations and warranties contained in this Subsection 5.3.2 as of the date of such Application for Payment.

5.3.3 Covenants.

for 8

On an annual basis on each anniversary of the date of execution of the Contract by the DB Team, the DB Team and, in the event the DB Team is a partnership, each partner of the DB Team who is a resident of Puerto Rico shall (a) submit to PRIFA the certifications or other documentation required under Subsection 5.3.1, and (b) expressly confirm the representations and warranties contained in Subsection 5.3.2.

The DB Team and each such partner hereby covenants that, during the term of the Contract, none of them shall (a) become delinquent in the payment of any taxes to Puerto Rico, its subdivisions or municipalities, or (b) fail to fully comply with the terms of any payment plan with respect to delinquent taxes to which it may be subject.

In the event the DB Team or any such partner has filed all income tax returns but owes any taxes, the DB Team agrees to pay such taxes from the amounts to be paid under the Contract, by PRIFA withholding the corresponding amount. The DB Team shall require each Subcontractor to agree to in writing, and make and perform the representations, warranties and covenants contained in this Section 5.3. The DB Team shall furnish promptly such written agreements to PRIFA. Each of the DB Team and, in the event the DB Team is a partnership, each partner of the DB Team who is a resident of Puerto Rico expressly agrees and acknowledges that (a) the representations, warranties and covenants contained in this Section 5.3 are essential conditions to the Contract, and (b) if PRIFA determines that any of such representations, warranties or covenants are not true and correct or performed, in whole or in part, PRIFA shall have sufficient cause to rescind, cancel or terminate the Contract. If such rescission, cancellation or termination occurs, the DB Team shall reimburse to PRIFA all payments received by the DB Team under the Contract.

5.3.4 In case of professional services to be provided through this Contract a special contribution equivalent to 1.5% of the total amount of such portion of the Contract, will be imposed to the DB team, which will be allocated to the General Fund; in accordance with Law 48-2013, as amended, and the Puerto Rico Secretary of the Treasury Circular Letters 1300-03-14, 1300-06-14, 1300-09-14, 1300-07-21.

5.4 Warranty on Materials, Parts and Equipment

for N

Without limitation to the warranties set forth in the General Conditions, the DB Team warrants that all materials, parts and equipment used and services performed under the Contract (a) comply in all respects with the terms and conditions of the Contract, (b) are free from any and all latent and patent defects in design, materials and workmanship, and (c) are suitable and adequate for the purposes for which they were designed and for such other purposes, if any, as are specified in the Contract.

The warranty period will begin on the date on which PRIFA accepts the service and/or installation of the material, part or equipment and will continue for a period of one (1) year following Substantial Completion (the "Minimum Warranty Period") or for such longer period as the manufacturer or supplier of such material, part or equipment may provide in a separate warranty or as otherwise provided by law of The Government of Puerto Rico. The DB Team shall, upon written notice from PRIFA during the applicable warranty period, fully remedy, free of any cost or expense to PRIFA, such defects or deficiencies as may exist with respect to any material, part, or equipment used or any service performed under the Contract, whether or not such remedy is commenced or completed prior to the expiration of the applicable warranty period; provided that, in the case of a material, part or equipment, such material, part or equipment has been properly stored, maintained, and operated by PRIFA within the specified requirements for such material, part or equipment. Without limiting the generality of the foregoing, the DB Team shall, at its own cost and expense, repair or replace, transport-in from the DB Team's facilities to the Site, and transport-out from the Site to the DB Team's facilities any and all materials, parts, and/or equipment necessary to fully remedy all defects or deficiencies subject to the foregoing warranties or otherwise to enable the DB Team to fully comply with its obligations under this Section 5.4. The Performance Bond shall serve as a guarantee for the DB Team's obligations under this Section 5.4 during the Minimum Warranty Period, and shall cover any failure, in whole or in part, by the DB Team to properly perform any of such obligations. With respect to any material, part or equipment procured by the DB Team from the manufacturer thereof or supplier, the DB Team shall obtain from such manufacturer or supplier, and, upon acceptance of such material, part or equipment by PRIFA, legally tender or assign to PRIFA in full, a written warranty from such manufacturer or supplier with respect to such material, part or equipment at least as broad in scope and duration as the warranties contained in this Section 5.4.

5.5 Conflicts of Interest

₽º H. The DB Team represents and warrants that it does not receive any payment or benefit of any kind for services rendered regularly in connection with an appointment of the DB Team to a governmental agency, body, public corporation or municipality of Puerto Rico.

The DB Team also represents and warrants that it may have entered into contracts with other governmental agencies or bodies, but that such circumstances do not constitute a conflict of interest for the DB Team.

The DB Team agrees and acknowledges it has a duty of complete loyalty to PRIFA in rendering services under the Contract, which duty includes not having any interests adverse to PRIFA. Adverse interests include representation of clients with interests in opposition to those of PRIFA. Also, the DB Team shall have the continuous obligation to disclose to PRIFA all information and circumstances regarding the DB Team's relations with clients and third parties and any interest which could influence PRIFA in exercising its rights or in enforcing the DB Team's obligations under the Contract during or after the term of the Contract.

The DB Team agrees and acknowledges that it has a conflict of interest when (i) it is required to argue on behalf of a client a position which it has a duty to oppose in order to comply with its obligations to a prior, present or potential client other than PRIFA, or (ii) its conduct is described as such in the canons of ethics applicable to the DB Team and its personnel, or in the laws of The Government of Puerto Rico, regulations or ordinances of Puerto Rico.

If, in the event the DB Team is a partnership, corporation or other entity, any of the partners, directors or employees of the DB Team engages in any conduct described in this Section 5.5, such conduct shall constitute a violation of the restrictions set forth herein.

The DB Team shall avoid even the appearance of a conflict of interest. The DB Team acknowledges that the Executive Director of PRIFA shall have the power to intervene in the acts of the DB Team or any Subcontractor or Sub-

subcontractor and/or their respective agents and employees for the purpose of enforcing the restrictions set forth in this Section 5.5. In the event that the Executive Director of PRIFA should discover the existence of adverse interests with respect to the DB Team, the Executive Director shall inform the DB Team, in writing, of PRIFA's intention to terminate the Contract within a period of thirty (30) days. During such period, the DB Team may request a meeting with the Executive Director to present its arguments regarding the alleged conflict of interest, which meeting shall be granted by PRIFA in every case. In the event that the DB Team does not request such a meeting during the specified thirty (30) day period or the controversy is not satisfactorily resolved during the meeting, the Contract shall be terminated by PRIFA.

The DB Team hereby warrants that no officer, employee, advisor or DB Team of PRIFA nor any member of the family unit, has any direct or indirect economic interest in this Contract and that no officer, employee, advisor or DB Team of the executive branch of The Government of Puerto Rico nor any member of their family unit has any interest and/or participation in the economic benefits or earnings related to this Contract.

5.6 Child Support



In the event the DB Team is an individual resident of Puerto Rico or a sole proprietor or partnership, the DB Team or each partner of the DB Team who is a resident of Puerto Rico, represents and warrants that the DB Team or such partner, as the case may be, has made all required child support payments and does not owe any child support, or has entered into a payment plan to pay any delinquent child support and is in full compliance with the terms of such payment plan. If the DB Team is a Corporation that has received one or more court orders requiring the Corporation to retain child support from its employee's salary, it certifies that it has made such retentions.

In the same way, it certifies and guarantees that at the moment it is not in breach with the law 168-2000, "Law for the Strengthening of the Family Support and Sustenance of Elderly People". In the case of legal persons, it certifies that it complies with the orders issued to its name as employer to withhold from the salaries of its employees the payments of alimony, by means of a certification of state of fulfillment.

If the DB team are subject to a judicial or administrative order under the provisions of Law 168-2000, they must certify that they are in compliance with the payment of the financial contribution or with the obligation imposed.

- **5.7** If required, the necessary waiver from any government entity that has been obtained by the DB Team will be part of the contract file.
- **5.8** At the time of execution of this Contract, the DB team certify that they are not a public corporation with shares exchanged on a duly regulated stock exchange. The DB team have completed the Certification of Legal Persons, prior to the Contract execution, and has been provided to the PRIFA.
- **5.9** The DB Team was selected as a provider of professional services in accordance with Executive Order 2021-029 and Circular Letter 013-2021, issued by the OGP. Likewise, both parties certify that they are aware of the provisions of said Executive Order and Circular Letter and that any contracting covered by this one that has not followed the processes and requirements established therein will be terminated.

ARTICLE 6 – CONDITIONS PRECEDENT

6.1 Conditions Precedent

PRIFA shall have no obligation to issue the Notice to Proceed until each of the conditions precedent set forth in Subsections 6.1.1 through 6.1.5 below has been satisfied or waived by PRIFA in its sole discretion.

- **6.1.1 Insurance.** All insurance required to be carried by or on behalf of the DB Team pursuant to the Contract shall be in full force and effect, in accordance with the provisions of the General Conditions, and originals or certified copies of all required insurance certificates or policies shall have been provided to PRIFA in accordance with the provisions set forth in the General Conditions.
- **6.1.2 Bonds.** PRIFA shall have received duly authorized and executed originals of the Performance Bond and the Payment Bond, in the forms attached hereto, respectively, as **Attachment D** to this Agreement, in accordance with the General Conditions.
- **6.1.3 Representations and Warranties.** The representations and warranties of the DB Team set forth in the Contract Documents, including, without limitation, those set forth in Article 5 of this Agreement, shall be true and correct in all material respects as of the date hereof and as of the date of issuance of the Notice to Proceed.
- **6.1.4 No Litigation.** There shall be no pending or threatened action, suit, investigation or proceeding (or basis therefore), at law of The Government of Puerto Rico or in equity, before or by any arbitration panel, court or governmental agency or body that (a) challenges, or might challenge, directly or indirectly, the selection of the DB Team to perform the Contract or the

Joh North North

authorization, execution, delivery, validity or enforceability of the Contract, or (b) materially adversely affects the DB Team's ability to perform the Contract.

6.1.5 Tax Certifications. The DB Team shall have complied with the requirements of Subsection 5.3.1.

ARTICLE 7 – MISCELLANEOUS

7.1 Entire Agreement

The Contract constitutes the entire integrated agreement of and between the parties, and any and all prior or contemporaneous promises, representations, agreements or understandings, whether oral or written, between or of the parties are expressly merged into the Contract and superseded hereby.

7.2 Severability

If any provision of the Contract is declared or determined to be invalid or unenforceable by a court of competent jurisdiction, such declaration or determination shall not affect or impair the validity or enforceability of the remaining provisions of the Contract, and the parties hereto agree to comply with such remaining provisions.

7.3 Notices

All notices and communications to PRIFA, PRIFA's Representative and the DB Team, including, without limitation, all orders, consents and approvals, shall be in writing, shall be deemed to have been received if delivered personally, or sent by registered or certified United States mail, return receipt requested, or by private express courier or mail service providing evidence of receipt, to the addresses set forth below or to such other address as the addressee shall have indicated by prior written notice to the person or entity giving notice:

If to PRIFA:

Puerto Rico Infrastructure Financing Authority PO Box 41207 Minillas Station San Juan, PR 00940 Tel. (787) 763-5757 ext.15915 Attn: Eduardo Rivera Cruz Executive Director

If to the DB Team: Contractor: DFM Contractor (Dynamic Ferrious+Concrete Manufacture), L.L.C. 68 Calle Guayama San Juan, P.R. 00917 (787) 998-0404 diomedes@dfmcontractors.com Att. Diomedes F. María, President

por por

Designer:

Spec Engineering Services, PSC B5 Calle Tabonuco Ste PMB 278 Guaynabo, P.R. 00968 Tel. (787) 722-2338/ (787) 630-8010 admin@specengpr.com attn. Roberto J. Marte de La Mota, P.E., President

7.4 No Waiver or Novation

The failure of PRIFA or PRIFA's Representative to enforce any provision of the Contract or any right or remedy available at law of The Government of Puerto Rico or in equity shall not be construed to be a waiver of any such provision, right or remedy, or to affect in any way the validity of the Contract or any part thereof. To be effective, a waiver of any right of PRIFA under the Contract must be express, in writing and specifically addressed to the DB Team.

PRIFA and the DB Team expressly agree that no amendment of the Contract or Change Order shall be understood or construed as a contractual novation of the Contract, unless both parties agree to the contrary specifically in writing. The foregoing provision shall be equally applicable in such other cases where PRIFA grants the DB Team an extension of time for compliance with any of the DB Team's obligations under the Contract, or where PRIFA fails to make any claim or demand with respect to any of its rights or remedies under the Contract.

Under no circumstances, except where PRIFA specifically agrees in writing, shall PRIFA's rights under the Contract be understood or construed to have been waived by any amendment, Change Order or extension of time or by reason of any failure to make any claim or demand with respect to any of PRIFA's rights or remedies under the Contract, even where PRIFA has agreed, as provided under the previous paragraph, that any of these circumstances shall constitute a contractual novation, and PRIFAI hereby expressly reserves its right to enforce or make any claim with respect to its rights and obligations under the Contract as if such amendment, Change Order, extension of time, failure to make a claim or demand, or novation, if any, had not occurred or been made.

7.5 Disclaimer of Liability and Indemnification

7.5.1 Disclaimer of Liability. In no event shall PRIFA be liable to the DB Team except for obligations expressly assumed by PRIFA under the Contract Documents, nor shall PRIFA ever be liable to the DB Team for indirect, special, incidental or consequential damages resulting from, arising out of, or in connection with, the Work, the Contract, any rescission, cancellation, termination or suspension of the Contract or any acceleration of the expiration

pur -

of the Contract. No representative of PRIFA nor any officer, agent, DB Team or employee of PRIFA (including, without limitation, PRIFA's Representative) shall be charged personally by the DB Team with any liability or be held liable to it under any term or provision of the Contract, for any breach of the Contract by PRIFA, or otherwise in connection with performance under the Contract.

7.5.2 Indemnification. Without limiting the scope of the indemnification clauses set forth in the General Conditions, the DB Team agrees to save and hold harmless, and to indemnify PRIFA against any and all expenses and costs of any nature (including, without limitation, attorneys' fees and costs) incurred by PRIFA in connection with any claim made by any person for personal injuries, including, without limitation, death, or for property damage caused by the DB Team, by act or omission, in the performance or non-performance of its obligations under the Contract.

7.6 Governing Law and Jurisdiction

- 7.6.1 Governing Law. The Contract shall be governed by, and construed in accordance with, the laws of Puerto Rico. The parties hereto expressly agree that their respective liability for damages under the Contract shall be governed by the Puerto Rico Civil Code and related case law of The Government of Puerto Rico as determined by the Supreme Court of The Government of Puerto Rico.
- 7.6.2 Jurisdiction and Venue. Each of the parties hereto expressly and irrevocably (a) agrees that the state courts of The Government of Puerto Rico shall have sole and exclusive jurisdiction to settle any dispute or controversy between the parties regarding the terms and conditions of the Contract or any other matter involving the Project, (b) submits itself and its assets to the jurisdiction of such courts, (c) waives any objection or defense that such courts lack in personal jurisdiction over such party, (d) waives any objection or defense which it may have at any time to venue residing in such courts with respect to any proceedings involving the Contract or the Project, (e) waives any claim that any proceedings involving the Contract or the Project have been brought in an inconvenient forum, and (f) agrees not to seek redress or institute any action with respect to the Contract or the Project in any court or other forum, whether federal or state, other than in the state courts of The Government of Puerto Rico Puerto Rico. Nothing contained in this Section shall preclude the parties from enforcing in any jurisdiction any judgment, award or order obtained in the state courts of The Government of Puerto Rico.
- **7.6.3 Change of Law.** Any change in law of The Government of Puerto Rico during the term of the Contract, including, without limitation, any changes in applicable tax law, that causes an increase in the Construction Manager's costs in supplying any products or services to PRIFA shall be the

for A Construction Manager's responsibility, and PRIFA shall not be obligated to make any additional payments or to pay any additional sums beyond the Contract Price.

- 7.6.4 No Litigation. There shall be no pending or threatened action, suit. investigation or proceeding (or basis therefore), at law or in equity, before or by any arbitration panel, court or governmental agency or body that (a) challenges, or might challenge, directly or indirectly, the selection of the Construction Manager to perform the Contract or the authorization, execution, delivery, validity or enforceability of the Contract, or (b) materially adversely affects the Construction Manager's ability to perform the Contract.
- **7.6.5** Mediation. In the event a dispute arises between the parties to this contract. the parties agree to participate in mediation. The parties agree to share equally the costs of the mediation. The mediation shall be administered by a mediator designated by both parties. Mediation involves each side of a dispute sitting down with an impartial person, the mediator, to attempt to reach a voluntary settlement. Mediation involves no formal court procedures or rules of evidence, and the mediator does not have the power to render a binding decision or force an agreement on the parties. In the event that the Construction Manager disagrees with any such administrative determination, 40l 7.7 then the Construction Manager may pursue any available legal remedies arising out of such mediation in the General Court of Justice of The Government of Puerto Rico. Court of First Instance of San Juan.

Force Maieure

Each of the parties hereto shall be excused from performing any obligation hereunder and shall not be liable in damages or otherwise for such nonperformance, if and only to the extent that such party shall be unable to perform, or is prevented from performing such obligation by an event constituting a Force Majeure. Force Majeure may include, but shall not be limited to, the following: acts of God, third party industrial disturbances, acts of the public enemy, war, blockages, boycotts, riots, insurrections, epidemics, earthquakes, hurricanes, major floods, civil disturbances, lockouts, fires, explosions, and interruptions of services due to any act or failure to act of any governmental instrumentality; provided that (a) each of these events, or any other claimed as a Force Majeure, and/or its effects, are beyond the reasonable control and are not caused by the fault or negligence of the party claiming the occurrence of a Force Majeure or of its employees, agents, affiliated companies or sub, (b) in the case of natural phenomena, are beyond normal intensity at the Site and are not ordinarily occurring, and (c) such party, within ten (10) days after the occurrence of the alleged Force Majeure, gives the other party written notice describing the particulars of the occurrence and its estimated duration. The burden of proof as to whether a Force Majeure has occurred shall be on the party claiming the occurrence of the Force Majeure.

7.8 independent DB Team

The DB Team shall be considered and shall act solely as an independent DB Team for all material purposes under the Contract, and nothing in the Contract shall be construed to create an agency, partnership, or joint-venture relationship between the DB Team and PRIFA or between any members of the DB Team and PRIFA. All Subcontractor, Sub-subcontractor or other persons engaged or contracted by the DB Team for the performance of the DB Team's obligations under the Contract and all personnel of any of the foregoing involved in any aspect of performing the Work shall be considered employees or agents of the DB Team or such Subcontractor or Sub-subcontractor (and not as employees or agents of PRIFA), and shall be subject to the direction, supervision and control of the DB Team or such Subcontractor or Sub-subcontractor (and not PRIFA), subject to the terms and conditions of the Contract Documents.

7.9 No Contractual Relationship

The Contract Documents shall not be construed to create a contractual relationship of any kind (a) between PRIFA's Representative and the DB Team, (b) between PRIFA and any Subcontractor, or (c) between any persons or entities other than PRIFA and the DB Team, except as specifically set forth in the Contract. The DB Team understands and agrees that the Engineer's obligations are to PRIFA and, by performing those obligations properly, the Engineer may increase the burdens and expenses of the DB Team, its Subcontractor and Subsubcontractors, or sureties of any of them.

7.10 Assignment

The DB Team shall not assign, delegate or subcontract any of its rights and obligations under the Contract, except with the prior written authorization of PRIFA. The request for such authorization shall contain a list of all subcontractors or assignees. The Awarded DB Team shall include all of the provisions of this agreement in every subcontract so that such provisions will be binding upon each of its subcontractors or assignees.

The DB Team shall be responsible to Owner for the acts and omissions of all of its Subcontractors, and Sub-Subcontractors, their respective agents and employees and/ or all other persons performing any of the Work or supplying any materials or equipment for the Work under their respective contracts with the DB Team. The DB Team shall rebuild, repair, restore and make good any damages to any portion of the Work that any subcontractor or assignee may cause, at its own cost and expense, before the final completion and acceptance of the Project.

7.11 Amendments

To the extent permitted by law of The Government of Puerto Rico, the terms of the Contract shall not be altered, modified, supplemented, or amended in any manner whatsoever, except by a written instrument duly executed by PRIFA and the DB Team.

7.12 Captions

The captions or headings in any Contract Document are for convenience only and in no way define, limit, or describe the scope or intent of any provisions or sections of such Contract Document.

7.13 Execution in Counterparts

This Agreement may be executed in multiple counterparts, each of which shall be an original and all of which shall constitute one and the same instrument and any of the parties hereto may execute this Agreement by signing any such counterpart.

7.14 Dissemination of Information

Certain of PRIFA's confidential or proprietary information may come into the DB Team's possession in the course of performing its obligations under the Contract. The DB Team shall hold such information and all other information that it develops or obtains from PRIFA or otherwise regarding the Project in confidence, shall not use such information other than for performance of its obligations under the Contract, and shall require its employees, agents, Subcontractor and Subsubcontractors to be bound to PRIFA by the same obligation of confidentiality. PRIFA reserves the right to release all information to the public and to the media relating to the Contract and the Work. The DB Team agrees, and to cause its employees, agents, Subcontractors and Sub-subcontractors, to refer all inquiries about the Contract or the Work to PRIFA.

for To ris To

Cancellation and Termination

Notwithstanding the provisions mentioned in the General Conditions, in the event of a substantial or material breach of the Contract by the DB Team or an emergency or other circumstance requiring PRIFA to take immediate action to protect its interests, limit its liability or prevent injury to any person or damage to any property, PRIFA shall have the right to rescind, cancel, terminate or suspend the Contract immediately and without prior notice to the DB Team. The exercise by PRIFA of its right to rescind, cancel, terminate or suspend the Contract shall not be construed as a waiver by PRIFA of any right or remedy it may have under the Contract or at law of The Government of Puerto Rico for any delay or breach by the DB Team in the performance of its obligations under the Contract.

7.15.1 Shall constitute sufficient cause to terminate this Agreement immediately, without notice, in the following cases: 1) negligence or neglect of its duties; or 2) misconduct on or off PRIFA facilities by the DB team; 3) If the DB team are convicted of the offenses referred to in Article 3.4 of the Code of Ethics, Law 2-2018, as amended; or (4) If PRIFA becomes aware that the DB team including natural or legal personnel or any president, vice president, director, executive director, or member of a board of officers or board of directors, or persons performing equivalent functions for the legal entity, are ineligible to obtain a contract for professional services in the public service under the provisions of Section 6.8 of Law 8-2017, as amended, known as: "Law for the Administration and Transformation of Human Resources in the Government of Puerto Rico".

7.16 Executive Order 2021-008 requires the use of technology, to prevent the government from requesting information from the citizens in its possession. This will result in a reduction in the cost of having to request this information from a number of agencies to complete different procedures. In accordance with the Executive Order, the Office of Innovation and Technology Services (PRITS) created the IDEAL Platform, a system of interoperability among the agencies of the Government of Puerto Rico, for government procedures or procedures including contracting, permits, requests for assistance and services. Through the IDEAL Platform, and with the consent of the DB team, PRIFA can access the required certifications available in this system. However, it shall be the responsibility of the DB team to provide certifications that are not available on said Platform. If the DB team do not issue their consent to the PRIFA, for the use of the IDEAL Platform, the required certifications will be provided under its responsibility.

7.17 It shall be the responsibility of the DB team to certify by affidavit before a Notary Public whether the natural or legal person or any president, vice president, director, executive director, or member of a board of officers or board of directors, or persons performing equivalent functions for the legal person, has been convicted or pleaded guilty to the offenses listed in Section 6.8 of Law 8-2017, as amended, known as: "Law for the Administration and Transformation of Human Resources in the Government of Puerto Rico".

ARTICLE 8 – CRIMINAL CHARGES CLAUSE

8.1 Certification

The DB Team certifies and guarantees that at the execution of this Contract, the DB Team, its partners, associates, officers, employees and agents have not been convicted, or that it has no knowledge of being the subject of any investigation in either a civil or a criminal procedure in a state or federal court for criminal charges related to the public treasury, the public trust, a public function, or a fault that involves public funds or property. It is expressly acknowledged that this certification is an essential condition of this Contract. If the certification is not correct in its entirety or in any of its parts, it shall constitute sufficient cause for PRIFA to terminate this Contract immediately, without prior notice, and the DB Team will have to reimburse PRIFA any amount of money received under this Contract.

If the status of the DB Team with regards to the charges previously mentioned changes at any time during the term of the Contract, it shall notify PRIFA

immediately. Failure to comply with this responsibility constitutes a violation of this clause and shall result in the remedies mentioned in the previous paragraph.

9.1 Incorporation

ARTICLE 9– ATTACHMENTS

This Agreement includes the **Attachments** listed below, each of which is incorporated hereby and made a part of the Contract. Those **Attachments** not referred to in this Agreement are referred to in the General Conditions.

Attachment A	Scope of Work
Attachment B	DB Team's Proposal Form submitted on December 19, 2024.
Attachment C	Solids Waste Disposal
Attachment D	Bonds
Attachment E	Cancelled Stamps
Attachment F	Other Documents
Attachment G	Bid Documents
Attachment H	Allowances
Attachment I	Certification Regarding Lobbying
Attachment J	OSHA's COVID-19 Guidance for the Construction Workforce
Attachment K	Federal Regulations and Provisions
Attachment L	HUD Regulations
Attachment M	DB Team Certification Requirement
Attachmont N	Executive Order 2022 014

Attachment N Executive Order 2022-014

ARTICLE 10 – ACT 73-2019

10.1 Eligibility Certificate

In accordance with the dispositions of Act 73-2019, the DB Team is submitting the Eligibility Certificate from the "Administración de Servicios Generales" No **202440485** ("RUL") and No. **202450764** ("RUP").

ARTICLE 11 – BUDGET CLAUSE

11.1 Budget Clause

The professional and construction services rendered under this agreement are budgeted and will be paid from **Account No.:** <u>030-306175</u>.

ARTICLE 12

12.1 None of the services rendered under this Contract can be claimed until the same is presented to the Office of the Comptroller of Puerto Rico for registration, as required with Law Number 18 of the 30th of October of 1975, as amended.

ARTICLE 13

13.1 DB Team certifies that at the time of signing of this Agreement, he has no claim of any nature against PRIFA or against any other Government Agency of the Government of Puerto Rico, nor is he an interested party in any judicial or administrative procedure against PRIFA or any other Government Agency of the Government of Puerto Rico.

ARTICLE 14 -- "CÓDIGO ANTICORRUPCIÓN PARA EL NUEVO PUERTO RICO"

- **14.1** The DB Team shall duly comply with the dispositions of Law 2-2018 "Código Anticorrupción para el Nuevo Puerto Rico". Therefore, it requires and provides that any natural or legal person wishing to do business with The Government of Puerto Rico certifies under oath that has not been convicted or pleaded guilty to the offenses according to Article 3.3 of that Act.
- 14.2 The DB team certify and warrants that, at the time of entering into this Agreement, it have not been convicted, They have pleaded guilty or is aware that he is the subject of investigation in a civil or criminal proceeding in the federal or state forum for events relating to any of the crimes listed in Law 2 of 4 January 2018. The corresponding affidavit is included in Attachment G. The DB team acknowledges their duty to continuously report, during the term of the contract, any fact that relates to the commission of an offense, mentioned in Art. 3 .4 of the Code of Ethics of Law 2-2018, as amended.

PRIFA notes and the DB team acknowledges that both parties are subject to the provisions of the Government Ethics Act and the Anti-Corruption Code for the New Puerto Rico of Law 2-2018, as amended, and of the federal government, documents that they undertake to know and to comply fully and of which PRIFA makes available to the DB team.

ARTICLE 15

15.1 In accordance with the Memorandum OSG No. 2023-001 and the Puerto Rico Budget and Management Office ("OGP" by its Spanish acronym) Circular Letter No. 008-2023 dated on December 27, 2023; the Government Secretariat Office shall have the power to terminate this agreement at any time.

ARTICLE 16. COVID-19

16.1 The DB Team must implement strict safety measures to mitigate contagion and protect the health of the workers against COVID-19 based on the guidelines and instructions from the Centers for Disease Control and Prevention ("CDC"), the Federal Department of Health, the Federal Department of Labor, the Puerto Rico Department of Labor and the Occupational Safety and Health Administration ("OSHA"). In addition, prior to start working the DB Team must provide the training, guidance, and ongoing supervision to workers related to new occupational safety measures.

Attached hereto, OSHA's COVID-19 Guidance for the Construction Workforce, as Attachment J.

ARTICLE 17

17.1 The DB Team acknowledges and accepts to comply with each of the regulations listed in **Attachment K and Attachment L,** in a case by case basis, as it may be required by the funding entity. The DB Team recognizes that compliance with these regulations is an essential condition of the Contract.

ARTICLE 18

- **18.1** The Parties acknowledge that the DB Team has submitted the certification entitled "Contractors Certification Requirements" required in accordance with the Contract Revision Policy of the Financial Supervision and Administration Board for Puerto Rico, Effective as of November 6, 2017 and as executed on April 30, 2021). The Contractor Certification Requirements is attached hereto, as **Attachment M** of the Contract.
- **18.2** The DB Team represents and warrants that the information included in the Contractor Certification Requirement is complete, accurate and correct, and that any misrepresentation, inaccuracy of falseness in such Certification will render the Contract null and void and the DB Team will have the obligation to reimburse immediately to the Commonwealth any amounts, payments or benefits received from the Commonwealth under the Contract.

ARTICLE 19-EXECUTIVE ORDER OE-2022-014

19.1 The Contractor recognizes and agrees to strictly comply with the provisions of Executive Order 2022-014 ("OE-2022-014") and the Labor Agreement of the Project, if required. OE-2022-014 is attached hereto, in **Attachment N**.

The Contractor will provide a minimum wage of Fifteen Dollars (\$15.00) per hour to skilled worker and Eleven Dollars (\$11.00) per hour to unskilled worker, for the work he performs on the Project, as defined in the OE-2022-014.

In addition, the Contractor certifies that its Subcontractors will comply with the provisions of the OE-2022-014. The Contractor shall include in any contract he grants to perform the work for the benefit of PRIFA, a clause in which the Subcontractor is obliged to comply with all the provisions of OE-2022-014, the Labor Agreement of the Project, if required, as well as any other document that is issued under the OE-2022-014. In addition, the Contractor's clause shall provide for the Subcontractor to include a similar compliance clause in any subcontract that he grants to perform the work under this Contract.
IN WITNESS WHEREOF, this Agreement has been executed as of the date first written above.

PUERTO RICO INFRASTRUCTURE FINANCING AUTHORITY

DB/TEAM

]

Brenda A. Virella Gresp6/ Esq. Legal Director Tax I.D 660-48-0699

CONTRACTOR

DFM CONTRACTOR (DYNAMIC+ CONCRETE MANUFACTURE) L.L.C. Leonardo Rivera Jaca Secretary Tax I.D. 660-91-8553

DESIGNER SPEC ENGINEERING SERVICES, PSC Roberto J. Marte De La Mota, P.E. President Tax 1.D.660-83-1409

ATTACHMENT A SCOPE OF WORK



AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario; Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramirez Baijes , Delcasse, Marselles, Clemenceau , Piccioni y Ave, Ashford"

ATTACHMENT A-1. SCOPE OF WORK

AT1.1 General Requirements

AT.1.1 PRIFA is seeking qualified, design-build proposers (hereafter "Contractor") to execute the field study, design, construct, or rehabilitated of the potable and sewer infrastructure, in Municipio de San Juan, Condado Area, in the following streets: Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramirez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford, and related infrastructure that may hindered the investment to be performed. This process is under PRIFA Procurement Regulation 5853 authorized by Law 44-1998 and as authorized defined by DTOP Regulation 7998 approved under law 218-2010, and all applicable Federal rules and procedures, including but not limited to 2 CFR 200, sections 318 through 328, Law 107-2020 Municipal Code, law 71-2021, Law 1-2012 Governmental Ethics Office of Puerto Rico and Law 2-2018. Both designer and Contractor must sign the design-Build contract, but it does not modify or substitute its obligations as Design Builder contractor towards PRIFA, PRASA, DRNA, Municipio de San Juan and as defined under Uniform General Conditions DTOP Regulation 7998.

AT1.1.2 Contractors must provide a Full and Complete Design and Build Services. PRIFA will provide the following documents for the development of the Full and Complete Design and Build process:

• Conceptual drawings with the superficial conditions and identification of the street (See Attachment K)

Conceptual Design, Specs, Narratives and Distribution Drawings only constitute current regulatory requirements and guidelines for the Design and Built Process. Also, it is a visual representation and will assist proponents to evaluate its capacity and capability to undertake the execution of the scope of work. Nevertheless, proponent will be responsible for the Full Detailed and Complete Design, Drawings, Specifications and permits required by current regulation and standards for the project.

AT1.1.3 The design and build for, "Diseño y Construcción Rehabilitación de infraestructura de agua potable, Alcantarrillado Sanitario, Municipio de San Juan Gondado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramirez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford", will be developed accordingly with all applicable code's compliance and regulation. The engineering designs of the wastewater (sewer / "alcantarillado") and drinking ("potable") water system must be functional, as per PRASA's requirements for the area. All parts and construction elements required by codes and regulations to operate the potable and sewer system must be included in the proposal.

þr H

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramirez Baijes , Delcasse, Marselles, Clemenceau , Piccioni y Ave Ashford"

AT1.1.4 Selected contractors will be subject to constant observation by PRIFA's program manager/field oversight staff. This staff, which may include contracted specialists along with staff from other government entities, will ensure the design and build are within PRASA, DRNA, Municipio of San Juan and in compliance with all applicable Federal, State, and local regulations. However, the Puerto Rico Aqueduct and Sewer Authority retains oversight and supervision duties, to ensure that they meet all the requirements established under the applicable State and federal regulations.

AT1 1.1.5 Contractor and subcontractors shall be reputable and qualified, must have previous performance history with the State's contractor licensing board, must not be on a State's "Debarred Contractor", must be registered and active in SAM.gov to verify that potential contractors have not been suspended or debarred from performing work funded by the federal government. The contractor shall also provide a safe working environment.

AT1.1.6 Contractor is responsible for the complete Full Detailed and Complete Design and Build of the Project, including but not limited to studies, plans, technical specifications, permits, endorsements, construction, fees, stamps, bonds, insurances, and Municipal Taxes (*Arbitrios y Patentes*).

AT 1.1.7 Contractor is responsible to provide an office trailer for the inspection until the final acceptance of the project. Consider the following for the trailer:

- Electricity
- Restroom
- Potable water
- Internet connection
- Desk (1)
- Executive Chair (1).
- Conference table (1)
- Folding Chairs (10)
- Big File Cabinet (2)
- Printer with scanner to hold paper size up to 11" x 17"
- Material Offices until the acceptance of the Project (paper, printer inks, sanitary paper, pens, pencils, scissors, clips, etc.)
- Microwave

Project's design and construction Must be all complete in no more than Four hundred (400) calendar days from the issue of the Notice to Proceed (NTP) for the substantial completion of the project.

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramirez Baijes , Delcasse, Marselles, Clemenceau , Piccioni y Ave: Ashford".

CONTRACTOR shall submit a detailed activity schedule such as Project Manager or Critical Path Method (CPM) schedule for both Designs phase and Construction phase with estimated dates and itemized cost of work to the Contracting Officer for review and approval.

AT1.1.8 The contractor must provide all labor, materials, tools and equipment, and design build services necessary for the full detailed and complete design and build of the project described below and other specific tasks as further defined by this SOW. Both design and construction services are parts of this project. The Contractor will provide design and review of the documents for compliance with all applicable national and local codes, standards, federal and state regulations. The design will be documented by stamped/sealed drawings by a registered professional architect or engineer from the Commonwealth of Puerto Rico. Work includes, but is not limited to Professional services (civil, structural, mechanical, electrical, plumbing, and architectural), general demolition if necessary and construction, mechanical, and electrical work, control and communications, utility systems and necessary techniques to perform the required construction or rehabilitation...

It is also required from the Designer to provide Supervision During Construction services until the final acceptance of the project. This cost must be included in the price. These services include, but not limited to, submittals evaluation and approval, responding with answers and drawings to Requests for Information and Requests for Clarification, participating in weekly project meetings and special issues meetings, evaluation and recommendations on Change Orders and claims, and preparing a monthly report on project progress and issues.

AT1.1.9. The Contractor shall provide and install a 8'-0" X 4'-0" project identification sign at the project site in accordance with the specifications sent by PRIFA. Location of identification sign to be coordinated between the Contractor and PRIFA's representative.

AT1.1.10 The Contractor shall be responsible for the maintenance of the current landscape in the Project. All green areas shall be left in optimum condition before completing the Project. All Construction *debris* must be disposed of in accordance with all Federal/ PR/ Municipal regulations and Laws.

AT1.1.11 The Contractor is responsible for obtaining all permits and endorsements from Regulatory Agencies necessary for the development and construction of the Project. Anticipated required permits and endorsements include, but not limited to, PRASA, PREPA and/or LUMA, DTOP, DRNA, *Instituto de Cultura Puertorriquena* (ICP), SHPO, Municipality of San Juan, EPA, and OGPe. The Contractor is also responsible for the payment of all permit stamps, permit and endorsement fees and Agencies contributions. All permits required shall be the Contractor responsibility. The Contractor must adhere to all Federal, State, and municipal applicable laws.

J

Addendum¹2

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramirez Baljes , Delcasse, Marselles, Clemenceau , Piccioni y Ave, Ashford"

All design and works to be performed shall be in strict compliance with current construction codes and requirements of the Regulatory Agencies. Also, see section 3.2 below.

AT1.1.12 The Contractor will be responsible to submit as-built CAD drawings at the end of the project reflecting the new changes and the actual conditions of the utilities to PRIFA as part of the close out documents.

AT1.1.13 PRIFA or its representative shall issue official written Notice to Proceed (NTP) orders for the services referenced in the contract. The NTP orders shall stipulate the provision of services. The Contractor is not authorized for the performance of any service outside written NTP orders provided by PRIFA or its representative.

AT1.1.14 The Contractor shall be solely responsible for maintaining security and safety at all work sites. The Contractor shall take all reasonable steps to ensure safety for both workers and authorized visitors to work sites through construction sites access control measures. Safety at all sites includes, but is not limited to, vehicular traffic control such as traffic cones and flag personnel. The Contractor will also be solely responsible to ensure that all OSHA requirements are met, and a safety officer assigned to the project for the duration of this contract. The Contractor shall also comply with OSHA's COVID 2019 Guidelines and shall provide a copy of its COVID 2019 Auto-certification by the PR Labor Department.

AT1.1.15 The Contractor shall perform all necessary material and laboratory tests for the project in compliance with all applicable current construction codes, requirements of the regulatory agencies, construction plans and technical specifications for the project, including the cost of each test.

AT1.1.16 The Contractor must fully **mitigate** the impact of their operations on local pedestrian and vehicular traffic. The Contractor is responsible for establishing and maintaining appropriate pedestrian/vehicular traffic controls and authorized visitor and personnel access control in all work areas. Traffic control shall consider alternatives with less impact to the community, including alternate access and considering hours with peak traffic (pedestrian and vehicular). In terms of the proposed works (excavation, studies, by-passes, pipe installation, material, disposal, etc.) the contractor shall consider alternatives with less impact to the community.

The Contractor shall adhere to all Federal, State, and municipal applicable laws in place at the time of contract activation. The Contractor must provide sufficient signing, flagging, and barricading to ensure the safety of vehicular and pedestrian traffic in all work areas, to provide necessary guidance to vehicle drivers so that they can satisfactorily navigate the site and to protect equipment contemplated to be used on site. All work must be done in conformity with all applicable local, state, and federal laws, regulations, and ordinances governing personnel, equipment, and workplace safety. Any notification of a deficiency in traffic control or other safety

ł

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramirez Baijes , Delcasse, Marselles, Clemenceau , Piccioni y Ave. Ashford"

items must be immediately corrected by the Contractor. The expense incurred by the Contractor for traffic control is an incidental expense contemplated as part of the Contractor's compensation under the terms and conditions of scope of services.

AT1.1.17 Properties will undergo abatement of regulated materials (*"materiales con contenido de asbestos y pintura con base de plomo"*) **prior** to any demolition or construction works by the Contractor. The Contractor is responsible for the Regulated Material Presence Report of all property areas, equipment fixtures, etc. to be impacted with the project in accordance with all applicable federal, state, and local laws, standards, and regulations. The contractor is responsible for the cost of reports.

AT1.1.18 The project includes and cash allowance of \$50,000.00 for all permits and the mitigation, removal and disposal of the regulated material found inside and outside of potable or Sewer system.

AT1.1.2 Permits, Applicable Laws, and Regulations:



All permits required must be the Contractor's responsibility. The Contractor must adhere to all applicable Federal, State, and municipal applicable laws, as well as FEMA, EPA and other federal policies in place at the time of contract activation. Contracts funded with federal grant or loan funds must be procured in a manner that conforms with all applicable Federal laws, policies, and standards, including those under the Uniform Guidance (2 CFR Part 200, et als, included but not limited to Appendix II). All required permits must be issued by the Regulatory Agencies prior to initiating any activity. Contractors who do not obtain the proper permits and/or do not follow permit requirements must be solely responsible for any costs associated with work deemed ineligible for reimbursement (with Federal or State funds), or for any fines, penalties, legal actions, or remediation requirements that may result. In entering a contract with PRIFA, Contractors must indemnify the Puerto Rico Aqueduct and Sewer Authority, PRIFA, the Government of Puerto Rico, and their other agents, contractors and assigns from any such costs or responsibilities. Any phase that does not have the corresponding use permit will not be accepted. The use permit must be processed by the contractor.

Expressly, the Buy America Act and Presidential Executive Order dated January 25, 2021, on Ensuring the Future is made of All of America by All of America's Workers is applicable to this Contract. A registry of compliance must be kept by the contractor during the execution of the project and be available upon request by PRIFA or its agents and representatives.

Final Certification and compliance with PRASA requirements are the responsibility of the Contractor. Therefore, the Contractor, with the assistance of PRIFA, must coordinate all visits and inspections with this entity prior to the delivery of the Project.

Addendum¹2

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagūez, Aguadilla, Joffre, Mariano Ramirez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford"

AT1-3.Design Deliverables:

- i. CONTRACTOR is responsible for the complete design of the Project, including, but not limiting itself to plans and technical specifications. The CONTRACTOR shall submit the following for Owner's approval:
- ii. Perform Survey measure and Geotechnical report for the project as part of its contract.
- iii. Perform a sewer system CCTV inspection/reconnaissance work to identify blockages, infiltration, exfiltration, informal interconnections, sanitary manhole locations, and other existing infrastructure if required. Document the finding in a report according to NASSCO & PRASA's protocols used to develop the Sewer System assessments.
- iv. Schematic Design and Action Plan Documents (30% of Design): Thirty (30) calendar days after Notice to Proceed. PRIFA will have ten (10) calendar days to take approval action.
- v. Design Documents (90% of Design): forty-five (45) calendar days after PRIFA approval of 30% of design. PRIFA will have ten (10) calendar days to take approval action.
- vi. Final Construction Drawings and Documents (100% of Design): fifteen (15) calendar days after PRIFA approval of 90% of design. PRIFA will have ten (10) calendar days to take approval action.

AT1.4 Site Works:

41

poll 2

AT1.4.1 Re-Construction SANITARY SEWER SYSTEM) Clls Barranquitas, Mayagüez, Aguadilla, Joffre, Delcasse, Marselles, Clemenceau y Ave. Ashford. Perform all work related to, but not limited to, the following;

- i. The DBTeam shall execute the Field studies (CCTV), stakeout, execution of exploratory surveys, geological studies, leveling, location of systems and utilities, flow measure, field study or investigative study necessary to carry out the design and construction of the reconstruction of sewer system. The System Shall be functional according to EPA and PRASA Standards
- ii. Divert, Clean, and inspect the approximately seven hundred and twenty-two (722) linear meters of existing 8" concrete pipe. Once the cleaning and camera inspection work is completed and approved, PRASA through its authorized representative will certify the extent of the necessary rehabilitation work.
- iii. The contractor will submit a unit cost for spot repair considering the installation of twenty four (24) linear meter of 8",10",12" SDR 35 PVC pipe. (Unit Price for Reparation) SEE ALLOWANCE #3
- iv. The rehabilitation of the existing pipeline by means of a casing system with elements of structural capacity and operation throughout the pipeline. In the 8",10", 12" approximately seven hundred and twenty-two (722) linear meters of a liner system will be supplied and installed in the submitted section, such system must be submitted

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramirez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford"

by the Contractor, certified by a licensed engineer and approved by PRASA. The Contractor shall be responsible for checking the current conditions of the healthcare system. The total length of the pipe and the diameter of the pipe shall be confirmed by the Contractor.

- v. The installation of the coating system (liner) must comply with the "Guidelines Specification for the installation of Cured-in-Place Pipe (CIPP)" of the NASSCO.
- vi. Restore twenty (21) <u>Manholes</u> registers in these sections. This restoration includes, but is not limited to: gutter restoration, floor, wall, and ceiling patching, epoxy coating application, step installation/replacement, etc. Wash the inside of the register at a pressure of no less than 5,000 psi, apply detergent and degreaser. Prepare the surface with a concrete surface profile between CSP-3 and CSP-6 according to International Concrete Repair Institute (ICRI) standards. Fill cracks and openings with a layer between 4 and 8 mils thick of a product equal to or similar to Steel Seam FT910 or Cerobond 300. Apply epoxy coating with a layer of between 70 and 125 mils of a product equal to or similar to DURA-PLATE 6100. The contractor shall provide evidence that personnel are properly trained and certified to perform works.
 - The total length of the pipe, diameter and total sanitary connections will be confirmed by the Contractor. The Contractor shall be responsible for including in its proposal the entirety of the piping, sanitary registers and connections for the entire project area

iii. Make the connections to the main pipes as illustrated in the design sketch. (Includes materials, labor, and necessary equipment

- ix. For each connection, a "clean-out" cleaning register will be left, embedded in concrete.
- x. In the event that there are connections with a depth greater than 2 m, the construction of a concrete footing and pedestal will be required, which will serve as protection for it.
- xi. The Contractor will submit an alternative for removing the existing sanitary pipe, supplying and installing 8",10",12" 0 SDR 35 PVC pipe. The costs will be broken down by section, record by record, this will be in case it cannot be covered
- xii. On the lowers street must be incorporated a linear price for dewatering excavation

AT1.4.2 Alternate Works SANITARY SEWER SYSTEM) "Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Delcasse, Marselles, Clemenceau y Ave. Ashford. Perform all work related to, but not limited to, the following

i. The DBTeam shall execute the Field studies execution of exploratory surveys, geological studies, leveling, location of systems and utilities, flow measure, field study or investigative study necessary to carry out the design and construction of the new

vii. viii.

42 |

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramirez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford"

sewer system. The System Shall be functional according to EPA and PRASA Standards 722 mt

- ii. Saw cut pavement for trenching, remove material of pavement 722 mt
- iii. Removal of material of excavation (Demolition And replacement of material in trench area)
- iv. Perform "Unclassified trench excavation for 8"",10"",12"" sewer pipe, measured from ground surface to bottom, including backfilling, tamping, sheet piling, disposal of unsuitable soil and dewatering, if necessary, for depths between: 1 to 5 meters.
- Provide Sub-base (Stone Course) and install make proper compaction according PRASA STANDARD All excavation backfill work will be carried out by depositing material in layers with a thickness of no more than 30 cm. The Contractor shall take all necessary measures to ensure compaction to a degree of not less than 95% "Modified Proctor Test
- vi. Furnishing and installation of P.V.C. SDR-35 sewer pipe, rubber gasket joint, including jointing material, etc. for: diameter 8" 483 mt
- Furnishing and installation of P.V.C. SDR-35 sewer pipe, rubber gasket joint, including jointing material, etc. for: diameter 10" 29 mt
- iii. Furnishing and installation of P.V.C. SDR-35 sewer pipe, rubber Gasket joint, including jointing material, etc. for: diameter 12" 210 mt
- ix. Precast concrete manhole 1.20m. dia., including excavation, backfilling, demolition and replacement of pavement, cast iron frame and cover, ladder rung ,grout, sheet piling and dewatering if necessary, etc for depths between: 1 to 7mt. 21 manholes. According PRASA Standard.

AT1.4.3 POTABLE WATER SYSTEM) IN THE STREETS: BARRANQUITAS, MAYAGÜEZ AND AGUADILLA.

- i. The contractor will pay the cost of supplying and installing approximately two hundred and eleven (211) linear meters of 4" 0 PVC DR 14 potable water pipe.
- Supply and install seventy (70) potable water connections ranging from 1/2" 0 to 4".
 0.
- iii. Supply and install four (4) fire hydrants.
- iv. Perform pressure testing on the installed pipe. Such testing shall be performed at a pressure of 1.5 times the operating pressure of the existing pipeline. This test will be performed in the presence of an AAA Authorized Representative for validation of the test. The Network Manager of SAN JUAN Operational Area will indicate to the Contractor the operating pressure of the pipeline for the determination of the test pressure.

vii. viii.

Addendum 2

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramirez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford"

- v. Disinfect the new pipe in coordination with PRASA. The Contractor will assist PRASA Laboratory personnel with the equipment and materials necessary for successful disinfection.
- vi. Once the pipeline has been tested and disinfected, and satisfactory results of the sanitary and bacteriological conditions of the pipeline have been received, the necessary interconnections will be made to leave the new pipeline in operation and permanently disconnect the existing pipeline from the system. The Contractor shall assist PRASA's Operations personnel with the equipment and materials necessary for the interconnection to be satisfactory. The existing pipe section will be left in place by installing a cap at each end.
- vii. All excavation backfill work will be carried out by depositing material in layers with a thickness of no more than 30 cm. The Contractor shall take all necessary measures to ensure compaction to a degree of not less than 95% "Modified Proctor Test".
- viii. The costs related to the collection of samples, laboratory analysis, preparation of reports, taking of tests at different levels with a separation of not more than 50 ML or at any other location selected by the inspection, as well as any other costs directly or indirectly related to the activity described above will be borne by the Contractor.
 - All quantities and/or dimensions will be confirmed by the Contractor. The Contractor shall be responsible for including in its proposal all materials for the entire project area. (Includes materials, labor, and necessary equipment.)
 - x. During the execution of the works, the Contractor shall replace and dispose of all material resulting from the excavations. Instead, all reference activity will be carried out using selected material rated A 2-4 or better for these purposes. Samples of the proposed material, its source of provenance, and certified classification will be provided for evaluation and approval by AAA Staff.

AT1.4.4 Excavation, trenching and resurfacing work on streets and highways should be performed as required below:

A. Trench y_filling:

The material to be used as filler shall be A-2-4. The Contractor shall consider in its proposal the classification and compaction curve tests of the material that may be required for this installation. Tests have to be carried out and they must reach no less than 95% compaction.

b. No trench will be left open at the end of the workday so that traffic flow in the area can be maintained and accidents avoided. The contractor in collaboration with PRIFA will coordinate with the community to reduce and mitigate the impact in the community.

B. Concrete Repaving

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alçantarillado Sanitario, Municipio de San Juan Condado, Calles Barranguitas, Mayagüez, Aguadilla, Joffre, Mariano Ramirez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford"

The concrete shall meet the minimum specifications indicated by the Municipal or State DTOP as applicable, The full length of the affected lane and the full width of the affected lane will be scarified and resurfaced.

In the event that the thermoplastic lines (either on the edge or in the center) are affected by the works, they will need to be replaced

All designs must comply with the Highway and Transportation Authority (ACT) Design Standards Regulations, Highway Design Manual, Uniform Traffic Control Devices Manual, AAA, ASTM, AWWA, General or Specific Laws and Regulations applicable in the exercise of engineering and approval of plans by an authorized representative of the relevant agencies

Any existing infrastructure (sidewalks, curbs, existing water and sewer connection fences, PREPA, telecommunications, fiber optics, etc.) that is impacted by the construction work must be repaired to conditions equal to or better than its original condition. Likewise, if any infrastructure interferes with the installation of this line, the contractor will be responsible for the relocation of the line.

For all pipe repair and/or installation work in the sanitary sewer system, the Contractor must submit a camera survey (video and written report) of the inside of the pipe in digital format (2 copies) that provides a full view (top to bottom and side to side, 360 degrees). This study must be coordinated with the project inspector (AAA), so that the project is present during the project. This study must be conducted by the company independent of the Contractor that meets the requirements of NASSCO.

AT1.4.5 CCTV Inspection Pre-Post Construction

- i. Physical measures, cleaning and closed-loop inspection of existing sanitary sewers
- ii. The intent of cleaning sanitary lines and registers is to remove all mud, dirt, sand, rocks, greases, and other solid or semi-solid materials to allow the water level to drop so that defects or deficiencies are visible. The closed-loop inspection will be conducted to assure the PRASA representative that the cleanup has been performed satisfactorily. If the inspection shows that the cleaning is unsatisfactory to the PRASA representative, the Contractor will be required to re-clean and inspect the sanitary line section until cleanliness is acceptable, at no additional cost to PRASA.
- iii. The pipe must be clean enough to allow it to be inspected by closed circuit (CCTV). This work will include the use of hydraulic cleaning equipment and vacuum trucks to remove sludge, dirt, solids, grease, etc., from sewers and logs. If the method is unsuccessful or does not provide a clean picture of the pipes, cleaning should be performed using pressure washing machines, jets, and mechanical cleaning equipment, such as scrapers,

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramirez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford"

scooters, heavy brushes, steel brushes, and any other equipment previously submitted and approved by the AAA representative.

- iv. The pipe must be clean enough to allow it to be inspected by closed circuit (CCTV). This work will include the use of hydraulic cleaning equipment and vacuum trucks to remove sludge, dirt, solids, grease, etc., from sewers and logs. If the method is unsuccessful or does not provide a clean picture of the pipes, cleaning should be performed using pressure washing machines, jets, and mechanical cleaning equipment, such as scrapers, scooters, heavy brushes, steel brushes, and any other equipment previously submitted and approved by the AAA representative.
- v. Satisfactory precautions should be taken during all cleaning operations to ensure that sewer lines are not damaged by misuse of cleaning equipment.
- vi. All disposed debris including solid or semi-solid material, sludge or grease shall be properly disposed of in a legally permitted location in accordance with state and federal regulations. Any removed material will not be retained on-site for more than two days. The use of closed containers will be mandatory for such temporary storage. The Contractor shall be responsible for all charges used for the disposition of such materials.
 Vii/ Closed-circuit (CCTV) inspection of sewer and log pipes shall use a high-definition video

system to remotely inspect and encode the defect (if any) of the pipe or log in "real time".

- a. The system shall have the capability to record to a digital video disc (DVD) and a hard disk the information identifying each inspected segment and a remote measuring device.
- b. The height of the camera will need to be adjusted inside the tube to maintain a centered position for filming.
- c. The illumination of the chamber shall be adequate to allow a clear image of the entire periphery of the pipe. Low-quality videos will be rejected and you will be asked again for the recording at no additional cost to AAA
- viii. Closed-circuit (CCTV) inspection and defect classification will be based on the most recent revision of the (PACP). As developed by NASSCO. All closed-circuit (CCTV) operators must be certified by (PACP).
- ix. The conduct of the inspection by closed circuit should be upstream to downstream.
- x. Cleanup, waste disposal, physical inspection and reporting shall be <u>considered</u> inherent to the project work and are included as part of the bidder's proposal
- xi. As part of the scope of work, the inspection and final report will be submitted by closed circuit (CCTV) to verify the conditions of the lines Cover sheet with the information of the project or area to be investigated. Table of Contents Explanatory Memorial Introduction Geographical Description of the Area [; Equipment Description of Procedures Findings (Tabulated) Recommendations (Tabulated) Appendices Photo (Satellite) Schematic (logs and pipe runs identified) Illustrations & Report

for A

46 |

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramirez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford"

AT1.4.6 Special Notes:

PRIFA shall have no obligation to treat any information submitted in connection with a Proposal as proprietary or confidential unless (i) the Proposer so identifies such information in its Proposal as proprietary or confidential, and (ii) PRIFA determines that the information is proprietary or a trade secret and legitimately requires such treatment or that it must otherwise be protected from publication according to law. PRIFA obligations with respect to protection and disclosure of such information shall always be subject to applicable law. If the Proposer desires to identify any information in its Proposal as proprietary or confidential, it shall limit such designation to only those portions of the Proposal that constitute proprietary information, trade secrets, or other confidential matters or data. Identification of the entire Proposal or entire sections of the Proposal designations as confidential or proprietary are strongly discouraged and may result in the Proposal, other than those portions identified and marked as confidential or proprietary, as it considers necessary or desirable in connection with this RFP; and, by the submission of the Proposal.

Obtaining appropriate permits and adhering to associated requirements is the responsibility of the Contractor performing the work. All required permits must be issued by the Regulatory Agency prior to initiating any site activity. Contractors who do not obtain the proper permits and/or do not follow permit requirements must be solely responsible for any costs associated with work deemed ineligible for Federal Funding or reimbursement of State or Municipal funds, or for any fines, penalties, legal actions, or remediation requirements that may result. In entering a contract with PRIFA, contractors must indemnify PRIFA, the Puerto Rico Aqueduct and Sewer Authority, the Government of Puerto Rico, and their other agents, contractors and assigns from any such costs or responsibilities.

AT1.4.6.1 Additional notes that must be considered are:

AT1.4.6.1.1 Safety:

The Contractor must be solely responsible for maintaining safety at all work on site. The Contractor must take all reasonable steps to ensure safety for both workers and visitors during the construction, includes but not limited to traffic control such as traffic cones and flag personnel. The Contractor will also be solely responsible to ensure that all OSHA requirements are met, and a safety officer assigned to the project for the duration of this contract. The Contractor is responsible for the security of site to ensure no unapproved ingress or egress is occurring on the site. Contractors who do not follow required and other reasonable safety requirements must be solely responsible for any costs associated with work deemed ineligible for reimbursement (with Federal or State funds), or for any fines, penalties, legal actions, awards,

ł

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramirez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford"

or corrective actions that may result. In entering a contract with PRIFA, Contractors must indemnify PRIFA, the Government of Puerto Rico, and other agents, contractors and assigns from any such costs or responsibilities.

AT1.4.6.2 On-Site Project Manager:

The Contractor must provide an on-site licensed project manager, PE, or RA. The project manager must provide a telephone number to PRIFA with which he or she can be reached for the duration of the project. The project manager will be expected to have daily, and weekly project meetings with PRIFA or its authorized representatives. Meeting topics will include, but not limited to, phases completed, phases under construction, permitting issues, submittals issues, requests for clarification, project completion progress, PRIFA coordination. Frequency of meetings may be adjusted by PRIFA. The Contractor's project manager must be available twenty-four (24) hours a day, or as required by PRIFA.

AT1.4.6.3 Traffic Control:

The Contractor must fully mitigate the impact of their operations on local traffic. The Contractor is responsible for design, establishing and maintaining appropriate traffic controls in all work areas. The Contractor must adhere to all Federal, State, and municipal applicable laws in place at the time of contract activation. The Contractor must provide sufficient signing, flagging, and barricading to ensure the safety of vehicular and pedestrian traffic in all work areas and to protect equipment contemplated to be used on each site. All work must be done in conformity with all applicable local, state, and federal laws, regulations, and ordinances governing personnel, equipment, and workplace safety. Any notification of a deficiency in traffic control or other safety items must be immediately corrected by the Contractor. No further work must take place until the deficiency is corrected. The expense incurred by the Contractor for traffic control is an incidental expense contemplated as part of the Contractor's compensation under the terms and conditions of scope of services.

AT1.4.6.4 Work Hours:

The Contractor must adhere to all applicable Federal, State, and municipal laws in effect at the time of contract activation. The standard working days will constitute five (5) days per week; however, work may be performed up to seven (7) days per week if coordinated with the community. Working hours may also be extended to low-traffic times and nighttime hours to minimize disruption of service of potable water and wastewater infrastructure related to scope of work. Any adjustments to work hours, as dictated by local conditions, must be coordinated between PRIFA, the Contractor, the community and when applicable, The Municipality and/or PRASA.

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramirez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave Ashford"

AT1.4.6.5 Private Work:

Neither the Contractor nor any subcontractors of The Contractor, must solicit work from private citizens nor others to be performed in the designated work areas during the term of this agreement. PRIFA reserves the right to require the Contractor to dismiss or remove from the project any workers or subcontractors as PRIFA sees necessary.

AT1.4.6.6Construction Specifications:

Project specifications shall include specifications for all products, materials, equipment, methods, and systems shown on the construction drawings in accordance with standard professional practice PRASA, DRNA, DTOP and the PRIFA requirements. The specification submitted for review shall include:

A. The name of the manufacturer, the product name, model number, or other identification as appropriate to clearly identify the product that will be used in the construction of the project.

B. Other data as appropriate to clearly identify the product that will be used in the construction of the project i.e. shop drawings, product data, and samples as required by the PRIFA/Puerto Rico Aqueduct and Sewer Authority documents; DTOP

C. The required stamp of the licensed architect or engineer of record will be considered as certification of compliance with the project's requirements.

D. Proposed Fee/Incidental Work:

AT1.4.6.7 Proposed Fee/Incidental Work:

Quoted prices include all insurance, bonds, field overhead, office overhead, labor, materials, equipment, subcontractors' costs, personnel lodging and meals, and profit. All costs for scope of services must be included in Contractor's prices as provided in the pricing attachment. The Total cost must be the sum of the unit price and will be considered as a Lump sum price proposal.

ATTACHMENT B DB TEAM'S PROPOSAL FORM

.

.

SEE ATTACHED



AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramírez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford"

ATTACHMENT A-2

Proposal Cost Form

FROM: DFM Contractors, LLC

Name of Proposer: DFM Contractors, LLC

Authorized Representative: Leonardo Rivera Jaca

Mailing Address: 68 Calle Guayama, San Juan, PR 00920



12/201201

Contact Telephone: 787-998-0404

Proposer proposes to perform all work described herein and comply with all requirements as part of "Diseño y Construcción Rehabilitación de infraestructura de agua potable, Alcantarrillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramirez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford:

1. Base Proposal

1.1 Proponent proposes to perform all the work described herein as part of the "Diseño y Construcción Rehabilitación de infraestructura de agua potable, Alcantarrillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramirez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford.", for the fixed lump sum amount of:
 Eight million two hundred fifty - nine thousand
 nine hundred three and thirteen Dollars (\$8,259,903.13
 Words Cents

2. The time to complete the Project from Notice to Proceed (NTP) is four hundred (400) calendar days.

pan -

42402

PUERTO R

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramírez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford"

Attachment A-2: LUMP SUM mathematical representation breakdown.

Facility	"Disño y Construcción, Reha Alcantarillado Sanitario, Mu	abilitaciór nicipio de	n de la Infrae 2 San Juan Co	structura de Indado, Clis E	Agua Potable, Iarranquitas,
/Proyecto	Mayagüez, Aguadilla, Joffre de	elcasse, N	larsellas, Cle	emenceau y A	ve. Ashford."
Municipality:	San Juan	E	Bid Number		AFI-BP-24-069
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
1	GENERAL CONDITIONS		•		•
1.1	Insurances and Bonds (P&P, etc)	LS	1	\$174,037.70	\$174,037.70
1.2	Project Sign (4 ft. X 8 ft.)	EA	1	\$6,000.00	\$6,000.00
, 1.3	CFSE	LS	1	\$142,246.96	\$142,246.96
1.4	Municipal Patent and Tax	LS	1	\$480,355.13	\$480,355.13
1.5	Mobilization	LS	1	\$240,000.00	\$240,000.00
1.6	Demobilization	LS	1	\$129,500.00	\$129,500.00
1.7	Inspection Office, Materials and	Months	12	\$3,000.00	\$36,000.00
				Sub Total	\$1,208,139.79
2	DESIGN	}	•		
Ź 2.1	Construction Documents, Drawings & Permits	LS	1	\$500,000.00	\$500,000.00
2.2	Services During Construction (including shop and record drawings)	Monthis	16	\$4,500.00	\$72,000.00
				St/b Total	\$572,000.00
3.1	SANITARY SEWER SYSTEM IN THE S Delcasse, Clemenceau y Ave. Ashfor	TREETS Ba rd (interco	nrranquitas, N nection).	layagüez, Agu	adilla, Joffre,
3.1.1	Tests, CCTV Disc and Report, Infiltration, Exfiltration	LM	722	\$1,129.70	\$815,643.40
3.1.2	Pipe Cleaning	LM	722	\$715.00	\$516,230.00
3.1.3	Liner for 8" Gravity Sanitary Line.	LM	483	\$572.00	\$276,276.00
3.1.4	Liner for 10" Gravity Sanitary Line.	LM	29	\$643.50	\$18,661.50
3.1.5	Liner for 12" Gravity Sanitary Line.	LM	210	\$858.00	\$180,180.00
3.1.6	EA Restauration of Manholes	EA	21	\$17,160.00	\$360,360.00
3.1.7	Connection to existing system By lining Metodology	EA	150	\$2,431.00	\$364,650.00
ontractors LL	?			Sub Totel	\$2,532,000.90
51	6101				l.

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramírez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford"

.

.

Facility	"Disño y Construcción, Reha	abilitaciór	n de la Infrae	structura de	Agua Potable,
/Proyecto	Alcantarillado Sanitario, Mu	nicipio de	San Juan Co	ndado, Clis B	arranquitas,
	Mayagüez, Aguadilla, Joffre de	elcasse, N	larsellas, Cle	menceau y A	ve. Ashford."
Municipality:	San Juan	E	id Number	· · · · · · · · · · · · · · · · · · ·	AFI-BP-24-069
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
3.1A	Alternate Design and contruction S Barranquitas, Mayagüez, Aguadilla, (iterconection).	ANITARY S Joffre, Del	SEWER SYSTEN casse, Clemen	1 IN THE STRE ceau y Ave. A:	ETS shford
3.1A.1	Saw cut (DemolitionAnd replacement of material in trench area)	LM	722	\$114.40	\$82,596.80
3.1A.2	Removal (Demolition And replacement of material in trench area)	СМ	750	\$114.40	\$85,800.00
3.1A.3	Sub-base (Stone Course)	СМ	450	\$100.10	\$45,045.00
3.1A.4	Unclassified trench excavation for 8",10",12" sewer pipe, measured from ground surface to bottom, including backfilling, tamping, sheet piling, disposal of unsuitable soil and dewatering if necessary, for depths between: 1 to 2 meters.	LM ,	722	\$114.40	\$82,596.80
3.1A.5	Furnishing and installation of P.V.C. SDR-35 sewer pipe, rubber gasket joint, including jointing material, etc. for: diameter 8"	LM	483	\$572 . 00	\$276,276.00
3.1A.6	Furnishing and installation of P.V.C. SDR-35 sewer pipe, rubber gasket joint, including jointing material, etc. for: diameter 10"	LM	29	\$643.50	\$18,661.50
3.1A.7	Furnishing and installation of P.V.C. SDR-35 sewer pipe, rubber Gasket joint, including jointing material, etc. for: diameter 12"	LM	210	\$858.00	\$180,180.00
3.1A.8	Precast concrete manhole 1.20m. dia., including excavation, backfilling, demolition and replacement of pavement, cast iron frame and cover, ladder rung ,grout, sheet piling and dewatering if necessaty, etc for depths between:_1-5_m	EA	21	\$21,450.00	\$450,450.00
12 24045 LLC	Connection to existing system By lining Metodology	EA	150	\$2,431.00	\$364,650.00
55 AL ALADZO				l	ai f

bol -

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramírez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford"

Facility	"Disño y Construcción, Reha	bilitaciór	n de la Infrae	structura de	Agua Potable,
/Proyecto	Alcantarillado Sanitario, Mun	icipio de	San Juan Co	ndado, Clis B	arranquitas,
	Mayagüez, Aguadilla, Joffre de	lcasse, N	larsellas, Cle	eménceau y A	we. Ashford."
Municipality:	San Juan	E	Bid Number		AFI-BP-24-069
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
•		•		Subtotal	\$1,586,256.10
3.2	POTABLE WATER SYSTEM) IN T	HE STREET	S: BARRANQL	JITAS, MAYAG	ÜEZ AND
	AGUADILLA		1		
3.2.1	Furnishing and installation of P.V.C. SDR-14 pipe, rubber gasket joint, including jointing material, elbows. for: 4 IN DIAMETER	LM	211	\$357.50	\$75,432.50
3.2.2	Pressure Test	EA	1	\$7,150.00	\$7,150.00
3.2.3	Disinfection	EA	1	\$7,150.00	\$7,150.00
3.2.4	Fire Hidrant with auxiliary Valves an Conection	EA	4	\$7,865.00	\$31,460.00
3.2.5	4" 0 Gate Valve	EA	3	\$2,002.00	\$6,006.00
3.2.6	Existing Potable System Interconection	Ea	2	\$2,860.00	\$5,720.00
3.2.7	Clients Interconection potable water connections ranging from 1/2" 0 to 4"	EA	70	\$2,860.00	\$200,200.00
3.2.8	Demolition And replacement of material in trench area	LM	211	\$114.40	\$24,138.40
3.2.9	Sub-base (Stone Course)	LM	211	\$114.40	\$24,138.40
3.2.10	Unclassified trench excavation for 4"0 potable pipe sdr 14, measured from ground surface to bottom, including backfilling, tamping, sheet piling, disposal of unsuitable soil and dewatering if necessary, for depths between: 1 to 2 meters	LM	211	\$114.40	\$24,138.40
	· · · · ·	. <u></u>	-	Sub Total	\$405,533.70
3.3	Bypass		1		
3.3.1	Installation	Each	24	\$7,150.00	\$171,600.00
3.3.2	Maintenance and Operation	Days	180	\$1,430.00	\$257,400.00
3.3.3	Removal	EACH	24	\$7,150.00	\$171,600.00
3.4	Dewatering				
3.4.1	Installation	Each	16	\$7,150.00	\$114,400.00
3.4.2	Maintenance and Operation	Days	80	\$2,145.00	\$171,600.00
3.4.2	Removal	Each	16	\$7,150.00	\$114,400.00

Und

53 | DFM 424020 PUERTO

Bol

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramírez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford"

Facility	"Disño y Construcción, Reha	bilitació	n de la Infra	estructura de	Agua Potable,
/Proyecto	Alcantarillado Sanitario, Mur	icipio de	e San Juan Co	ondado, Clis E	Barranquitas,
	Mayagüez, Aguadilla, Joffre de	lcašse, N	Aarsellas, Cl	emenceau y A	Ave. Ashford."
Municipality:	San Juan	E	Bid Number		AFI-BP-24-069
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
	Traffic control devices (
3.5.1	Temporary	LM	1040	\$228.80	\$237,952.00
	barrier and signs).				
3.7	Repaving BARRANQUITAS, MAYAG Ashford.	üez and	AGUADILLA D	elcasse, Cleme	enceau y Ave.
3.7.1	Scarified and Resurfacing	SM	6016	\$14.30	\$86,028.80
	A. Concrete Repaving acording a				
3.7.	Municipio de San Juan OR ACT	· SM	6016	\$25.74	\$154,851.84
				Sub Total	\$1,479,832.64
3.8	Regulated Materials Allowance #1				,
	Allowance Asbestos and Lead,			\$50,000.0	\$50,000,00
3.8.1	Permits Removal and Disposal	LS	1	o	\$50,000.00
3.9	Re-Routing Storm Sewer conection	s Allowan	ce #2		
/	Allowance for RE-ROUTING any				-
201	Storm sewer system connections	16	4	\$286 000 00	\$786,000,00
5.9.1	to separate from sanitary sewer	LS		\$280,000.00	\$280,000.00
	System			1	
3.10	SPOT REPAIR ALLOWANCE #3				
	Spot Repair Unclassified trench				
	excavation for 8",10",12" sewer				
	pipe, measured from ground				
3 10 1	backfilling tamping sheet	IM	22	\$1 144 00	\$25 168 00
5.10.1	piling, disposal of unsuitable soil	-141		• • • • • • • • • • • • • • • • • • • •	<i>420,100,000</i>
	and dewatering if necessary, for		÷		1
	depths				
	between: 1 to 5 meters Allowance				
	Spot Repair Furnishing and				
	installation of P.V.C. SDR-35				
3.10.2	sewer pipe, rubber gasket	LM	22	\$1,001.00	\$22,022.00
	joint, including jointing material,				
	diameter 8"				
	Spot Repair, Eurnishing and				
	installation of P.V.C. SDR-35				
2 10 2	sewerpipe, rubber gasket	184	22	\$1.001.00	\$22 022 00
3.10.3	joint, including jointing material,	LIVI	~~~	\$1,001.00	\$22,022.00
ciors	etc. for:			1	
112010	- Chiameter 10"		1	l	
<u> </u> 3	181				
					. 1
1 \ 4240	20 / /				UN .
	1.1				V .
Plum	RIC				
VERTO	J. Same				

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramírez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford"

Facility /Proyecto	"Disño y Construcción, Reha Alcantarillado Sanitario, Mun Mayagüez, Aguadilla, Joffre de	bilitación icipio de Icasse, N	n de la Infrae San Juan Co Aarsellas, Cle	structura de <i>l</i> ndado, Clis B menceau y A	Agua Potable, arranquitas, we. Ashford."
Municipality:	San Juan	Ś B	id Number		AFI-BP-24-069
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
3.10.4	Furnishing and installation of P.V.C. SDR-35 sewer pipe, rubber Gasket joint, including jointing material, etc. for: diameter 12"	LM	22	\$1,144.00	\$25,168.00
3.10.5	Precast concrete manhole 1.20m. dia., including excavation, backfilling, demolition and replacement of pavement, cast iron frame and cover, ladder rung ,grout, sheet piling and dewatering if necessaty, etc for depths between:_1-5_m	EA	2	\$21,450.00	\$42,900.00
3.10.6	Sewer Connection of clients Spot Repair	EA	1	\$2,860.00	\$2,860.00
				හැය ැලකු	\$476,140.00
				िविवी	\$8,259,903.13

- 1. PRIFA will award this Proposal to **one sole Proponent for the entire work** as required by the Contract Documents as a **Lump Sum Price**. Breakdown is required for corroboration of lump sum.
- 2. The Proposal Price Breakdown (Attachment A) presented, is limited to mathematical representation of the Proponent's Project Cost and to establish the items corresponding proposed unit cost for the Project. It doesn't constitute a Breakdown for Payment. PRIFA reserves the right to increase or decrease the Scope of Work within these unit costs as reference, if they are under reasonable cost analysis parameters as explained in 2 CFR § 200.404 and OMB Circular A-87. Contract and amendments, if any, will be subject Fiscal Oversight Management Board Contract review Policy. The Proponent is responsible for compliance with all contract documents.
- 3. Be advised that the CONTRACTOR is accountable for the complete project requirements indicated in the Proposal Documents and shall build, furnish, install, and complete all project components.
- 4. The lump sum provided are for the entire work as required by the Contract Documents; prices include all labor, equipment, materials, bailing, incidental work, overhead, profit, insurance, mobilization, demobilization, materials laboratory testing, etc. to cover the finished work called for L/ under the Contract Documents. Changes will be processed in accordance with the Uniform Separate Conditions for Public Works Contracts. All line items in this breakdown shall be filled, if so are not



55 I

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramírez Baijes, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford"

going to include any amount, write \$0.00. Nevertheless, Proponent will be responsible to execute all scope of work.

- 5. Proponent agrees that the Contract Price includes any and all office overhead expense that the CONTRACTOR may incur for days of delay, whatever the cause of the delay may be. The Proponent waives any claim for office overhead expenses, arising out of or relating to this Contract.
- 6. Proponent agrees that the Contract Price includes any and all job site overhead that the CONTRACTOR may incur for an additional period equal to thirty percent (30%) of the period to the Contract's scheduled Substantial Completion, whatever the cause may be. The Proponent waives any type of claim of such job site overhead incurred during that period, arising out of or relating to this Contract.
- 7. Contractor is responsible for the payment of all laboratories testing of materials required as part of the Technical Specifications and Construction Drawings. It is understood that the Contractor is responsible for filing all applicable permits and endorsements needed to start construction, such as: Categorical Exclusion, "Permiso Unico Incidental", "Permiso Extracción de Corteza Terrestre", Excavation and Demolition Notifications (CSP), Etc.
- 8. It is understood that the CONTRACTOR is responsible for the payment of all applicable permits and endorsements fees, agencies contributions (PREPA, PRASA, etc.) and taxes. The Base Bid Proposal Price includes the cost of municipal patents and taxes ("patentes y arbitrios municipales"). Refer to the Uniform General Conditions for Public Works Contracts. Contractor by submitting proposal, represents PRIFA that has consulted with the Municipality all related costs related to the project, including but not limited to, municipal patents and taxes ("Patentes y arbitrios Municipales").
- 9. After the CEST Plan is prepared and the necessary controls are installed, the Contractor and Sub-Contractor will be responsible for inspecting and maintaining them. The Contractor should have a professional engineer who will be responsible for periodically inspecting and certifying that the CEST Plan has been properly installed.
- 10. The Contractor is responsible for the compliance and payment of the DTOP and/or Municipality of San Juan Replacement Bond, if applies. The Contract Price includes the cost of all General Conditions and safety requirements to complete the Project. Refer to the Uniform General Conditions for Public Works Contracts. Maintenance of Traffic (MOT) techniques in the Contract Documents are guidelines of the measures to be implemented. Compliance of the MOT measures to be implemented with regulatory Agencies or Entities shall be, in its entirety, the Contractor's responsibility.
- 11. The CONTRACTOR must comply with Law 70, as amended, also known as "Ley para la Reducción y Reciclaje de Desperdicios Sólidos". Prices include all insurance, bonds, overhead and profit, labor, materials, equipment, and subCONTRACTORs' costs needed to deliver the service to include personnel lodging and meals.

This Proposal is submitted by:

Name: DFM Contractors, LLC

Representative

- S

AFI BP 24-069 "Diseño y Construcción, Rehabilitación de la Infraestructura de Agua Potable, Alcantarillado Sanitario, Municipio de San Juan Condado, Calles Barranquitas, Mayagüez, Aguadilla, Joffre, Mariano Ramírez Baijez, Delcasse, Marselles, Clemenceau, Piccioni y Ave. Ashford"

(printed): Leonard	Rivera Jaca
Representative (signed):	
Proposer's Name	DFM Contractors, LLC

Proposer's Authorized Representative Signature (If Corporation, Signed and Sealed

Date December 17, 2024



۲″_



SAN JUAN METRO AREA, PUERTO RICO

COASTAL STORM RISK MANAGEMENT STUDY FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

AUGUST 2021

This page was intentionally left blank.

Organization of this report meets the requirements provided in Appendix G of ER 1105-2-100 (30 June 2004), documenting the iterative U.S. Army Corps of Engineers (USACE) Plan Formulation Process. The planning process consists of six major steps:

- (1) Specification of problems and opportunities
- (2) Inventory, forecast, and analysis of existing conditions within the study area
- (3) Formulation of alternative plans
- (4) Evaluation of the effects of the alternative plans
- (5) Comparison of the alternative plans

(6) Selection of the recommended plan based upon the comparison of the alternative plans.

Steps may be repeated as problems become better understood and new information becomes available.

Steps 1 and 2 are discussed in Chapters 1-2, and provide the foundation for developing alternative plans and selection of a recommended plan outlined in Chapter 3.

Each chapter describes plan development as it progresses through the four integrated environments that shape a coastal storm risk management (CSRM) project: the built environment (upland development, etc.); the natural environment (species of concern and their habitat); the physical environment (currents, tides, sea level rise, etc.), and the economic environment (vulnerability of built environment to damages). Concerns relative to plan formulation and National Environmental Policy Act (NEPA) review are summarized and encapsulated in the discussions of these four main environments.

The recommended format of an Environmental Assessment (EA) is provided in 40 CFR 1502.10 and has been integrated into the Feasibility Report. The basic table of contents for the report outlines how the EA format has been integrated into the planning process to develop a recommended plan that meets the requirements of both USACE Plan Formulation Policy and NEPA.

Note that sections pertinent to the NEPA analysis are denoted with an asterisk.

TABLE OF CONTENTS Main Report

Executive SummaryES-1 EA: Summary
1 Introduction
2 Existing and Future Without-Project Conditions
3 Plan Formulation
4 The Recommended Plan
5 Effects of the Recommended Plan
6 Environmental Compliance
7 Recommendations
8 List of Preparers
9 References and Index9-1
Appendices
APPENDIX A – ENGINEERING APPENDIX B – COST ENGINEERING AND RISK ANALYSIS APPENDIX C – ECONOMIC ANALYSIS APPENDIX D – REAL ESTATE PLAN APPENDIX E – PLAN FORMULATION APPENDIX F – ENVIRONMENTAL ATTACHMENT 1 – 404(b)(1) ATTACHMENT 2 – Coastal Zone Management Consistency ATTACHMENT 3 – Environmental Justice Analysis ATTACHMENT 4 – Preliminary Mitigation Plan ATTACHMENT 5 – Agency Consultations APPENDIX G – PERTINENT CORRESPONDENCE
APPENDIX G – PERTINENT CORRESPONDENCE

APPENDIX H – CULTURAL RESOURCES

TABLE OF CONTENTS Main Report

Elements marked with an asterisk (*) provide further detail on sections required for National Environmental Policy Act compliance

1	INTRODUCTION*	1-1
1.1	FEDERAL STUDY PURPOSE*	1-1
1.2	STUDY SPONSOR	1-1
1.3	STUDY AUTHORITY	1-1
1.4	LOCATION AND NEED*	1-2
1.5	STUDY BACKGROUND AND SCOPING	1-5
1.6	RISK INFORMED DECISION FRAMEWORK & STUDY TIMELINE	1-9
1.7 1 1	RELATED DOCUMENTS*	1-10 1-10 1-11
1.8	FEDERAL PROJECTS NEAR THE STUDY AREA	1-11
1.9	OTHER NON-FEDERAL PROJECTS ADJACENT OR NEAR TO STUDY ARE	۹1-12
2	EXISTING AND FUTURE WITHOUT-PROJECT CONDITIONS	2-1
2.1	GENERAL SETTING*	2-1
2.2	NATURAL ENVIRONMENT*	2-2
2	2.2.2 WEILANDS AND SUBMERGED AQUATIC VEGETATION (SAV)	2-3 2-5
2	2.2 PROTECTED SPECIES	2-11
2	2.7 INVASIVE SPECIES	2-20
2 2	.2.8 AIR QUALITY	2-22
2	.2.10 NOISE	2-23
2	.2.11 COASTAL BARRIER RESOURCES	2-25
2	.2.12 CULTURAL AND HISTORIC RESOURCES	2-26
-2		

San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

2.2.15 EXISTING PROJECTS	2-34
2.3 PHYSICAL ENVIRONMENT (CONDITIONS)	2-35
2.3.1 SEA LEVEL CHANGE	2-35
2.3.2 STORM INTERACTIONS WITHIN THE PHYSICAL ENVIRONMENT	2-36
2.3.3 GEOLOGY	2-44
2.4 BUILT ENVIRONMENT	2-45
2.4.1 EXISTING STRUCTURES AND INFRASTRUCTURE	2-45
2.4.2 HURRICANE EVACUATION ROUTES AND ZONES	2-52
2.4.3 LIFE SAFETY	2-53
2.5 SOCIO-ECONOMIC ENVIRONMENT	2-53
2.6 OVERVIEW OF INTERACTIONS OF THE FOUR ENVIRONMENTS (ENVIRO	
PHYSICAL BUILT & FCONOMIC)	2-56
	2-58
2.6.1 WEST SAN IIIAN BAY 1A	2-60
2.6.2 WEST SAN IIIAN BAY 1B	2-60
2.6.6 WEST SAN IIIAN BAY 2	
2.6.4 WEST SAN IIIAN BAY 3	
2.6.6 WEST SAN JUAN BAY 4	2-66
2.7 MODELING OF THE FUTURE WITHOUT-PROJECT CONDITIONS WITH G	2CRM
2.7.1 MODEL ASSUMPTIONS	2-69
2.7.2 G2CRM MODEL INPUT OVERVIEW - ENGINEERING HYDRODYNAM	ICS 2-71
2.7.3 G2CRM MODEL INPUT OVERVIEW – ECONOMIC	2-73
2.7.4 FUTURE WITHOUT-PROJECT MODEL RESULTS	2-73
	2 1
5 FLAN FORMULATION	3- I
3.1 PLAN FORMULATION RATIONALE	3-1
	2.0
3.2.1 STUDT SCOPING PROCESS	
3.3 PROBLEMS AND OPPORTUNITIES*	3-4
3.3.1 PROBLEMS AND OPPORTUNITIES	3-4
3.4 OBJECTIVES	3-5
3.4.1 FEDERAL OBJECTIVES	3-5
3.4.2 PLANNING OBJECTIVES	
3.4.3 USACE RESILIENCE INITIATIVE	
3.4.4 STATE AND LOCAL OBJECTIVES	
3.5 CONSTRAINTS	
3.5.1 PLANNING CONSTRAINTS	

0.0.2	2 LOCAL CONSTRAINTS	3-8
3.6 3.6.1	MANAGEMENT MEASURES 1 IDENTIFICATION OF MANAGEMENT MEASURES	3-8 3-9
3.7 3.7.1 3.7.2 3.7.3	EVALUATION AND COMPARISON OF MEASURES 1 PLANNING CRITERIA SCORING 2 SCREENING OF MEASURES 3 ALTERNATIVE FORMULATION	3-14 3-15 3-15 3-16
3.8 3.8.1	THE FOCUSED ARRAY OF ALTERNATIVES 1 EVALUATION AND COMPARISON OF THE FOCUSED ARRAY	3-20 3-21
3.9	SCREENING OF ALTERNATIVES	3-34
3.10	PLAN SELECTION RATIONALE	3-34
3.11 Lago	OPTIMIZATION OF LENGTH OF ELEVATED LIVING SHORELINE ALONG CONDA	.DO 3-35
3.12	THE RECOMMENDED PLAN	3-36
4 TH	HE RECOMMENDED PLAN	4 -1
4.1	DESCRIPTION OF THE RECOMMENDED PLAN	4-1
4.1 4.2 4.2.1 4.2.2 4	DESCRIPTION OF THE RECOMMENDED PLAN BENEFITS OF THE RECOMMENDED PLAN 1 ECONOMIC SUMMARY 2 BENEFITS WITH REGARD TO THE FOUR P&G ACCOUNTS AND THE P&G CRIT	4-1 4-1 4-1 ERIA 4-
4.1 4.2 4.2.2 4 4.3 PLANN 4.3.2 4.3.2 4.3.2 4.3.2 4.3.2 4.3.2 4.3.2 4.3.2 4.3.2 4.3.2 4.3.2	DESCRIPTION OF THE RECOMMENDED PLAN BENEFITS OF THE RECOMMENDED PLAN 1 ECONOMIC SUMMARY 2 BENEFITS WITH REGARD TO THE FOUR P&G ACCOUNTS AND THE P&G CRIT PROJECT DESIGN - CONCEPTUAL DETAILS OF THE RECOMMENDED PLAN BY NING REACH 1 CONDADO LAGOON (CL-1) 2 WEST SAN JUAN BAY 1B (WSJB-1B) 3 WEST SAN JUAN BAY 1B (WSJB-1B) 3 WEST SAN JUAN BAY 2 (WSJB-2) 4 WEST SAN JUAN BAY 3 (WJSB-3) 5 WEST SAN JUAN BAY 4 (WSJB-4) 6 RECREATION 9 OPERATIONS AND MAINTENANCE CONSIDERATIONS	4-1 4-1 ERIA 4- ERIA 4- 4-6 4-6 4-8 4-11 4-12 4-14 4-15 4-16 4-16 4-16

San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

4.4. 4.4. 4.4.	 4 BREAKWATER DESIGN REFINEMENT	4-18 4-18 4-19
4.5	SEA LEVEL CHANGE CONSIDERATIONS	4-19
4.6 (LERRI	LANDS, EASEMENTS, RIGHTS OF WAY, RELOCATION AND DISPOSAL AREA DS)	S 4-19
4.7	RECOMMENDED PLAN COST	4-21
4.8	RECOMMENDED PLAN COST SHARING	4-21
4.9	FINANCIAL ANALYSIS OF NON-FEDERAL SPONSOR'S CAPABILITIES	4-22
4.10 4.10	VIEWS OF THE NON-FEDERAL SPONSOR	4-22 4-22
4.11	CONSISTENCY WITH SACS	4-23
4.12	FEDERAL IMPLEMENTATION RESPONSIBILITIES	4-23
4.13	NON-FEDERAL IMPLEMENTATION RESPONSIBILITIES	4-24
114		
4.14 4.14	4.1 RESIDUAL RISK	4-24 4-25
4.14 4.14 5 E	FFECTS OF THE RECOMMENDED PLAN*	4-24 4-25 5-1
4.14 4.14 5 El 5.1 5.1.	RISK AND UNCERTAINTY 4.1 RESIDUAL RISK FFECTS OF THE RECOMMENDED PLAN* NATURAL (GENERAL) ENVIRONMENT 1 SURFACE WATER QUALITY 2 TURBIDITY AND SUSPENDED SOLIDS 3 WETLANDS AND SAV 4 HARDBOTTOM HABITAT 5 ESSENTIAL FISH HABITAT 5 ESSENTIAL FISH HABITAT 6 PROTECTED SPECIES 7 BIRDS 8 INVASIVE SPECIES 9 AIR QUALITY 10 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE 11 NOISE 12 COASTAL BARRIER RESOURCES 13 CULTURAL AND HISTORIC RESOURCES 14 AESTHETICS 15 RECREATION	4-24

5.2 5.2.	CUMULATIVE EFFECTS
6 E	NVIRONMENTAL COMPLIANCE* 6-1
6.1	SCOPING
6.2	COOPERATING AGENCIES
6.3	LIST OF RECIPIENTS
6.4	COMMENTS RECEIVED AND RESPONSE
6.5	ENVIRONMENTAL COMMITMENTS
6.6	COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS
6.6.	1 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) OF 1969
6.6.	2 ENDANGERED SPECIES ACT OF 19736-4
6.6.	3 FISH & WILDLIFE COORDINATION ACT OF 19586-4
6.6.	4 NATIONAL HISTORIC PRESERVATION ACT OF 1966 (INTER ALIA)
6.6.	5 CLEAN WATER ACT OF 19726-5
6.6.	6 CLEAN AIR ACT OF 19726-5
6.6.	7 COASTAL ZONE MANAGEMENT ACT OF 19726-5
6.6.	8 FARMLAND PROTECTION POLICY ACT OF 19816-5
6.6.	9 WILD AND SCENIC RIVER ACT OF 19686-6
6.6.	10 MARINE MAMMAL PROTECTION ACT OF 19726-6
6.6.	11 ESTUARY PROTECTION ACT OF 19686-6
6.6.	12 FEDERAL WATER PROJECT RECREATION ACT6-6
6.6.	13 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT OF
197	6 6-6
6.6.	14 COASTAL BARRIER RESOURCES ACT AND COASTAL BARRIER IMPROVEMENT
AC	F OF 19906-7
6.6.	15 RIVERS AND HARBORS ACT OF 18996-7
6.6.	16 ANADROMOUS FISH CONSERVATION ACT 6-7
6.6.	17 MIGRATORY BIRD TREATY ACT AND MIGRATORY BIRD CONSERVATION ACT6-7
6.6.	18 UNIFORM RELOCATION ASSISTANCE AND REAL PROPERTY ACQUISITION
POl	ICIES ACT OF 19706-7
6.6.	19 EXECUTIVE ORDER (EO) 11990, PROTECTION OF WETLANDS
6.6.	20 E.O 11988, FLOOD PLAIN MANAGEMENT6-8
6.6.	21 E.O. 12898, ENVIRONMENTAL JUSTICE6-10
6.6.	E.O. 13045, DISPARATE RISKS INVOLVING CHILDREN6-10
6.6.	E.O. 13089, CORAL REEF PROTECTION
6.6.	24 E.O. 13112, INVASIVE SPECIES
6.6.	25 ENVIRONMENTAL OPERATING PRINCIPLES6-11
7 R	ECOMMENDATIONS

San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

7.1	ITEMS OF LOCAL COOPERATION	7-1
8	LIST OF PREPARERS	
8.1	PREPARERS	8-1
8.2	REVIEWERS	8-1
9	REFERENCES AND INDEX	
9.1	REFERENCES	9-1
9.2	INDEX	9-3

Introduction

Puerto Rico is significant to the nation with its rich cultural heritage, unique environmental resources, and tourism. Storms and hurricanes put Puerto Rico's metropolitan areas, with their dense populations, at risk of coastal flooding. Coastal flooding from storms and hurricanes has been increasingly evident over past years, with special attention on the storm season in 2017, which left destruction from multiple hurricanes, such as Hurricane Maria, Hurricane Irma, and winter storm Riley.

This U.S. Army Corps of Engineers (USACE) report is an interim response to the study authority to determine Federal interest in a plan to reduce damages as a result of coastal flooding from coastal storms and hurricanes in the San Juan Metropolitan (Metro) Area. More specifically, this study has assessed coastal flood risk from extreme high water events that result from storm surge, waves, tides and sea level change and combinations of these forces under the Coastal Storm Risk Management (CSRM) mission. The effects of sea level change (SLC), which is expected to exacerbate coastal flooding, have also been assessed. The study developed and evaluated CSRM alternatives for the San Juan Metro Area, which for this study includes the municipalities of San Juan, Cataño, Guaynabo, and Toa Baja. The alternatives described in this report are formulated to reduce risk to structures which house residents, industries, and businesses; associated structures; vehicles; and critical infrastructure which are critical to the nation's economy. Throughout the report, these will be collectively referred to as assets.

Purpose and Need

This study of the San Juan Metro Area began with the non-federal sponsor, the Department of Natural and Environmental Resources (DNER), bringing concerns about problems in the area to the U.S. Army Corps of Engineers (USACE). The year 2017 brought two back to back hurricanes, Irma and Maria, which caused widespread damages to homes and businesses. In response to these problems, USACE is pursuing this study, under Section 204 of the Flood Control Act of 1970, Public Law 91-611, with funds provided under the Bipartisan Budget Act (BBA) of 2018 Public Law 115-123.

The purpose of the San Juan Metro Area CSRM study is to determine if there is Federal interest in a Federal plan to reduce damages to assets as a result of coastal flooding from storm surge, tide and waves (rather than inland rainfall and stormwater runoff) during coastal storms and hurricanes along the back bay areas in the municipality of San Juan and adjacent municipality communities. The report has considered all alternatives and their effects, under the National Environmental Policy Act (NEPA) of 1969.

This report is an interim response to the study authority. Section 204 of the Flood Control Act of 1970, Public Law 91-611, authorizes the Secretary of the Army, acting through the Chief of Engineers, to prepare plans for the development, utilization and conservation of water and related land resources of drainage basins and coastal areas in the Commonwealth of Puerto Rico. Funds for this study were appropriated under Bipartisan Budget Act of 2018, Public Law 115-123.
EXECUTIVE SUMMARY

Study Area

Puerto Rico is the smallest of the Greater Antilles and is located in the Northeast of the Caribbean shield made up of the Greater Antilles and Minor Antilles. Vulnerability to hurricanes is primarily due to the proximity of Puerto Rico to the typical track of hurricanes as they move east to west across the Caribbean.

The study focuses on the critical areas most likely to experience damage from coastal flooding within the San Juan Metro Area, which include Reach 1, West San Juan Bay (WSJB) reach and Reach 3, Condado Lagoon (CL) reach. The study area for Reaches 1 and 3 encompasses roughly 9.5 square miles of area and contains approximately 22 structures identified as critical infrastructure, in addition to approximately 14 schools, and major hurricane and tsunami evacuation routes.

Reaches 1 and 3 (**Reference Figure 1-1 in Chapter 1**) were identified by the non-federal sponsor as highrisk coastal flooding areas to be studied under this scope, which was validated by community response during NEPA scoping meeting and confirmed using social vulnerability tools developed by South Atlantic Coastal Study (SACS). The team decided to assess the scope of coastal flooding beyond the initially identified areas to better understand the system influences. Areas were separated into 6 study reaches based on their respective watershed basins, and named accordingly: Reach 1 - West San Juan Bay, Reach 2 - East San Juan Bay, Reach 3 - Condado Lagoon, Reach 4 - Cano Martin Pena, Reach 5 - Los Corozos and San Jose Lagoon and Reach 6 -Torrecilla Lagoon. During further investigation, Reaches 1 and 3 were carried forward while Reach 2 was screened out from further analysis and Reaches 4-6 were de-scoped from this study and recommended to be included in a new study under the same authority. The rationale for these decisions is described further in Chapter 1, Section 1.5 of this report

The study area has approximately 20,000 assets with a combined estimated value of approximately \$3.4 billion. Coastal flooding from extreme high water events that result from storm surge, waves, and tides cause major damages to these assets, and will continue to do so with increased risk from sea level change. Additionally, coastal flooding is hazardous to the community, and negatively impacts the economic development of stores, hotels and restaurants, and decreases property values.

The Recommended Plan

This study analyzed 32 measures, resulting in a focused array of 18 alternatives which were then evaluated and compared according to USACE planning principles. The Recommended Plan reasonably maximizes net benefits to contribute to national economic development (NED) and is consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.

The Recommended Plan consists of a collection of key structural and natural and nature-based features in strategic locations designed to appropriate elevations which work together to reduce the risk of damages as a result of coastal flooding from extreme high water events that result from storm surge, waves, tides and sea level change, and combinations of these forces, in the San Juan Metro Area.

The Recommended Plan includes levees (1.5 miles), a series of breakwaters over 0.7 miles along the Cataño shoreline, seawall/floodwalls (6.5 miles), elevated living shoreline (0.7 miles), discharge structure on the Malaria Canal, and associated inland hydrology features (to ensure that rainfall runoff is able to continue to outflow as it currently does, with the Recommended Plan features in place). The

EXECUTIVE SUMMARY

Recommended Plan also contributes to creation of habitat. Although the Recommended Plan was formulated to avoid and minimize impacts to the extent practicable, impacts are expected to occur which is evaluated further in Chapter 5, and would be addressed through mitigation, which is evaluated in the preliminary mitigation plan in **Appendix F, Environmental, Attachment 4**, and in Chapter 4 in the Main Report. There is some uncertainty in terms of the quantity and siting of onsite compensatory mitigation which would be further evaluated during the PED Phase of the project when site-specific survey data is available. Upon final design, any functional lift (habitat creation) provided by the construction of the Recommended Plan would be incorporated into the functional assessment and the final mitigation plan. The graphic overview shows the Recommended Plan and key features in more detail.

Benefits of the Recommended Plan

This study concludes that there is Federal Interest in a cohesive plan to reduce the risk of storm surge and associated damages to the San Juan Metro Area, summarized in the graphic overview. The Recommended Plan brings benefits to the nation in all of the four Principles and Guidelines¹ (P&G) accounts under National Economic Development (NED), Environmental Quality (EQ), Regional Economic Development (RED), and Other Social Effects (OSE). Additionally, the Recommended Plan meets the planning criteria of being complete, efficient, effective, and acceptable. Under the National Environmental Policy Act of 1969 (NEPA), the Recommended Plan has been evaluated for effects, which are described in Chapter 5 in the Main Report. The USACE environmental operating principles² have been used throughout the planning process and identified and addressed specifically in Section 6.6.25 of the main report. The Recommended Plan is economically justified with a benefit to cost ratio of 4.8 (FY21 discount rate of 2.5%). These benefits, as well as incremental justification of the 5 reaches within the Recommended Plan is discussed in Section 4.2 of Chapter 4.

Sea Level Change (SLC)

Following procedures outlined in ER 1110-2-8162 and EP 1100-2-1, low, intermediate, and high sea level rise values were analyzed within the 50-year planning horizon and the 100 year adaptation horizon using the official USACE sea level change calculator tool. This analysis was used to inform the design of the features in the recommended plan, as well as to consider what adaptation strategies, if any, could be needed. Projections for sea level rise are based on a start date of 1992, which corresponds to the midpoint of the current National Tidal Datum Epoch of 1983-2001. In the future with-project and without-project conditions, sea level rise could be expected to increase by 0.58 (low), 1.26 (intermediate), and 3.39 feet (high) by year 2079 with respect to the above mentioned epoch for San Juan, Puerto Rico (Station ID 9755371). Under the intermediate curve within the 100-year horizon, no adaptation measures would be anticipated for the recommended plan. Other scenarios are discussed in Section 4.5.

¹ The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, established by the U.S. Water Resources Council on March 10, 1983, have been developed to guide the formulation and evaluation studies of the major Federal water resources development agencies. These principles and guidelines are commonly referred to as the "P&G," and will be cited throughout the plan formulation sections of this report.

² USACE has formalized its commitment to the environment by creating a set of "Environmental Operating Principles" applicable to all its decision making and programs. These principles foster unity of purpose regarding environmental issues and ensure that environmental conservation and preservation, and restoration are considered in all USACE activities.

FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

Environmental Considerations

The environmental quality account considers non-monetary effects on ecological, cultural, and aesthetic resources. Under this account, the preferred plan should avoid or minimize environmental impacts and maximize environmental quality in the project area to the extent practicable considering other criteria and planning objectives. After development of the focused array of alternatives, the team coordinated with resource agencies who participated during the team meetings. These meetings focused on the primary resources that could be impacted by the proposed alternatives. For the purposes of alternatives analysis, all action plans were compared to the future without-project condition (i.e., NEPA No Action³), which factors in 50 years of sea level change (to 2079). Effects for each alternative were evaluated, and were carefully considered during plan formulation and for selection of the Recommended Plan. More detailed descriptions of the analysis and impacts can be found in Section 5 of this report and in **Environmental Appendix F and Plan Formulation Appendix E**.

Cost Estimate and Implementation

Based on Fiscal Year 2021 (October 1, 2020 price levels), the estimated total project first cost of the Recommended Plan is \$365,190,000. In accordance with the cost sharing provisions of Section 103 of WRDA 1986, as amended, the non-federal sponsor must contribute a minimum of 35 percent of construction costs. The remaining portion of the non-federal share can be provided in lands, easements, rights-of-way, relocations and dredged or excavated material disposal areas; in-kind contributions; cash; or a combination. The estimated share of costs is adjusted based on Section 1156 of WRDA 1986, as amended (33 USC 2310), which provides a waiver for a portion of non-federal cost sharing for Puerto Rico, Territories, and Indian Tribes. As a result, the non-federal share would be reduced by \$511,000 and the federal and non-federal costs include the value of lands, easements, rights-of-way, relocations and disposal areas (LERRD) which are estimated at \$33,400,000. Project construction is assumed to begin in 2024 and take approximately 5 years, assuming concurrent construction crews in various locations.

WBS Code	Item	Total Project First Cost (FY21)
06	Fish & Wildlife Facilities ⁴	\$9,531,000
09	Channels and Canals	\$613,000
10	Breakwaters & Seawalls	\$88,900,000
11	Levees & Floodwalls	\$103,804,000
13	Pumping Plant	\$40,369,000
15	Floodway Control & Diversion Structures	\$22,950,000
01	Lands and Damages	\$28,881,000

Table ES-1-1. Recommended Plan Cost Summary (Project First Cost, FY21 Price Levels).

³ The future without-project (FWOP) condition is the consequence, 50 years into the future, of taking no action. For the purposes of simplicity in this report and to serve multiple audiences, term "no-action" will be used in combination with "future without-project condition" and understood as described in the sentence above.

⁴ "Fish and Wildlife Facilities" includes all estimated mitigation costs that may be required as a result of impacts to submerged aquatic vegetation (SAV), mangroves, and freshwater wetlands.

EXECUTIVE SUMMARY

30	Preconstruction, Engineering and Design (PED) ⁵	\$39,659,000
30	Real Estate Administration Cost (Fed)	\$3,051,000
30	Real Estate Administration Cost (non-fed)	\$4,542,000
31	Construction Management	\$22,890,000
	Project First Cost	\$365,190,000

Table ES-1-2. Summar	y of Project	Cost Sharing	(Project First	t Costs, FY21	L Price Levels).
----------------------	--------------	---------------------	----------------	---------------	------------------

Item	Federal Share	Federal Cost	Non- federal Share	Non-federal Cost	Project First Cost
Project First Cost	65%	\$237,374,000	35%	\$127,817,000	\$365,190,000
LERRD Credit ⁶				\$33,400,000	
Section 1032 of WRRDA 14 Waiver		\$511,000		(\$511,000)	
Adjusted Cost Share ⁷		\$237,885,000		\$127,306,000	
Non-Fed Cash Contribution ⁸				\$93,906,000	

Coordination with Agencies and the Public

Stakeholders include the communities in the municipalities of San Juan, Cataño, Guaynabo, and Toa Baja; Department of Natural and Environmental Resources (DNER), Puerto Rico Ports Authority (PRPA), Department of Public Works, San Juan Bay Estuary, as well as Federal environmental agencies, state and local agencies, and non-governmental organizations (NGO). The study team has met with communities during the studies, and has bi-weekly meetings with DNER, National Marine Fisheries Service (NMFS), and United States Fish and Wildlife Service (USFWS).

All environmental compliance is complete. The Section 106 Programmatic Agreement (PA) has been signed by the Jacksonville District Engineer and Puerto Rico SHPO, executed on March 15, 2021. The PA can be found in **Cultural Resources Appendix H**. Endangered Species Act (ESA) concurrence was received from USFWS on 31 August 2020 and the NMFS letter of concurrence was received on 14 January 2021. With regard to the water quality certification (WQC), a letter was received from DNER on 23 November 2020, which stated that the proposed Federal activities are conditionally consistent with and are not likely

⁵ The 30 account includes an estimate for cultural resource surveys to be conducted during PED. Based on current information, experience, investigations, and methods to avoid mitigation, there is a low likelihood of requiring mitigation for historic properties and therefore costs for mitigation of historic properties have not been assigned to the 18 account.

⁶ This includes Lands, Easements, Relocations, Right-of-Way, and Disposal areas (LERRD) plus non-federal administrative costs.

⁷ Cost share is adjusted in the amount of \$511,000 per Section 1156 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2310).

⁸ Cost share cash contribution when both adjustments for \$511,000 per Section 1156 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2310), and LERRD credit, are applied.

FINAL INTEGRATED FEASIBIILITY REPORT AND ENVIRONMENTAL ASSESSMENT

EXECUTIVE SUMMARY

to exceed the water quality standards and that DNER is likely to issue a WQC once DNER receives enough information in a WQC request. The WQC will be requested during the PED phase. Essential Fish Habitat (EFH) consultation was initiated with release of the draft report and NMFS EFH conservation recommendations were received 14 September 2020; SAJ responded 5 October 2020 completing USACE requirements for EFH consultation under the Magnuson-Stevens Fishery Conservation Management Act (MSFCMA) EFH provisions. Coastal Zone Management Act (CZMA) concurrence was received on 28 October 2020. All correspondence as described above can be found in **Environmental Appendix F, Attachment 5**.

Residual Risk

The proposed project would greatly reduce, but not completely eliminate, future coastal storm risk and damages which result from coastal flooding within the project area. Coastal storm damages, caused primarily by coastal flooding, would be reduced by approximately 98% to 100% in the location of the project area over the 50 year period of analysis; therefore, the residual damages would be in the range of 0% to 2%. Periodically revisiting sea level rise trends described earlier will be crucial for adaptive management to manage risk.

The Recommended Plan is designed to reasonably maximize net NED benefits in accordance with ER 1105-2-100 rather than to achieve a specific level of protection. The future without project damages modeled by Generation II Coastal Storm Risk Model (G2CRM) show that the vast majority of damages occur at or below the 1% annual exceedance coastal flood elevation, which is a storm water level that has a 1% chance of occurring in any given year.

Reaches West San Juan Bay 1A and East San Juan Bay were screened out from the study after the analysis showed that minimal damages are occurring in these areas. The cost to build a project in these reaches to reduce the damages would be higher than the benefit received. As a result, these areas are not economically feasible to pursue; along with additional considerations under planning criteria, these reaches were screened from further analysis. However, the low damages shown by the analysis indicates there is low risk of coastal flooding damages to the communities.

Preliminary analysis by the team showed that there are flooding problems in reaches 4 through 6, resulting in potential risk of damages to assets and socially vulnerable communities from hydrologically induced flooding (precipitation) in addition to storm surge. These areas are recommended to be evaluated under a separate study in order to adequately address both storm surge and precipitation holistically. The same study authority that is used for this study could be used. The risk of coastal flooding in theses reaches is not affected by the proposed Recommended Plan.

San Juan Metro Area Coastal Storm Risk Management (CSRM) Study, Puerto Rico

INTRODUCTION

BACKGROUND

Puerto Rico is significant to the nation with its rich cultural heritage, unique environmental resources, and tourism. Storms and hurricanes put Puerto Rico's metropolitan areas, with their dense populations, at risk of coastal flooding. The study area within the San Juan Metro Area has approximately 20,000 assets, with a combined estimated value of approximately \$3.4 billion. Coastal flooding from storm surge, tide and wave contributions cause major damages to these assets and will continue to do so with increased risk from sea level change.

PROBLEMS



- Communities experience coastal flooding damages, which results from storm surge, tide, and wave contributions.
- 2. Community resilience is impacted before, during and after storms and hurricanes.
- 3. Future sea level rise conditions will exacerbate these problems.

STUDY AUTHORIZATION AND PROCESS

Authority for the San Juan Metro (back bay) Coastal Storm Risk Management (CSRM) study is granted under Section 204 of the Flood Control Act of 1970, Public Law 91-611. Study funds were appropriated under Bipartisan Budget Act of 2018 Public Law 115-123.

fema.gov



Final Integrated Feasibility Report & Environmental Assessment

ECONOMICS – The National Economic Development Plan (NED)

Recommended Plan ECONOMIC SUMMARY (FY21 price level, 50-year period of analysis, 2.5% discount rate)				
Total Average Annual Cost	\$15.3M	50 40		
Average Annual Total Benefits	\$72.9M	30 20		
Average Annual Net Benefits	\$57.6M			
Benefit Cost Ratio (BCR) (2.5 % discount rate)	4.8	202		

ENVIRONMENTAL & CULTURAL RESOURCES

The National Environmental Policy Act (NEPA) is a federal law enacted in 1969. As required by NEPA, the Corps has assessed potential environmental effects, including cultural resources, of alternatives and the Recommended Plan. The findings are explained in the NEPA document, which is integrated into this Final Report and Environmental Assessment. Although the NED plan was formulated to avoid and minimize impacts to every extent possible, impacts are expected to occur to submerged aquatic vegetation (SAV), mangroves, and wetlands, and would be addressed with mitigation close to the project site. Environmental compliance for this feasibility report is complete.

FNGINFFRING & MODFLING

STILLWATER ELEVATION

---- INORMAL HIGH TIDE

STORM SURGE & WAVE SETUP



RECOMMENDED PLAN & BENEFITS

The Recommended Plan reasonably maximizes net benefits to contribute to national economic development (NED) and is consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.



EQ

flooding with approximately 98-100% reduction in damages to assets Risk reduction to Hurricane and Tsunami Emergency evacuation route

TOTAL =20,000 assets, estimated value of \$3.48 Population: ~2 Million

Elevated living shoreline will create habitat Potential Incidental water quality improvements

Although the NED plan was formulated to avoid and minimize impacts to every extent possible, impacts are expected to occur and would be addressed with mitigation Anticipated that mitigation can be constructed close by

U.S. ARMY CORPS OF ENGINEERS



The graph shows that benefits would be expected to begin in the year 2029. Recommended Plan is 98% to 100% effective at reducina damages.



Economic damages The engineering analysis for this study has considered the natural coastal processes, geological setting, existing protective features in the study area, as well as sea level rise scenarios. The team has leveraged data and local expertise from the sponsor (PR DNER) and other aroups (PR Academia, stakeholders, Federal agencies, etc.) along with modeling to order to fully understand the problems and develop alternatives to reduce storm damages within the study area. The Corps certified model Generation II Coastal Storm Risk Model (G2CRM) was used for this study.



Maintains life safety

Reduces flooding frequency and duration for both major storm events and nuisance tidal flooding (Condado Lagoon) Increases community resilience associated with sea level rise for entire San Juan Metro Area Existing recreational facilities are not impacted Some features contribute to incidental opportunities for outdoor activities Public access to water is maintained Features work together to strengthen economy of the metro area



San Juan Metro Area Coastal Storm Risk Management (CSRM) Study, Puerto Rico THE RECOMMENDED PLAN A Cohesive Plan to Reduce the Risk of Damages from Coastal Flooding in the San Juan Metro Area



Final Integrated Feasibility Report & Environmental Assessment

JUCI



KEY FEATURES Structural

- Levees = 1.5 miles
- Seawall/floodwall = 6.5 miles
- 1 Discharge Structure (Malaria Canal)
- Natural & Nature Based Features (NNBF)
- Elevated living shoreline = 0.7 miles
- Breakwater = 0.7 miles
- Habitat creation (Elevated Living shoreline)
- Mitigation for SAV, mangroves, wetland

Incidental recreation opportunities *It is also recommended that the nonfederal sponsor pursues non-structural measures such as local outreach & evacuation plan/notification

improvements PROJECT FIRST COST*: \$365.2M (*includes 37% risk-based contingency) Federal Cost (65%): \$237.9M** Non-Federal Cost (35%): \$127.3M** (**Section 1032 of WRRDA 14 was applied)

AVG OPERATION & MAINTENANCE: Estimated \$819,000/year over 50-year period of analysis

AAEQ NET BENEFITS: \$57.6M AAEQ Benefits: \$72.9M AAEQ Costs: \$15.3M

BCR: 4.8 at 2.5%



U.S. ARMY CORPS OF ENGINEERS





1 INTRODUCTION*

1.1 FEDERAL STUDY PURPOSE*

This U.S. Army Corps of Engineers (USACE) study evaluates alternatives and recommends a Federal project to reduce coastal flooding from storms and hurricanes within the San Juan Metro Area. More specifically, this study has assessed coastal flood risk from extreme high water events that result from storm surge, waves, tides and sea level change and combinations of these forces under the Coastal Storm Risk Management (CSRM) mission. The effects of sea level change (SLC), which is expected to exacerbate coastal flooding, will also be assessed. The study develops and evaluates CSRM alternatives for the San Juan Metro Area, which for this study includes the municipalities of San Juan, Cataño, Guaynabo, and Toa Baja. The alternatives described in this report are formulated to reduce risk to structures which house residents, industries, and businesses; associated structures; vehicles; and critical infrastructure⁹ which are critical to the nation's economy. Throughout the report, these will be collectively referred to as assets.

1.2 STUDY SPONSOR

The non-federal sponsor for this study is the Puerto Rico Department of Natural and Environmental Resources (DNER).

1.3 STUDY AUTHORITY

Authority for the San Juan Metro CSRM study is granted under Section 204 of the Flood Control Act of 1970, Public Law 91-611 which authorizes the Secretary of the Army, acting through the Chief of Engineers, to prepare plans for the development, utilization and conservation of water and related land resources of drainage basins and coastal areas in the Commonwealth of Puerto Rico. Funding for this study was appropriated under Bipartisan Budget Act of 2018, Public Law 115-123. The full text of the authorization is as stated below

SEC. 204. (a) The Secretary of the Army, acting through the Chief of Engineers, is authorized to cooperate with the Commonwealth Puerto Rico, political subdivisions thereof, and appropriate agencies and instrumentalities thereof, in the preparation of plans for the development, utilization, and conservation of water and related land resources of drainage basins and coastal areas in the Commonwealth of Puerto Rico, and to submit to Congress reports and recommendations with respect to appropriate participation by the Department of the Army in carrying out such plans. Such plans that may be recommended to the Congress shall be harmonious components of overall development plans being formulated by the Commonwealth and shall be fully coordinated with all interested Federal agencies.

(b) The Secretary of the Army, acting through the Chief of Engineers, shall consider plans to meet the needs of the Common wealth for protection against floods, wise use of flood plain lands, improvement of navigation facilities, regional water supply and waste management

⁹ Critical infrastructure is referred to throughout this report as structures which serves a critical function to the community, and therefore may have increased risk of negatively impacting the community's resilience in terms of health and safety during and after a storm event. Critical infrastructure in this report is as follows: hospitals, care facilities, police stations, fire departments, airports, shelters, and hurricane/tsunami evacuation routes.

systems, outdoor recreational facilities, the enhancement and control of water quality, enhancement and conservation of fish and wildlife, beach erosion control, and other measures for environmental enhancement.

1.4 LOCATION AND NEED*

Puerto Rico is the smallest of the Greater Antilles and is located in the Northeast of the Caribbean shield made up of the Greater Antilles and Minor Antilles. In addition, it is in the 18.5 ° N parallel of the Tropic of Cancer at latitude 65 ° W. Vulnerability to hurricanes is primarily due to the proximity of Puerto Rico to the typical track of hurricanes as they move east to west across the Caribbean. The San Juan Metro Area is located in the northeastern portion of Puerto Rico. This study includes the municipalities of San Juan, Cataño, Guaynabo, and Toa Baja. The location and vicinity map is shown in the **graphic overview**.

Puerto Rico is significant to the nation with its rich cultural heritage, unique environmental resources, and as an international tourist destination. Problems from storms and hurricanes have been increasingly evident over past years, with special attention on the storm season in 2017 which left destruction from multiple hurricanes, such as Hurricane Maria, Hurricane Irma, and winter storm Riley.

At least 16 major hurricanes have affected the study area since late 1893, as described below in **Table 1**. Two of the most damaging hurricanes, Hugo and Maria, are described below, and help to demonstrate the need for a project to reduce coastal flooding associated with hurricane and storm events.

Month/Year	Name	Category
August 1893	San Roque	N/A
August 1899	San Ciriaco	N/A
September 1928	San Felipe II	Category 5
September 1931	San Nicolás	Category 1
September 1932	San Ciprián	Category 3
September 1956	Santa Clara	Category 1
September 1989	Hugo	Category 4
September 1995	Marilyn	Category 2
September 1996	Hortensia	Category 1
September 1998	Georges	Category 3
September 2004	Jeanne	Tropical Storm
August 2011	Irene	Tropical Storm
September 2011	Maria	Tropical Storm
August 2015	Erika	Tropical Storm
September 2017	Irma	Category 5
September 2017	Maria	Category 4

Table 1-1. Hurricanes affecting the study area since 1893.

San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT According to the National Academies of Sciences, Engineering, and Medicine (*Hurricane Hugo, Puerto Rico, the Virgin Islands, and Charleston, South Carolina, Sept 17-22, 1989*) Hurricane Hugo was a Category 4 storm when it crossed the Caribbean islands. Hugo subjected northeastern Puerto Rico to hurricane-force winds and rains and causing extensive damage, particularly in the San Juan area. Damage to buildings ranged from smaller damages to total devastation. Many roofs were damaged or destroyed, as well as doors, windows, and cladding. Several important lifeline systems were interrupted or damaged. Damages were estimated at about \$3 billion in the Caribbean.

Hurricane Maria made landfall to the coast of Puerto Rico as a Category 4 hurricane on September 20, 2017. The National Hurricane Center, Tropical Cyclone Report, Hurricane Maria, 16-30 September 2017, revised 14 Feb 2019, states the following: "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 billion¹⁰, 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 as well as the south coasts of Vieques and St. Croix. Along these areas, marinas and harbors were severely damaged due to the combination of the waves and currents associated with the surge. 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." Relative to this study, the above description describes the broad damages reaching beyond the study area, and includes not only storm surge damage, but wind and economic loss as well. It is extremely relevant to describe the destruction that can be associated with hurricanes relative to associated storm surge, and the uncertainty of where hurricanes will strike.

In the wake of Hurricane Maria and Hurricane Irma, a report was produced called the Housing Damage Assessment and Recovery Strategies Report, Puerto Rico, June 29, 2018. The data presented below is from that report and reflects the 2016 American Community Survey (ACS 2016) for population and assessed FEMA verified loss (FVL) per registrant across municipalities in Puerto Rico. Data from that report was pulled for the municipalities of Cataño, Guaynabo, and San Juan, within the study area, shown in **Table 1-2.** The data shows there were \$108,520,604 in damages after those storms, compiled from those who registered. It should be noted that the vast majority of damages from Hurricane Maria includes not only storm surge damage, but wind and economic loss as well. It should also be noted that Hurricane Maria did not directly strike the San Juan Metropolitan area. If it had, it is assumed the damages would likely be even more costly.

¹⁰ A confidence range is used to describe uncertainty in an estimate.

	ACS Pop			Moderate	Major		Total With	FVL per
Municipality	2016	Registrants	Total FVL*	Damage†	Damage	Destroyed	Damage	Registrant
Catano	26,137	7,727	\$9,774,184	1,895	79	19	1,993	\$1,265
Guaynabo	92,444	27,996	\$25,985,124	5,822	161	63	6,046	\$928
San Juan	363,744	122,302	\$72,761,296	16,573	522	164	17,262	\$595
			\$108,520,60					
Total	482,325	158,025	4	24,290	762	246	25,301	\$687

Table 1-2. Compiled data from FEMA and Housing and Urban Development (HUD) data¹¹.

Also associated with Hurricane Maria, FEMA provided significant assistance through the Individuals and Households Program (IHP) to the municipalities in the study area, which includes San Juan, Guaynabo, and Cataño. In total, FEMA provided \$90.7M in aid to these municipalities

(https://www.fema.gov/disaster/4339). This aid does not represent the full extent of damages to the San Juan Metropolitan area, as it represents only a portion of damages are awarded in aid on a situational basis.

According to the National Hurricane Center Tropical Cyclone Report, Hurricane Maria, 16-30 September 2017, a National Ocean Service (NOS) tide gauge in San Juan Bay measured a storm surge of 2.4 ft, but the sensor went offline for a period and may not have recorded the highest water level. Across the island, many buildings suffered significant damage or were destroyed.

The immediate project area has experienced varying storm events ranging in severity. The largest surge event recorded during the relatively short period of record (approximately 42 years) at the NOAA gauge within San Juan (9755371) had a resultant annual exceedance probability (AEP) of 6.5%. This means that the largest surge event recorded in the past 42 years in the project area has a 6.5% chance of being exceeded each year. There is data available island-wide for past storms and from FEMA Verified Loss (FVL) and within the study area, which is provided above. However, the data does not specifically isolate estimates of inundation and wave attack from storm damages from Maria or other past storms in the study area. For context purposes, modeling of the study area has been conducted to estimate what storm damages could potentially occur if the study area experienced an AEP event between 33% and 0.2% (Storm events with a 33% to .20% chance of occurring in any year). Damages were modeled for a wide range of plausible storms, some of which have the potential to be much more catastrophic than Maria, and showed that economic damages to structures and contents could occur in an upper bound of \$460M.

In summary, the information that is provided in this section, such as summaries of FEMA data and modeling results that give insight into potential storms, provide evidence that there is legitimate need for coastal flooding management in the study area to prevent future damages from coastal flooding, which may be made worse by sea level changes. Sections 2, 3 and 4 of this report, as well as Appendix A, Engineering and Appendix C, Economics, provide more details about the modeling completed for this study. The results of those analyses show the difference that a potential project in this study area could make.

¹¹ Housing Damage Assessment and Recovery Strategies Report, Puerto Rico, June 29, 2018, Appendix B.

^{*} FEMA Verified Loss

1.5 STUDY BACKGROUND AND SCOPING

Originally, the study was scoped to assess shoreline erosion along the ocean-facing coastline of the San Juan Metro Area. A NEPA scoping meeting was held in San Juan on November 8, 2018 where the study team presented the general study scope and requested feedback from communities. During that process, several communities expressed concerns of coastal flooding on bay and estuarine shorelines in locations such as in the Cataño municipality, as well as the Condado Lagoon area within the San Juan municipality. As a result, the feasibility of addressing shoreline erosion on beach systems and ocean-facing shorelines as a Federal project along the coastline of the San Juan Metro area was incorporated into another ongoing USACE study, called the Puerto Rico Coastal Storm Risk Management (CSRM) Study (reference Section 1.7 for a brief description), to allow this study to focus solely on bay and estuarine coastal flooding. There is no overlap in the study areas for these two projects, and each study has separate problems and objectives which can be addressed independently of one another though collectively they provide complimentary risk reduction to San Juan and Puerto Rico. The non-federal sponsor, DNER, also supported the decision to rescope the study and echoed support for the study to focus on coastal flooding in the Condado Lagoon and Cataño back bay areas.

This study has assessed coastal flooding risks to bay and estuarine shoreline flooding areas, generally defined as areas connected to tidally influenced bays and estuaries which are hydraulically connected to the ocean. Throughout this report the term "coastal flooding" will be used to refer the flood levels generated by a storm event which includes contributions from storm surge, waves and astronomical tide. Sea level change will also be assessed as it is anticipated to exacerbate the impacts of coastal flooding.

Reaches 1 (Cataño) and 3 (Condado Lagoon) were identified by the non-federal sponsor as high-risk coastal flooding areas to be studied under this scope, which was validated by community response during NEPA scoping meeting and confirmed using social vulnerability tools developed during South Atlantic Coastal Study (SACS). The team decided to assess the scope of coastal flooding beyond the initially identified areas to better understand the full potential of coastal flooding in the area.

To do this, three data sets were overlaid in Geographic Information System (GIS) to determine the study area extent based on a high risk of storm surge and sea level rise. These three data sets are: 1) Flood Risk Zones (FEMA 2018 Advisory: 0.2% VE & AE Flood Zones¹²; 2) Sea Level Rise Forecasts (NOAA sea level viewer at 6 feet above MHHW); and 3) Flooding (ADCIRC + SWAN: Cat 5 Maximum of MEOW's (Maximum Envelopes of Water¹³) plus 1 meter sea level rise) (**Figure 1-2**).

¹² Represents flooding that could occur from a storm with a 2% chance of occurring, in VE and AE zones. VE and AE flood zones are defined by FEMA.

¹³ Flooding that could occur from a category 5 hurricane. MEOW is Maximum Envelope of Water, which is maximum storm surge footprint from each simulation is composited, retaining the maximum height of storm surge in a given basin grid cell, using ADCIRC and SWAN models.





Areas within this initially defined region were separated into 6 study reaches based on their respective watershed basins, and named accordingly: Reach 1 - West San Juan Bay, Reach 2 - East San Juan Bay, Reach 3 - Condado Lagoon, Reach 4 - Cano Martin Pena, Reach 5 - Los Corozos and San Jose Lagoon and Reach 6 -Torrecilla Lagoon. Ultimately, Reaches 1 and 3, which include Cataño and Condado Lagoon respectively, were carried forward while Reaches 4-6 were de-scoped from this study, and Reach 2 was screened out from further analysis in this study. The rationale for this de-scoping of these areas is described in the following discussions.

Reaches 4-6 are recommended to be deferred to a future study. The risk of deferring the study of these reaches to a future study is tolerable. Preliminary analysis by the team showed that there are flooding problems in reaches 4 through 6, resulting in potential risk of damages to assets and socially vulnerable communities as a result of predominately hydrologically induced inland flooding (precipitation) as well as smaller parts of coastal flooding. This is different from Reaches 1 and 3 where reaches experience problems as a result of predominately coastal flooding rather than inland flooding. As a result, reaches 4-6 are recommended to be evaluated under a separate study in order to adequately address both inland flooding and coastal flooding holistically. The same study authority that is used for this study could be used. The risk of flooding in theses reaches is not affected by the proposed Recommended Plan.

Reach 2 was also screened from further analysis, with support from the sponsor. The majority of the area in Reach 2 is owned, operated and maintained by the Port of San Juan, with some residential areas around the perimeter area on higher ground. Modeling of future without-project conditions showed that damages were very low. After further analysis, it was determined that the cost of the most likely alternatives to reduce damages in the area would be higher than the benefits, creating negative net benefits and a benefit to cost ratio less than 1.0. There would appear to be minimal risk of coastal flooding

damages in this area in the future without-project condition due to structures and infrastructure existing on high ground that is set back from coast. More details on the analysis leading to this decision can be found in Section 2.7.4.

The reduced study area (**Figure 1-3**) includes the initially scoped high-risk reaches, Reach 1, known throughout this report as the WSJB reach, and Reach 3, known throughout this report as Condado Lagoon (CL) reach. The combined study area encompasses roughly 9.5 square miles of area, with approximately 20,000 assets, including approximately 22 structures identified as critical infrastructure, in addition to approximately 14 schools, and major hurricane and tsunami evacuation routes.





REACH 1 - WEST SAN JUAN BAY

This reach encompasses an area which is approximately 9 square miles, and which is located to the West and South of San Juan Harbor. This reach contains portions of the municipalities of Cataño, Guaynabo, and San Juan. This area experiences not only coastal flooding from storm surge, as well as being at risk for sea level change, but the Cataño shoreline in particular experiences wave attack from waves approaching through the harbor. This reach contains approximately 16 structures identified as critical

infrastructure, one of which is a major hurricane and Tsunami evacuation route (PR-165)¹⁴, in addition to 14 schools and 4 assembly points¹⁵ (Tsunami Program Map Tool, <u>http://prddst.uprm.edu/apps/prtmp/</u>).

This reach was further delineated into 5 planning reaches, based on geographic features and how coastal flooding would interact with different areas of the study area. Throughout this report, they are called WSJB-1a, WSJB-1b, WSJB-2, WSJB-3, and WSJB-4 (See **Figure 1-4**). Each planning reach is separable from one another, meaning that any measure/alternative ultimately used for each area would not reduce storm surge risk in any of the other planning reaches.

REACH 3 – CONDADO LAGOON

This reach encompasses an area which is approximately .5 square miles, located to the East of San Juan Harbor and bordering the Condado Lagoon. This reach is within the San Juan municipality and suffers from storm surge and tidal influences from Condado Lagoon. This area experiences frequent flooding from extreme tides and well as storms. This area also serves as a major throughway to communities evacuating from the west, and houses major Tsunami and Hurricane evacuation route PR-26. This reach is also at risk from sea level change. This reach remains as one planning reach, and is called CL-1 throughout this report.

Figure 1-3. Six Planning Reaches in the Study Area.



¹⁴ GIS data is from FEMA Caribbean Division and was collected in 2016 & 2017.

¹⁵ Assembly points are a location for information updates from emergency responders.

San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

1.6 RISK INFORMED DECISION FRAMEWORK & STUDY TIMELINE

The evaluation and planning of coastal storm risk projects requires that risk management decisions are made despite significant uncertainty in factors such as storm occurrence and sea level change, to name just a few. The risk management framework is a decision making framework that allows USACE remain efficient and effective in making decisions given uncertainty with today's complex challenges and limited resources.

Since the inception of "SMART Planning" in 2011, where feasibility studies are required to be completed in 3 years and with \$3M, USACE Planning has engaged in a significant transformation in the incorporation of risk-informed, decision-focused thinking into planning processes. The process emphasizes that study teams should use a reasonable level of detail to collect data and model alternatives to analyze and evaluate effectiveness in order to identify a USACE recommended plan.

Risk-informed planning embodies all the principles and tasks of the USACE risk management framework and the six-step planning process. This paradigm shift to explicitly assessing and managing risk is more important than ever in meeting the USACE Civil Works mission.

The study schedule and milestones are shown in **Figure 1-5**. Key Milestones during the Feasibility Phase are described as follows:

- 1. <u>Alternatives Milestone Meeting (AMM)</u>: The Alternatives Milestone meeting marks the decision maker's agreement on a clear and logical formulation and evaluation rationale that indicates the study team is making appropriate risk-informed decisions and has a clear direction on next steps to complete the study. This milestone was achieved on December 13, 2018.
- 2. <u>Tentatively Selected Plan Milestone (TSP)</u>: At this milestone, the study team has completed the evaluation and comparison of a focused array of distinctly different strategies for achieving the water resources objectives in the study area and identified a Recommended Plan to carry forward. This milestone was achieved on June 16, 2020. At this point in the study, the Recommended Plan has been characterized to a level of detail consistent with an approximately 10% level of design for structural and nonstructural measures. During feasibility level design, the designs, cost estimates, and benefit analysis will be refined for both structural and nonstructural measures included in the TSP. Risk and uncertainty will also be evaluated to determine ranges of economic benefits and costs and project performance in order to meet the requirements of ER 1105-2-101.
 - <u>Release Draft Report for Public and Agency Review</u>: This integrated draft feasibility report and EA documents the analysis that led to the selection of the Recommended Plan to a level of detail required for the release for concurrent public, technical, legal, and policy review and independent external peer review (IEPR).
- 3. <u>Agency Decision Milestone</u>: The study team has also identified additional analysis that is needed following the release of the draft report to develop sufficient cost and design information for the final feasibility-level analysis and feasibility report/EA. The Feasibility Level Design becomes the agency recommended plan after the Agency Decision Meeting. This phase of the study includes development of the Final Draft Report and additional design of

the recommended plan, approximately 35%, to reduce risk and uncertainty with cost data, engineering effectiveness, environmental impacts, and economic benefits.

- <u>Final Report Release for State & Agency Review</u>: This integrated final feasibility report and EA documents the analysis that led to the selection of the recommended plan and is released for public and agency final review and comment.
- 4. <u>Chief's Report:</u> If the recommended plan is supported by USACE decisions makers, it will receive an approved Chief's Report recommending it for Congressional authorization for construction.

The plan will then need to receive Congressional authorization appropriations for construction, and would be cost shared as appropriate between USACE and DNER. Upon receipt of these items, the project will continue to the preconstruction engineering and design (PED) phase where a more detailed analysis will be completed in order to develop plans and specifications needed to construct the project.

Figure 1-4. Feasibility Study Schedule and Milestones.



1.7 RELATED DOCUMENTS*

1.7.1 RELATED USACE AND NEPA STUDIES

The studies mentioned below are independent of the San Juan Metro Area CSRM study.

- <u>Puerto Rico Coastal Storm Risk Management Study</u>: This USACE study is currently in progress and is studying the feasibility of a Federal plan to reduce risk from erosion, wave attack, and inundation along beach and ocean-facing shorelines of San Juan and Rincon, Puerto Rico. This study is projected to complete the Chief's Report by October 2021.
- <u>South Atlantic Coastal Study (SACS)</u>: The SACS is underway and provides a risk management framework designed to help local communities better understand changing flood risks associated with climate change and to provide tools to help those communities better prepare for future flood risks. In particular, it encourages planning for resilient coastal communities that incorporates wherever possible sustainable coastal landscape systems that takes into account future sea level and climate change scenarios.
- <u>Puerto Rico Vulnerability Study:</u> This report was prepared by USACE, and finalized in October 2018, as the final report in a four phase series of reports to analyze evacuation behavior, shelters, hazards and vulnerability to hazards in Puerto Rico.

1.7.2 PRIOR NON-FEDERAL STUDIES

• <u>Coastal Engineering Handbook, Puerto Rico:</u> This handbook was produced by Tetra Tech for DNER in May 2019 as a means to provide best practices in coastal areas of Puerto Rico.

1.8 FEDERAL PROJECTS NEAR THE STUDY AREA

- <u>Caño Martín Peña Ecosystem Restoration Project</u>: The main purpose of the project is to clear vegetation in the Cano Martin Pena, and restore native vegetation along the fringes, allowing flow to be restored. Congress authorized the project in Section 5127 of the Water Resources Development Act (WRDA) of 2007, Public Law 110-114, with authorization contingent on the Assistant Secretary of the Army for Civil Works (ASA(CW)) reviewing a report prepared by the nonfederal interest and determining that the report meets the evaluation and design standards of the Corps and that the project is feasible. The report included an Environmental Impact Statement (EIS). On May 16, 2016, the ASA(CW) approved the Caño Martín Peña Ecosystem Restoration Project as feasible and an environmentally sound project.
- <u>Rio Puerto Nuevo Flood Control Project</u>: This project reduces the risk of damages from flooding as a result of rapid upstream runoff, inadequate channel capacity, constriction at bridges, and elimination of the floodplain by urbanization in the Rio Puerto Nuevo channel. The project includes 6 segments that will be constructed through separate contracts through 2032. A Chief's Report was signed on April 25, 1986. It was authorized under Section 401 of the Water Resources Development Act of 1986 (Public Law 99-662), with funding from the Bipartisan Budget Act of 2018 to address damages from Hurricanes Harvey, Irma and Maria. NEPA documents are studies were completed in 1984, 1993, and 2002. USACE will prepare additional NEPA documentation as appropriate during the PED phase.
- <u>San Juan Harbor, Puerto Rico Project</u>: This project incorporates improvements to the navigation channel to increase transportation cost savings and efficiencies in the harbor. Key features include widening the Army Terminal Channel from 250 feet to 450 feet, as well as flares in the Army Turning Basin, and a 1,050-foot expansion of San Antonio Channel. Deepening would also be implemented in Cut 6 (from 42 to 46 feet) and from 40 to 44 feet in Anegado Channel, Army Terminal Channel, and Army Channel Turning Basin. Additionally, San Antonio Channel and Cruise ship basin east would be deepened to a previously authorized depth of 36 feet (Currently only constructed to 30 feet). These features are shown in **Figure 1-6**. The approved integrated report contained an environmental assessment (EA). A Chief's Report was signed on August 23, 2018, and the project was authorized under Section 1401 of WRDA 2018.

In addition, authorization has been received for a WRDA 2016 Section 1122 Beneficial Use of Dredged Material project associated with outstanding submerged aquatic vegetation compensatory mitigation for impacts from prior dredging in 2001. The Section 1122 restoration plan proposes the placement of suitable dredged material from the San Juan Harbor Navigation Project into the artificial lagoon depressions. This has the potential to restore approximately 18 acres of seagrass habitat



Figure 1-5. San Juan Harbor, Puerto Rico Project.

• <u>San Juan Harbor Federal Navigation Project Under Section 1135 for Work at La Esperanza</u> <u>Peninsula:</u> This project falls under the Continuing Authorities Program (CAP), for ecosystem restoration in the La Esperanza area.

1.9 OTHER NON-FEDERAL PROJECTS ADJACENT OR NEAR TO STUDY AREA

- <u>La Concha Reefs near Condado</u>: This project is under development and proposes to alter wave energy in critical locations along the seaward shoreline of Condado where high wave energy causes damage and life safety hazards.
- <u>Malaria Control Canal Project</u>: The Department of Natural and Environmental Resources (DNER) Malaria Control Canal Project includes six sluice gates in combination with a pump station. The DNER pump stations are designed to work in tandem with the sluice gates are currently not under operation, although FEMA has supplied seven temporary pumps that operate at 15,000 gallons/minute each. Some of the sluice gates are fixed in the closed position.



2 EXISTING AND FUTURE WITHOUT-PROJECT CONDITIONS 2.1 GENERAL SETTING*

This chapter describes conditions as they currently exist, and as they are projected to exist if a project is not implemented, within the San Juan Metro Area, Puerto Rico. Information gathered in this step helps to describe the problems and opportunities and forecast future conditions. The future without-project (FWOP) condition is the most likely condition of the study area without construction of a Federal project. The future without-project (FWOP) condition is the most likely condition is the consequence, 50 years into the future, of taking no action. For the purposes of simplicity in this report and to serve multiple audiences, term "no-action" will be used in combination with "future without-project condition" and understood as described in the sentence above.

The San Juan Metro Area is significant to the nation with its rich historical and cultural heritage, environmental resources, and tourism, with approximately 2,000,000 people living and working in the area. San Juan Bay is the focal point for most of the past and present development within the San Juan metropolitan area, and the bay's drainage basin has been almost completely urbanized. The study area has approximately 20,000 assets¹⁶, including critical infrastructure (roads, hospitals, airports, utilities, etc.) with a combined estimated value of approximately \$3.4 billion. The San Juan Metro Area study area is approximately 9.5 square miles, spanning 6 reaches over 4 municipalities. The back bay portion of the San Juan Metro Area is influenced by tropical systems generally during the summer and fall and by northeasters during the late fall, winter, and spring. Although hurricanes typically generate larger waves and storm surge, northeasters can have a greater cumulative impact on the area due to longer storm duration and greater frequency of event occurrence. Periodic and unpredictable hurricanes and coastal storms, with their intense breaking waves and elevated water levels, can cause significant damage to the shoreline and back bay structures and critical infrastructure. Low elevations make this area particularly at risk for elevated water levels from coastal flooding during hurricanes and storms, which are expected to be exacerbated by sea level rise. The natural environment includes submerged aquatic vegetation (SAV), freshwater wetlands, and mangroves. Key species include but are not limited to swimming green and Hawksbill sea turtles (San Juan Bay), Antillean manatee and Yellow Shouldered Black Bird and Brown Pelican. The area is highly urbanized with dense populations. It contains concrete homes built at one level, with some high rises, and contains critical infrastructure including evacuation routes. The future without-project condition within the period of analysis (2029 to 2079) is identified as having continued damages to assets and degraded access to emergency services prior to, during and after future storm events. This will result in continued maintenance and reconstruction of structures and infrastructure following storm events. Life safety considerations also cannot be overstated and are described further throughout this chapter and Chapter 3. The effects of coastal flooding, including associated risks to the environment, safety risks, and frequent tidal flooding in Condado Lagoon (noted as an incidental problem in terms of this study's objectives), all of which negatively affect the economy and overall community resilience which will be further exacerbated by sea level rise. By the year 2079 sea level rise is forecast to increase by 0.58 feet under the USACE low curve; increase by 1.26 feet under the USACE intermediate curve; and increase by 3.39 feet under the USACE high curve.

¹⁶ The term "assets" is used throughout the report and is defined in this report as structures, vehicles, and critical infrastructure.

This chapter characterizes the setting in more detail, within four main environments: 1: Natural Environment, 2. Physical Environment; 3. Built Environment; and 4. Economic Environment. In additional to these descriptions, existing input into the USACE certified model is briefly discussed, which serves to verify the existing conditions and then estimates conditions projected out 50 years into the future. These conditions become the baseline of comparison for alternative evaluations for plan formulation (described in Chapter 3).

2.2 NATURAL ENVIRONMENT*

The San Juan Metro area is located on the North coast of Puerto Rico and has approximately 40 to 50 miles of heavily developed shoreline. San Juan Bay is directly connected to the Atlantic Ocean via the Boca del Morro which is the entrance to San Juan Harbor. Condado Lagoon lies to the east of San Juan Bay and Cataño and La Esperanza lie on the west side of San Juan Bay. La Esperanza Park contains an embayment with perimeter vegetation (generally mangroves and exotic species) and sandy beaches approximately 30-50 feet wide with vegetation in some locations on the north side. Condado Lagoon's shoreline consists primarily of vegetation (red and black mangroves), concrete seawalls, and nearshore submerged aquatic vegetation including sea grass.

2.2.1 WATER QUALITY

EXISTING CONDITION

The San Juan Bay estuary system includes San Juan Bay, Condado Lagoon, San José Lagoon, Los Corozos Lagoon, La Torrecilla Lagoon, and the Piñones Lagoon, as well as the interconnecting Martín Peña and San Antonio Channels and the Suárez Canal. "San Juan Bay is the focal point for most of the past and present development within the San Juan metropolitan area, and the bay's drainage basin has been almost completely urbanized. The intensity and diversity of human activities taking place within the metropolitan area have influenced the water and sediment quality of the estuary in many ways, impairing in many instances its functions and values (SJBEP 2000)". However, San Juan Bay's direct connection to the Atlantic Ocean via the Boca del Morro results in relatively high average dissolved oxygen levels between 5.0-6.5 mg/L and oceanic salinities of 33-37 ppt just below the water's surface (-2-feet) within San Juan Harbor (Anamar 2013). The Rio Puerto Nuevo turning basin is located in the southeast portion of the harbor near the mouth of the Puerto Nuevo River which is a large source of sediment and fresh water into the harbor. The River connects to the low flowing Caño Martín Peña which connects to the San José Lagoon. The Caño Martín Peña and San José Lagoon are severely degraded from highly turbid, organic and bacteria-rich waters with low levels of dissolved oxygen.

2.2.1.1 REACH 1 - WEST SAN JUAN BAY

San Juan Bay is microtidal and the western bay is shallow. Water circulation in this area is driven by the wind and by tidal currents, but is generally poor. In areas of limited circulation, such as La Esperanza, sediments accumulate. The Malaria Control Canal (MCC) carries urban storm runoff from low-lying residential and industrial areas of Cataño and drains into the embayment at La Esperanza Park. The Cano Aguas Frias drains cooling water outflow from the Palo Seco Power Plant, just north of La Esperanza Park, into northwest San Juan Bay. To the southeast, freshwater flows from the Puerto Nuevo River are driven by local rainfall which flushes untreated and treated stormwater runoff and wastewater from Caño Martín

Peña and San José Lagoon into the harbor. Despite this, the Puerto Rico Environmental Quality Board (EQB), through the promulgation of the Puerto Rico Water Quality Standards Regulation, has designated the waters of the San Juan Bay as "Class SC", where "Class SC" are coastal waters intended for uses where the human body may come in direct contact with the water (such as fishing, boating, etc.) and for use in propagation and preservation of desirable species. The turbidity standard for Class SC waters in Puerto Rico is not to exceed 10 nephelometric turbidity units (NTU), except by natural phenomena (EQB 2020).

2.2.1.2 REACH 3 – CONDADO LAGOON

Urban storm water and runoff, entering the lagoon primarily from the east end, degrades water quality. In addition, deep artificial depressions within the lagoon act as storage pools for organic matter and nutrients discharged into the lagoon. As a result, water quality is degraded and aquatic habitat, such as seagrasses, is negatively impacted.

FUTURE WITHOUT-PROJECT CONDITION

Coastal flooding of natural areas with associated sedimentation would continue to cause chronic increases in turbidity and sedimentation along and adjacent to the shorelines and degraded water quality in San Juan Bay and Condado Lagoon.

2.2.2 WETLANDS AND SUBMERGED AQUATIC VEGETATION (SAV)

2.2.2.1 REACH 1 - WEST SAN JUAN BAY

EXISTING CONDITION

Wetlands

Centuries of development have severely altered the natural ecosystems of San Juan Bay. Most of the shoreline is now hardened and developed. Despite this the San Juan Bay Estuary is the largest estuary in Puerto Rico, part of the National Estuary Program (NEP), and an estuary of national importance. Coastal mangrove wetland habitats occur throughout the estuary and within West San Juan Bay along the Cano Aguas Frias, La Esperanza Park (a dredged material placement area for construction of the Federal navigation channel between 1963-1965) and the MCC and at the mouth of the Puerto Nuevo River. Mangrove species found in San Juan Bay include: red (Rhyzophora mangle), black (Avicennia germinans), and white (Laguncularia racemosa). Like seagrasses (discussed below), mangroves are a highly productive habitat that "provide feeding, breeding, nesting, and roosting areas for birds, mammals, and reptiles, with the vegetative detritus of mangroves serving as the base of the food web for crabs, mollusks, shrimp, and fish, among others" (SJBEP, 2000). Mangroves are important for shoreline protection and stabilization. In addition, mangrove habitats provide many important ecological functions, including providing refugia for juvenile stages of managed fish species, and have been identified as significant resources for federally listed species. These systems also provide organic matter that forms the basis of a littoral-zone, marine food web. Sloughs (channels of slow-moving water) penetrate mangrove wetlands adjacent to channel areas. Some of these sloughs are natural, while some are man-made. These are extremely important areas that provide species with passageways for movement into and out of interior mangrove areas. They are also important for refuge and feeding areas for various fishes and invertebrates such as juvenile spiny lobster (Panulirus argus) and gray snapper (Lutianus griseus).

In addition to mangroves, palustrine emergent freshwater wetlands occur along the MCC. These areas have been degraded through anthropogenic alterations in the watershed resulting in poor water quality and reduced habitat value.

SAV

Submerged aquatic vegetation (SAV) consisting of marine macro-algae and seagrass occurs at scattered locations and generally at depths less than -15ft (-4.6m). Both red and green macro-algae are prevalent throughout the bay. Seagrass species include shoal grass (*Halodule wrightii*), paddle grass (*Halophila decipiens*), manatee grass (*Syringodium filiforme*), and turtle grass (*Thalassia testudinum*). Scattered turtle and paddle grass beds have been found in San Juan Bay (NOAA 2016; USACE 2017). These include mono-specific beds of paddle grass, mixed red and green macro-algae with paddle grass, and sparse turtle grass as documented with underwater video during benthic surveys conducted by the NMFS and the USACE from January through December 2016 (Reports available at:

http://www.saj.usace.army.mil/About/Divisions-Offices/Planning/Environmental-

Branch/Environmental-Documents/, Puerto Rico, San Juan Harbor Navigation Study, Appendix H1 & H2).

Seagrasses significantly modify the physical, chemical, and geological properties of coastal areas; they provide nutrients, primary energy, and habitats which sustain our coastal fisheries resources; and they provide foraging grounds for some endangered marine species (Vicente, 1990). Federally protected species such as green sea turtles (*Chelonia mydas*) and Antillean manatees (*Trichechus manatus manatus*) feed directly on seagrasses. Seagrass beds also serve as a substrate for epiphytes, such as filamentous algae and epiphytic diatoms, which in turn serve as food for invertebrates and fish.

FUTURE WITHOUT-PROJECT CONDITION

In the future without-project condition/No Action Alternative, coastal flooding of natural areas with associated sedimentation could negatively impact SAV, mangrove and palustrine emergent wetlands in the San Juan Bay area. In addition, mangroves could out compete and replace palustrine emergent wetlands with future SLR.

2.2.2.2 REACH 3 – CONDADO LAGOON

EXISTING CONDITION

Wetlands

Through the years, mangroves have been cleared around the shoreline of the Condado Lagoon for various reasons such as dredging and filling. Some mangrove still exists along the shoreline fringe. However, the growth of mangroves around the lagoon is restricted due to the shoreline stabilization (riprap) placed along some of the shoreline. The mangrove species found around the Condado Lagoon are: red (Rhyzophora mangle), black (Avicennia germinans), and white (Laguncularia racemosa). In an attempt to increase the acres of mangroves around the shoreline of the Condado Lagoon, the San Juan Bay Estuary Program (SJBEP) has in place a program to plant mangroves, which consists of restoring a portion of the fringing mangrove wetland along the shoreline of the Lagoon. The mangrove restoration effort is listed in the SJBEP Comprehensive Conservation and Management Plan as Action HW-3.

SAV

SAV within the Condado Lagoon consists of seagrass and algae. Four species of seagrasses have been documented to occur in the Condado Lagoon (MRI, 2005). Reported types of seagrasses are shoal grass (*Halodule wrightii*), paddle grass (*Halophila decipiens*), manatee grass (*Syringodium filiforme*) and turtle grass (*Thalassia testudinum*). However, during surveys in 2008 and 2011 S. filiforme was not observed throughout the lagoon. Three seagrass species were observed during the 2011 benthic survey: *H. decipiens, T. testudinum,* and *H. wrightii. H. decipiens* was the dominant seagrass. No *H. decipiens* occurrences were recorded below 6 m (20 ft.) at any of the investigated sites. *H. decipiens* was most abundant in the mid depth range 2.7 to 5.8 m (9.0 to 19.0 ft.), but did not occur any deeper than 5.7m (19 ft.). *T. testudinum* had the second highest number of occurrences. No *T. testudinum* was found deeper than 6.7 m (22.0 ft.). The highest numbers of *T. testudinum* were recorded at shallow (1.8 to 2.4 m [6 to 8 ft.]]) and mid-range depths (2.7 to 5.8 m [9 to 19ft]). *H. wrightii* was sighted in only one quadrant at a depth of 5.2 m (17.0 ft.).

A total of 13 different genera of macroalgae were observed during the 2011 benthic surveys. The different macroalgae genus observed were: *Acetabularia, Amphiroa, Batophora, Caulerpa, Dictyopteris, Dictyota, Gracilaria, Halimeda, Jania, Laurencia, Padina, Sargassum,* and *Udotea. Caulerpa spp., Dictyota spp., Acetabularia spp.*, and *Laurencia spp.* were the dominant genera. No macroalgae were recorded below 8 m (26 ft.).

FUTURE WITHOUT-PROJECT CONDITION

In the future without-project condition/No Action Alternative, coastal flooding of natural areas with associated sedimentation would continue to negatively impact SAV and mangroves in Condado Lagoon.

2.2.3 HARDBOTTOM HABITAT

2.2.3.1 REACH 1 - WEST SAN JUAN BAY

EXISTING CONDITION

In addition to the SAV, hardbottom habitat occurs within San Juan Bay but primarily adjacent to Boca del Moro (narrow, discontinuous linear or fringing "reef" consisting of corals covering fossil sand dunes [i.e., eolianites], **Figure 2-1**; Caribbean Fisheries Management Council [CFMC] 2004), along the Cataño shoreline (scattered rocks with macro-algae, **Figure 2-2**), and elsewhere on hard substrates (rocks, pilings, docks, bulkheads). Encrusting zoanthids, octocorals (*Leptogorgia, Briareum*), sponges, polychaetes, and sea stars have been documented. Hard corals (including seven (7) species listed as threatened under the ESA) are found on the fringing reefs along the northern coastline out of the action area.

Hardbottom habitat provides valuable structure for benthic (occurring at the bottom of a body of water) fauna and flora, as well as fish habitat. Hardbottom refers to a classification of coral communities that occur in temperate, subtropical, and tropical regions that lack the diversity, density, and reef development of other types of coral communities (SAFMC 1998). For the purposes of this investigation, hardbottom habitat is defined as exposed areas of rock or consolidated sediments, distinguished from surrounding unconsolidated sediments, which may or may not be characterized by a thin veneer of live or dead biota (the plant and animal life of a region). Hardbottom provides habitat and foraging grounds for a diverse

array of invertebrate and fish species. These communities support habitat-structuring sessile (non-mobile) epifauna (organisms living on the sea floor) such as sponges, corals, bryozoans, and ascidians (Burgess et al. 2011).

The Cataño area is subject to substantial turbidity and sedimentation as well as a lack of hard substrate to support a thriving coral community (NMFS EFH consultation from Appendix C of USACE 2016).

FUTURE WITHOUT-PROJECT CONDITION

Coastal flooding of natural areas with associated sedimentation could negatively affect nearshore hardbottom under the FWOP condition.

Figure 2-1. Limestone substrate adjacent harbor entrance channel (SOURCE: NOAA 2016).







2.2.3.2 REACH 3 - CONDADO LAGOON

EXISTING CONDITION

The northwestern portion of Condado Lagoon is more exposed to the Ocean and contains hard substrate that supports various coral species. However, the portion of Condado Lagoon south of the Ashford Avenue Bridge is more protected from wave action and has limited hard substrate to support corals. Habitat characterization sampling conducted by MRI (2005) revealed hard bottom and coral communities within the Condado Lagoon, exclusively on the north side near the El Boqueron inlet. No hard coral communities have been reported south of Dos Hermanos Bridge in the lagoon basin itself. The existence of hard coral communities is less likely to occur in the basin area due in part to high turbidity and poor water quality conditions.

FUTURE WITHOUT-PROJECT CONDITION

Coastal flooding of natural areas with associated sedimentation could affect nearshore hardbottom under the FWOP condition.

2.2.4 ESSENTIAL FISH HABITAT

EXISTING CONDITION

The Essential Fish Habitat (EFH) provisions of the Magnuson-Stevens Act are intended to protect those waters and substrates necessary to fish for spawning, breeding, feeding or growth to maturity. If a

San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT proposed action potentially affects EFH, then consultation with NMFS is required. The EFH consultation ensures the potential action considers the effects on important habitats and supports the management of sustainable marine fisheries.

In the Caribbean waters under the jurisdiction of the U.S. (within the Exclusive Economic Zone, EEZ), EFH is identified and described based on areas where the life stages of 17 managed species of fish and marine invertebrates occur. Fourteen of the 17 managed species, which have been documented in the study area, are listed in **Table 2-1** below.

Since all of these species occur in all habitats within the Caribbean waters under U.S. jurisdiction, EFH includes all waters and substrates, including unconsolidated sediment, coral habitats, submerged vegetation, and adjacent intertidal vegetation, including wetlands and mangroves that are necessary for the reproduction, growth, and feeding of marine species.

2.2.4.1 REACH 1 & 3 – WEST SAN JUAN BAY AND CONDADO LAGOON

All of San Juan Bay is tidally influenced, so it and adjacent wetlands are considered EFH. Therefore, EFH within the project area includes estuarine and marine submerged and emergent vegetation, tidal freshwater wetlands, tidal creeks, water column, intertidal and subtidal mudflats (unconsolidated bottom), coastal inlets, coral and artificial reefs, and hardbottom. Many of these habitats foster growth and provide food and protection from predators and are integral to producing healthy populations of commercially and recreationally important species. Species that may occur in the project area habitats are noted in **Table 2-1**.

able 2 1. Manageu species abcamentea in the study area.						
Species	Common Name	SPAG*	FMP			
Chaetodon striatus	Banded Butterflyfish		Reef Fish - aquarium trade			
Epinephelus guttatus	Red Hind	*	Reef Fish			
Cephalopholis fulvus	Coney	*	Reef Fish			
Lutjanus analis	Mutton Snapper		Reef Fish			
Lutjanus apodus	Schoolmaster		Reef Fish			
Lutjanus griseus	Gray Snapper	*	Reef Fish			
Ocyurus chrysurus	Yellowtail Snapper	*	Reef Fish			
Haemulon plumieri	White Grunt		Reef Fish			
Balistes vetula	Queen Triggerfish		Reef Fish			
Sparisoma chrysopterum	Redtail Parrotfish		Reef Fish			
Holocentrus ascensionis	Squirrelfish		Reef Fish			
Malacanthus plumieri	Sand Tile Fish		Reef Fish			
Panulirus argus	Spiny Lobster		Spiny Lobster			
Strombus gigas	Queen Conch		Queen Conch			

Table 2-1. Managed species documented in the study area.

Source: Rivera, 2015; CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011. *SPAG: Potential Spawning Aggregation site in San Juan Bay (Ojeda et. al. 2007).

Per the Fishery Management Plan (FMP) for each of the four groups below, EFH is defined as (CFMC and NOAA 2004):

Spiny Lobster FMP: EFH in the U.S. Caribbean consists of all waters from MHW to the outer boundary of the EEZ- habitats used by phyllosoma larvae and seagrass, benthic algae, mangrove, coral, and live/hard bottom substrates from MHW to 100 fathoms depth used by other life stages.

Queen Conch FMP: EFH in the U.S. Caribbean consists of all waters from MHW to the outer boundary of the EEZ – habitats used by eggs and larvae and seagrass, benthic algae, coral, live/hard bottom and sand/shell substrates from MHW to 100 fathoms depth used by other life stages.

Reef Fish FMP: EFH in the U.S. Caribbean consists of all waters from MHW to the outer boundary of the EEZ – habitats used by eggs and larvae and all substrates from MHW to 100 fathoms depth used by other life stages.

Coral FMP: EFH in the U.S. Caribbean consists of all waters from mean low water (MLW) to the outer boundary of the EEZ – habitats used by larvae and coral and hard bottom substrates from MLW to 100 fathoms depth – used by other life stages.

Figure 2-3. Composite EFH for species and life stages of the Spiny Lobster, Queen Conch, Reef Fish, and Coral.



San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

FUTURE WITHOUT-PROJECT CONDITION

Coastal flooding of natural areas with associated could cause increased turbidity and potentially loss of sea grasses. In addition, mangrove habitat could be impacted by inundation as well. Therefore, the FWOP condition could have a negative effect to EFH.

2.2.5 PROTECTED SPECIES

2.2.5.1 REACH 1 & 3 – WEST SAN JUAN BAY AND CONDADO LAGOON

The U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) have responsibilities under the Endangered Species Act of 1973 (ESA) to protect certain species. There are many threatened and endangered (T&E) species known to occur near San Juan Bay. However, not all of them would be affected by a proposed action. Accordingly, the USACE is working with USFWS Field Office in Boqueron, Puerto Rico, as well as the NMFS Southeast Regional Office in St. Petersburg, Florida to focus on the species listed in **Table 2-2**. This list includes the federally-listed T&E species that could be present in the area based upon their geographic range. However, the actual occurrence of a species in the area would depend upon the availability of suitable habitat, the season of the year relative to a species' temperature tolerance, migratory habits, and other factors. The following sections summarize species-specific information relevant to the study area.

Common Name	Scientific Name	Status	Year Listed
Marine Mammals			
Antillean Manatee	Trichechus manatus	Т	2017
Marine Turtles			
Leatherback turtle	Dermochelys coriacea	E	1970
Hawksbill turtle	Eretmochelys imbricata	E	1970
Green turtle	Chelonia mydas	Northwest Atlantic DPS; T	2016
Fish			
		Central and Southwest Atlantic	
Scalloped hammerhead shark	Sphyrna lewinii	DPS; T	2014
Nassau grouper	Epinephelus striatus	Т	2016
Giant manta ray	Manta birostris/ M.	Т	2017
Corals			
Elkhorn coral	Acropora palmata	Т	2006
Staghorn coral	Acropora cervicornis	Т	2006
Pillar coral	Dendrogyra cylindrus	Т	2014
Rough Cactus Coral	Mycetophyllia ferox	Т	2014
Lobed Star Coral	Orbicella annularis	Т	2014
Mountainous Star Coral	Orbicella faveolata	Т	2014
Boulder Star Coral	Orbicella franksi	Т	2014
Terrestrial Reptiles			
Puerto Rico Boa	Epicrates inornatus	E	1976

Table 2-2. Selected federally-threatened and endangered species potentially present in the vicinity ofSan Juan Harbor, Puerto Rico.

San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

Common Name	Scientific Name	Status	Year Listed
E – federally-endangered			

T – federally-threatened

Endangered: A taxon "in danger of extinction throughout all or a significant portion of its range." Threatened: A taxon "likely to become endangered within the foreseeable future throughout all or a significant portion of its range."

2.2.5.1.1 FISHES

EXISTING CONDITION

Of the three listed fish species, Nassau grouper are most likely to occur in the vicinity of the project. However, in the late 1980's Nassau grouper reached commercial extinction and a fishery moratorium was implemented in the 1990s but commercial fishing continued in Florida and the U.S. Atlantic (including Puerto Rico) despite initial moratoriums (Frias-Torres, 2008). The giant manta ray is considered to be a migratory species that is commonly found offshore in the open ocean and on the outer continental shelf.

Scalloped Hammerhead Shark. The hammerhead sharks are recognized by their laterally expanded head that resembles a hammer. The scalloped hammerhead shark (*Sphyrna lewinii*) is distinguished by a marked central indentation on the anterior margin of the head, along with two more indentations on each side of this central indentation, giving the head a "scalloped" appearance. The body is fusiform, with a large first dorsal fin and low second dorsal and pelvic fins. Coloration is generally uniform gray, grayish brown, bronze, or olive on top of the body that shades to white on the underside with dusky or black pectoral fin tips. This shark is a high trophic level predator and opportunistic feeder with a diet that includes a wide variety of teleosts, cephalopods, crustaceans, and rays. The northwest Atlantic Ocean DPS was listed under the ESA as threatened on September 2, 2014.

Estuaries and coastal embayments have been identified as particularly important nursery areas, while offshore waters contain important spawning and feeding areas. Adult habitat consists of continental shelf areas further offshore, with adult aggregations common over seamounts and near islands. The scalloped hammerhead shark can be found in coastal warm temperate and tropical seas worldwide. In the western Atlantic Ocean, the species range extends from the northeast coast of the United States (from New Jersey to Florida) to Brazil, including the Gulf of Mexico and Caribbean Sea. The species could occur along the north coast of Puerto Rico outside the area of influence of the proposed action.

Nassau Grouper. The Nassau grouper (*Epinephelus striatus*) is a long-lived (29 years maximum), moderate sized Serranid fish with large eyes and a robust body. The range of color is wide, but ground color is generally buff, with five dark brown vertical bars and a large black saddle blotch on top of caudal peduncle and a row of black spots below and behind its eye. There is also a distinctive dark tuning-fork mark beginning at the front of the upper jaw, extending dorsally (on top) along the interorbital region, and then dividing into two branches on top of the head behind the eyes; another dark band from the tip of the snout through the eye and then curving upward to meet its fellow just before the dorsal-fin origin. Juveniles exhibit a color pattern similar to adults. On 29 June 2016, NMFS issued a final rule (81 FR 42268) listing the Nassau Grouper as a threatened species under the ESA.

The Nassau grouper is primarily a shallow-water, insular fish species that has long been valued as a major fishery resource throughout the wider Caribbean, South Florida, Bermuda and the Bahamas. The Nassau grouper is considered a reef fish, but it transitions through a series of developmental shifts in habitat. The larvae are planktonic and after 35-40 days recruit from an oceanic environment into demersal habitats hiding in macroalgae, coral, and seagrass beds.

The Nassau grouper's confirmed distribution currently includes Bermuda, Florida, throughout the Bahamas and Caribbean Sea. The species does occur along the north coast of Puerto Rico outside the area of influence of the proposed action.

Giant Manta Ray. On January 12, 2017, NMFS published a proposed rule in the Federal Register (82 FR 3694) to list the giant manta ray (*Manta birostris/M. alfredi*) as threatened species under the ESA. The distribution of the giant manta ray is worldwide in tropical and temperate ocean waters. On the U.S. Atlantic Coast, the giant manta ray has been documented as far north as New Jersey. The giant manta ray is commonly encountered on shallow reefs or sighted feeding offshore at the surface. The giant manta ray is occasionally observed in sandy bottom areas and seagrass beds. Regional sub-populations appear to be small and generally contain less than 1,000 adult individuals and are generally declining except for those areas where they are specifically protected (Hawaii, Maldives, Yap, Palau). The primary threats to *Manta* species are targeted fishing and fishery bycatch. This species is anticipated to occur outside the area of influence of the proposed action.

FUTURE WITHOUT-PROJECT CONDITION

No effects to these overfished and oceanic species are anticipated in the FWOP. They are not expected to occur in San Juan Bay and therefore would not be affected by coastal flooding of natural areas with associated sedimentation in the FWOP condition.

2.2.5.1.2 SEA TURTLES

EXISTING CONDITION

Four different sea turtle species could occur in the study area, Loggerhead, Leatherback, Hawksbill, and Green. Of the four species, the hawksbill and green are the most common in San Juan Bay. Although sandy beach habitat occurs within San Juan Bay along La Esperanza and in Condado Lagoon, DNER has not documented nesting there (Carlos Diez, Puerto Rico Department of Natural and Environmental Resources, San Juan, Puerto Rico, personal communication, July 12, 2016). Sea turtle nesting is limited to the sandy beaches along the north coast of Puerto Rico adjacent to San Juan Bay.

Leatherback. Leatherback sea turtles (*Dermochelys coriacea*) are widely distributed throughout the oceans of the world, and are found in waters of the Atlantic, Pacific, and Indian oceans (Ernst and Barbour, 1972). Leatherback turtles are the largest living turtles and have a larger migration range than any other sea turtle species. The leatherback is the most pelagic (open ocean) of the sea turtles and is often seen near the edge of the continental shelf; however, they are also observed just offshore of the surf line. They enter coastal waters on a seasonal basis to feed in areas where jellyfish are concentrated.

Zug and Parham (1996) pointed out that the main threat to leatherback populations in the Atlantic is the combination of fishery-related mortality (especially entanglement in gear and drowning in trawls) and the intense egg harvesting on the main nesting beaches. Boat strikes are also a threat and source of mortality

for leatherbacks in Puerto Rico. There is potential for leatherbacks to be present off the north coast during migration and leatherback nesting has been documented on the sandy beach north of the Avenida Ashford (Dos Hermanos) Bridge (USFWS, 2005 – Harberer 2005). No critical habitat has been designated for leatherback turtles in the project area.

Loggerhead. The loggerhead (*Caretta caretta*) is characterized by a large head with blunt jaws. The carapace and flippers are a reddish-brown color; the plastron is yellow. Adults grow to an average weight of about 200 pounds. The USFWS and the NMFS listed the Northwest Atlantic Ocean distinct population segment (DPS) of the loggerhead sea turtle as threatened on September 22, 2011 (76 FR 58868). No loggerhead sea turtle nesting has ever been documented in Puerto Rico (Carlos Diez, Puerto Rico Department of Natural and Environmental Resources, San Juan, Puerto Rico, personal communication, July 12, 2016). The species feeds on mollusks, crustaceans, fish, and other marine animals. The loggerhead sea turtle can be found throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans. It may be found hundreds of miles out to sea, as well as in inshore areas such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers. Coral reefs, rocky places, and ship wrecks are often used as feeding areas. This species could occur offshore San Juan Harbor. No critical habitat has been designated for loggerhead turtles in the project area.

Hawksbill. The hawksbill turtle (*Eretmochelys imbricata*) is small to medium-sized compared to other sea turtle species. Hawksbill turtles are unique among sea turtles in that they have two pairs of prefrontal scales on the top of the head and each of the flippers usually has two claws. This species was listed under the ESA as endangered in 1970.

Hawksbill turtles use different habitats at different stages of their life cycle, but are most commonly associated with healthy coral reefs. The ledges and caves of coral reefs provide shelter for resting hawksbills both during the day and at night. Hawksbills are known to inhabit the same resting spot night after night. Hawksbills are also found around rocky outcrops and high energy shoals. These areas are optimum sites for sponge growth, which certain species are the preferred food of hawksbills. They are also known to inhabit mangrove-fringed bays and estuaries, particularly along the eastern shore of continents where coral reefs are absent.

The nesting season varies with locality, and nesting occurs all year long in Puerto Rico. Hawksbills nest at night and, on average, about 4.5 times per season at intervals of approximately 14 days. They nest under the vegetation on the high beach and nests have been observed having the last eggs of the clutch as close as 3 inches from the sand's surface. Hawksbill sea turtles have been reported in San Juan Bay and nesting has been documented on the sandy beach north of the Avenida Ashford (Dos Hermanos) Bridge (USFWS, 2005 – Harberer 2005). Designated Critical Habitat (DCH) for this species occurs approximately 50 miles east of the project area around Culebra Island.

Green. The nesting range of green sea turtles in the southeastern United States includes sandy beaches of mainland shores, barrier islands, coral islands, and volcanic islands between Texas and North Carolina, the U.S. Virgin Islands (USVI) and Puerto Rico (NMFS and USFWS, 1991). Green turtles (*Chelonia mydas*) are primarily herbivorous, feeding on algae and sea grasses, but also occasionally consume jellyfish and sponges. Green turtle foraging areas in the southeastern United States include any coastal shallow waters having macroalgae or sea grasses, including areas near mainland coastlines, islands, reefs, or shelves, and any open-ocean surface waters, especially where advection from wind and currents concentrates pelagic (open ocean) organisms (Hirth, 1997; NMFS and USFWS, 1991). Adults of both sexes are presumed to

migrate between nesting and foraging habitats along corridors adjacent to coastlines and reefs. DCH for this species occurs approximately 50 miles east of the project area around Culebra Island. The SAV habitat found in San Juan Harbor and Condado Lagoon are important grazing areas for the green sea turtle.

FUTURE WITHOUT-PROJECT CONDITION

Coastal flooding of natural areas with associated sedimentation under the FWOP condition could negatively affect foraging sea turtles from loss of SAV habitat in San Juan Bay. According to DNER, no records of sea turtle nesting have been documented in San Juan Bay and DCH does not occur near the project area.

2.2.5.1.3 ANTILLEAN MANATEES

EXISTING CONDITION

Antillean manatees (*Trichechus manatus manatus*) have large, seal-shaped bodies with paired flippers and a round, paddle-shaped tail. They are typically grey (color can range from black to light brown) and are occasionally spotted with barnacles attached to them or colored by patches of green or red algae. Average adult manatees are about nine feet long and weigh about 1,000 pounds (<u>https://www.fws.gov/southeast/wildlife/mammals/manatee/</u>).

The Antillean manatee inhabits the coastal waters of Puerto Rico, and has been documented both feeding and traveling in West San Juan Bay and the Condado Lagoon area. Seagrass beds in the bay and lagoon provide suitable foraging habitat for the species. Furthermore, the location of the lagoon provides suitable shelter for the species (SJBEP, 2011). The USFWS has jurisdiction for protection of the manatee under the ESA and the MMPA. On April 5, 2017, the USFWS published a final rule reclassifying the West Indian manatee and its two recognized subspecies (Florida and Antillean) from endangered to threatened (82 FR 16680). This species is also protected by Puerto Rico Law Number 241 (Wildlife Law of the Commonwealth of Puerto Rico) and Regulation Number 6766, which regulates the management of threatened and endangered species in Puerto Rico. No DCH has been designated for this species in the project area.

FUTURE WITHOUT-PROJECT CONDITION

Coastal flooding of natural areas with associated sedimentation under the FWOP condition could affect foraging manatees through loss of SAV habitat.

2.2.5.1.4 CORALS

EXISTING CONDITION

West San Juan Bay and Condado Lagoon

The following ESA listed corals could occur at the mouth of the bay adjacent Boca del Moro and north of Dos Hermanos Bridge at the mouth of the Condado lagoon.

Elkhorn Coral. Elkhorn coral (*Acropora palmata*) belong to the most abundant group of corals in the world (Acropora genus) and once represented the most dominant reef building species throughout Florida and the Caribbean. Elkhorn coral is a large, branching coral with thick and sturdy antler-like branches and is found in shallow reefs, typically in water depths from 0-35 feet, as these corals prefer areas where wave
action causes constant water movement. Colonies are fast growing: branches increase in length by 2-4 inches (5-10 cm) per year, with colonies reaching their maximum size in approximately 10-12 years. Over the last 10,000 years, elkhorn coral has been one of the three most important Caribbean corals contributing to reef growth and development and providing essential fish habitat. This species was listed under the ESA as threatened on May 9, 2006.

Elkhorn coral was formerly the dominant species in shallow water (3-16 ft. [1-5 m] deep) throughout the Caribbean and on the Florida Reef Tract, forming extensive, densely aggregated thickets (stands) in areas of heavy surf. Coral colonies prefer exposed reef crest and fore reef environments in depths of less than 20 feet (6 m), although isolated corals may occur to 65 feet (20 m).

NMFS has designated critical habitat for elkhorn and staghorn corals in four areas: Florida, Puerto Rico, St. John/St. Thomas, and St. Croix. **Figure 2-4** shows the designated areas for Puerto Rico, which includes all areas surrounding the islands of the Commonwealth of Puerto Rico, 98 ft. (30 m) in depth and shallower, seaward of the U.S. Coast Guard Convention on the International Regulations for Preventing Collisions at Sea (COLREGS demarcation line). Per NOAA chart 25670, the COLREGS demarcation line transects outer bar channel Cut-2 in San Juan Harbor. In addition, a 4(d) rule (50 CFR Part 223) establishing "take" prohibitions for elkhorn and staghorn corals went into effect on November 28, 2008 for these areas. Take includes collecting, bothering, harming, harassment, damage to, death, or other actions that affect health and survival of listed species. This species has been documented in the study area on the narrow, discontinuous linear or fringing "reef" consisting of corals covering fossil sand dunes (i.e., eolianites) trending in an east-west direction and extending, in some sites, up to 0.9 miles off shore (CFMC, 2004; CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011; Coll Rivera Environmental, 2005). DCH for this species occurs in outer Bar Channel Cuts 1 and 2 at the entrance to San Juan Harbor.



Figure 2-4. Elkhorn and Staghorn Corals Designated Critical Habitat (DCH).

Staghorn Coral. Staghorn coral (*Acropora cervicornis*) is a branching coral with cylindrical branches ranging from a few centimeters to over 6.5 feet (2 m) in length. This coral exhibits the fastest growth of all known western Atlantic corals, with branches increasing in length by 4-8 inches (10-20 cm) per year. This species was listed under the ESA as threatened on May 9, 2006.

Staghorn coral occurs in back reef and fore reef environments from 0-98 feet (0 to 30 m) deep. In addition to growing on reefs, staghorn corals often form colonies on bare sand. The upper limit is defined by wave forces, and the lower limit is controlled by suspended sediments and light availability. Fore reef zones at intermediate depths of 15-80 feet (5-25 m) were formerly dominated by extensive single species stands of staghorn coral until the mid-1980s.

Staghorn coral is found in the Atlantic Ocean, Caribbean Sea, and western Gulf of Mexico. Specifically, staghorn coral is found throughout the Florida Keys, the Bahamas, the Caribbean islands, and Venezuela. The northern limit of staghorn coral is around Boca Raton, Florida. The dominant mode of reproduction for staghorn coral is asexual fragmentation, with new colonies forming when branches break off a colony and reattach to the substrate. Sexual reproduction occurs via broadcast spawning of gametes into the water column once each year in August or September. Individual colonies are both male and female

San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT (simultaneous hermaphrodites) and will release millions of "gametes." The coral larvae (planula) live in the plankton for several days until finding a suitable area to settle, but very few larvae survive to settle and metamorphose into new colonies. The preponderance of asexual reproduction in this species raises the possibility that genetic diversity is very low in the remnant populations. This species has been documented in the study area on the narrow, discontinuous linear or fringing "reef" consisting of corals covering fossil sand dunes (i.e., eolianites) trending in an east-west direction and extending, in some sites, up to 0.9 miles off shore (CFMC, 2004; CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011; Coll Rivera Environmental, 2005). DCH for this species occurs in outer Bar Channel cuts 1 and 2 at the entrance to San Juan Harbor.

Pillar Coral. Pillar coral *(Dendrogyra cylindrus)* colonies form numerous, heavy, cylindrical spires, that grow upwards from an encrusting base mass. The colonies can attain a height of 10 feet (3 m), with a pillar diameter of more than 4 inches (10 cm). Polyps are normally extended during the day, giving the colony a fuzzy appearance. This species was listed under the ESA as threatened on 10 October 2014. Colonies are typically found on flat gently sloping back reef and fore reef environments in depths of 3-82 feet (1-25 m). The species does not occur in extremely exposed locations. This species occurs in the Caribbean, the southern Gulf of Mexico, Florida, and the Bahamas. In addition, it has been documented in the study area on the narrow, discontinuous linear or fringing "reef" consisting of corals covering fossil sand dunes (i.e., eolianites) trending in an east-west direction and extending, in some sites, up to 0.9 miles off shore (CFMC, 2004; CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011; Coll Rivera Environmental, 2005). NMFS has not yet proposed DCH for this species.

Rough Cactus Coral. Rough cactus coral (*Mycetophyllia ferox*) colonies consist of flat plates with radiating valleys. It is a widely recognized valid species with colonies comprised of thin, weakly attached plates with interconnecting, slightly sinuous, narrow valleys. Tentacles are generally absent and corallite centers tend to form single rows. The walls of the valleys commonly join to form closed valleys, a feature not seen in other members of Mycetophyllia. The ridges are usually small and square, with a groove on top. The ridges, or walls between valleys, are commonly quite thin, and are irregular, and valleys are narrower. This species was listed under the ESA as threatened on 10 October 2014.

This species is most common in fore reef environments from 5-30 meters (but is more abundant from 10-20 meters), but also occurs at low abundance in certain deeper back reef habitats and deep lagoons. This species occurs in the Caribbean, southern Gulf of Mexico, Florida, and the Bahamas. In addition, it has been documented in the study area on the narrow, discontinuous linear or fringing "reef" consisting of corals covering fossil sand dunes (i.e., eolianites) trending in an east-west direction and extending, in some sites, up to 0.9 miles off shore (CFMC, 2004; CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011; Coll Rivera Environmental, 2005). NMFS has not yet proposed DCH for this species.

Lobed Star Coral. Lobed star coral (*Orbicella annularis*) colonies grow in several morphotypes that were originally described as separate species. The species occurs as long, thick columns with enlarged, dome-like tops; large, massive mounds; sheets with skirt-like edges; irregularly bumpy mounds and plates or as smooth plates. Colonies grow up to 10 feet (3 m) in diameter. The surface is covered with distinctive, often somewhat raised, corallites. This species was listed under the ESA as threatened on 10 October 2014.

Lobed star coral inhabits most reef environments and is often the predominant coral between 22-82 ft. (7-25 m). The flattened plates are most common at deeper reefs, down to 165 ft. (50 m). Common to Florida, Bahamas and Caribbean. In addition, it has been documented in the study area on the narrow, discontinuous linear or fringing "reef" consisting of corals covering fossil sand dunes (i.e., eolianites) trending in an east-west direction and extending, in some sites, up to 0.9 miles off shore (CFMC, 2004; CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011; Coll Rivera Environmental, 2005). NMFS has not yet proposed DCH for this species.

Mountainous Star Coral. This species has been called the "dominant reef-building coral of the Atlantic" (Brainard et al 2011). *Orbicella faveolata* buds extratentacularly to form head or sheet colonies with corallites that are uniformly distributed and closely packed, but sometimes unevenly exsert. Septa are highly exsert, with septocostae arranged in a variably conspicuous fan system, and the skeleton is generally far less dense than those of its sibling species. Active growth is typically found at the edges of colonies, forming a smooth outline with many small polyps. This species was listed under the ESA as threatened on 10 October 2014.

Orbicella faveolata is found from 3-100 feet (1-30 m) in back-reef and fore-reef habitats, and is often the most abundant coral between 30-65 feet (10-20 m) in fore-reef environments. This species occurs in the Caribbean, the Gulf of Mexico, Florida, and the Bahamas. May also be present in Bermuda, but this requires confirmation. In addition, it has been documented in the study area on the narrow, discontinuous linear or fringing "reef" consisting of corals covering fossil sand dunes (i.e., eolianites) trending in an east-west direction and extending, in some sites, up to 0.9 miles off shore (CFMC, 2004; CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011; Coll Rivera Environmental, 2005). NMFS has not yet proposed DCH for this species.

Boulder Star Coral. This species (*Orbicella franksi*) builds massive, encrusting plate or subcolumnar colonies via extratentacular budding. The characteristically bumpy appearance of this species is caused by relatively large, unevenly exsert, and irregularly distributed corallites. Boulder Star Coral is distinguished from its sibling *Orbicella* species by this irregular or bumpy appearance; a relatively dense, heavy, and hard skeleton (corallum); thicker septo-costae with a conspicuous septocostal midline row of lacerate teeth; and a greater degree of interspecies aggression. This species was listed under the ESA as threatened on 10 October 2014.

This species mostly grows in the open like other species of this genus but smaller, encrusting colonies are common in shaded overhangs. It is uncommon in very shallow water, but becomes common deeper. This species occurs in the Caribbean, the Gulf of Mexico, Florida, and the Bahamas. In addition, it has been documented in the study area on the narrow, discontinuous linear or fringing "reef" consisting of corals covering fossil sand dunes (i.e., eolianites) trending in an east-west direction and extending, in some sites, up to 0.9 miles off shore (CFMC, 2004; CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011; Coll Rivera Environmental, 2005). NMFS has not yet proposed DCH for this species.

FUTURE WITHOUT-PROJECT CONDITION

In the future without-project condition, coastal flooding of natural areas with associated sedimentation would continue to result in degraded water quality and effects to listed corals.

2.2.5.1.5 Puerto Rican Boa

EXISTING CONDITION

The Puerto Rican boa was listed as endangered in 1970 (35 FR 13519). It is the largest snake in Puerto Rico, averaging a length of 6 ½ feet. The color can be variable but typically ranges dark browns, grays, and blacks with a series of spots or black bars and a blackish belly. This boa is unique to Puerto Rico and is widespread in its distribution across the island. The species is abundant in protected and inaccessible areas. It can be found in a variety of habitats and is arboreal and terrestrial. Sub-adults' and adults' diet consists of birds, small mammals, and lizards. The Puerto Rican boa is non-poisonous and generally harmless unless provoked. No DCH has been identified for the Puerto Rican boa. The Puerto Rican boa appears to be widely distributed throughout Puerto Rico and utilizes a wide variety of habitats, ranging from mature forest to plantations and disturbed areas (USFWS 2011). Gould et al. (2008) stated that the PR boa predicted habitat model includes the following land cover types: moist and wet forest, woodland and shrubland, mangrove, Pterocarpus, mature dry forest, and dry forest near water bodies, at or below 1,000 m of elevation. This species is more likely to occur in WSJB than Condado Lagoon.

FUTURE WITHOUT-PROJECT CONDITION

In the FWOP/No Action Alternative, significant effects to Puerto Rican boa are not anticipated. While inundation could negatively affect mangrove habitat, this resource could also increase in coverage under future SLR possibly increasing habitat for the boa.

2.2.6 BIRDS

EXISTING CONDITION

REACH 1 & 3 – WEST SAN JUAN BAY and CONDADO LAGOON

Various areas within West San Juan Bay and Condado lagoon are utilized by many species of birds for nesting and feeding. According to the Puerto Rico Breeding Bird Atlas

(<u>http://www.aosbirds.org/prbba/Puerto%20Rico%20Status.html</u>), about 58 species of birds are found within the San Juan Bay area, 44 of which are sea birds, waterfowl or wading birds that utilize the shallows, wetlands and open water of San Juan Bay. The brown pelican (*Pelecanus occidentalis*) is a permanent resident in the bay. Pelicans feed throughout the bay but prefer the calm waters behind the Esperanza peninsula and mangrove lined shores. Numerous gulls, terns, and frigate birds also use the Esperanza peninsula and sheltered waters behind it for roosting and feeding (USFWS 2017).

FUTURE WITHOUT-PROJECT CONDITION

Without the proposed CSRM measures adverse impacts to bird habitat from inundation and sedimentation could occur. Mangroves could out-compete and replace existing WSJB palustrine emergent wetlands with future SLR. This could affect bird assemblages in the area due to loss of habitat.

2.2.7 INVASIVE SPECIES

EXISTING CONDITION

REACH 1 & 3 – WEST SAN JUAN BAY and CONDADO LAGOON

Invasive species can adversely impact native plant and animal populations by disrupting natural ecosystem functions. Islands have long been considered to be particularly vulnerable to biotic invasions. The 1,032 species of alien plants reported for Puerto Rico and Virgin Islands (PRVI) represent about a third of total plant diversity on these islands (DRNA 2015). Some aquatic invasive species that may occur in the project area or in the area of influence include:

- Freshwater Plants
 - *Phragmites australis* (Common reed)
 - *Melaleuca quinquenervia* (Bottlebrush tree)
- Freshwater Animals
 - o Iguana iguana (Green iguana)
 - Cherax quadricarinatus (Australian red claw crawfish)
- Marine/Estuarine Animals
 - *Pterois volitans* (Red lionfish)
 - Oreochromis aureus (Blue tilapia)
 - *Petrolisthes armatus* (Green porcelain crab)
 - Perna viridis (Asian green mussel)
 - o Phyllorhiza punctata (Australian spotted jellyfish)
- Marine/Estuarine Plants
 - *Halophila stipulacea* (Mediterranean seagrass)

Species can be introduced by a variety of different mechanisms; however, most estuarine and marine species introductions are associated with shipping (Ruiz et al. 2000). Commercial shipping is the only direct mechanism related to this project. Presently, the largest single source of shipping-related introductions is ballast water (Carlton 1985, Lavoie et al. 1999). Ballast water is pumped into the hull of a vessel to stabilize the vessel and keep it upright while carrying cargo. This water can be discharged at the receiving port as the cargo is loaded or unloaded. Each vessel may take on and discharge millions of gallons of water. Ballast water taken on in foreign ports may include an abundance of aquatic plants, animals, and pathogens not native to Puerto Rico. If discharged into state waters, these foreign species may become problematic. In addition to ballast water discharge, another important source for the introduction of nonindigenous organisms is the fouling community that grows on the hull, rudder, propellers, anchor, anchor chain, or any other submerged structure of vessels that are not properly cleaned or maintained. Historically, such fouling communities were composed of massive layers of a variety of organisms, both attached and

merely entrained in or living on that growth. Although such extensive growth is not as common on seagoing vessels in recent times, it still provides an opportunity for worldwide transport of fouling organisms, particularly on towed barges and other structures like mothballed ships and exploratory drilling platforms.

FUTURE WITHOUT-PROJECT CONDITION

In the future without-project condition, the potential will continue to exist for introduction of invasive species. Recent Federal regulations require the shipping industry to implement better controls to prevent the introduction of invasive species through the ballasts of vessels (USCG 2012). These regulations should decrease the rate at which invasive species are introduced to the study area. The USCG will continue to monitor, enforce, and revise regulations related to the discharge of ballast water while vessels are in port according to the USCG Ballast Water Management Final Rule Published 23 March 2012.

2.2.8 AIR QUALITY

EXISTING CONDITION

REACH 1 & 3 – WEST SAN JUAN BAY and CONDADO LAGOON

Puerto Rico is a United States territory with commonwealth status. The USEPA, Region 2 and the Puerto Rico EQB regulate air quality in Puerto Rico. The Clean Air Act (CAA) gives USEPA the responsibility to establish the primary and secondary National Ambient Air Quality Standards (NAAQS) that set acceptable concentration levels for seven criteria pollutants: particulate matter, fine particulate matter, sulfur dioxide, carbon monoxide, nitrous oxides, ozone, and lead. Short-term standards (1, 8, and 24-hour periods) have been established for pollutants contributing to acute health effects, while long-term standards (annual averages) have been established for pollutants contributing to chronic health effects. On the basis of the severity of the pollution problem, nonattainment areas are categorized as marginal, moderate, serious, severe, or extreme. Each state has the authority to adopt stricter standards; however Puerto Rico has accepted the United States Federal Standards. USEPA regulations designate Air-Quality Control Regions (AQCRs) in violation of the NAAQS as nonattainment areas. USEPA regulations designate AQCRs with levels below the NAAQS as attainment areas. Maintenance AQCRs are areas previously designated nonattainment areas that have subsequently been designated attainment areas for a probationary period through implementation of maintenance plans.

West San Juan Bay and Condado Lagoon are located within the Puerto Rico AQCR which is comprised of the entire Commonwealth of Puerto Rico, including Vieques, Culebra, and surrounding islands (40CFR§81.77). Puerto Rico has adopted the NAAQS established by the USEPA and has developed a State Implementation Plan under the CAA that incorporates permitting and regulatory requirements for stationary and mobile sources of air pollution. All areas within the AQCR are in attainment or unclassifiable (due to lack of data) for NAAQS for the following criteria pollutants: ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, PM2.5, and lead (USEPA 2008).

Due to their locations, West San Juan Bay and Condado Lagoon experience nearly constant on-shore trade winds and sea breezes. These areas are surrounded by the municipalities of San Juan, Guaynabo, and Cataño. Non-compliance was due to pollution from power plants, industrial facilities, motor vehicles, and major San Juan emitters. In 2010 the municipality of Guaynabo became compliant air quality standards. In 2011 USEPA provided a grant to the Polytechnic University of Puerto Rico in the amount of \$886,095 to install pollution-reduction technology on 72 heavy-duty trucks and replace 10 old heavy-duty trucks with 2010 or newer lower emissions diesel trucks in the Port of San Juan. These upgrades reduced the air emissions of fine particles (particulate matter, (PM)), nitrogen oxides (NOx), and carbon monoxide from

diesel engines operating in the port. The municipality of Guaynabo is identified as being in moderate nonattainment of the NAAQS for particulate matter with a diameter of 10 micrometers or less (USEPA 2008).

The PREPA owns and operates two power plants in the vicinity. The San Juan Power Plant located in the area of the bay and the Palo Seco Power Plant located in Cataño just outside the entrance of the Bay. In order to comply with upcoming Mercury and Air Toxics Standards (MATS) administered by the USEPA and to reduce cost of electricity production in Puerto Rico, PREPA is preparing to convert a number of the power generation units at its San Juan and Palo Seco Power Plants to burn natural gas as the primary fuel instead of Bunker C and Diesel (No. 6 and No. 2 type) fuel oil.

FUTURE WITHOUT-PROJECT CONDITION

If no-action were taken, no change to the existing air quality would be expected. Ambient air quality conditions in San Juan Bay would more than likely remain the same.

2.2.9 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

EXISTING CONDITION

REACH 1&3 – WEST SAN JUAN BAY and CONDADO LAGOON

West San Juan Bay and Condado Lagoon are highly developed. All of the major port storage facilities have confinement areas sufficient to contain any spills and no hazardous or toxic materials or waste have been identified within the project footprint. No hazardous, toxic, or radioactive waste has been encountered or released in the project area. Sediments from the bay typically have traces of heavy metals, Polychlorinated biphenyls (PCBs), pesticides, Polycyclic Aromatic Hydrocarbons (PAHs), and petroleum products, at low levels that do not affect the sediment quality or the water quality of the bay.

FUTURE WITHOUT-PROJECT CONDITION

In the FWOP condition, the major port storage facilities may require modification due to future SLR in order to maintain containment areas sufficient to encompass any spills. No significant effects to or from hazardous and toxic materials are anticipated from the FWOP condition.

2.2.10 NOISE

EXISTING CONDITION

REACH 1 & 3 – WEST SAN JUAN BAY and CONDADO LAGOON

Noise is often defined as any sound that is undesirable because it interferes with communication, is intense enough to damage hearing, diminishes the quality of the environment, or is otherwise annoying. Response to noise varies by the type and characteristics of the noise source; distance from the source; receptor sensitivity, and time of day. Noise can be intermittent or continuous, steady or impulsive, and it may be generated by stationary or mobile sources. Noise is described by a weighted sound intensity (or level), which represents sound heard by the human ear and is measured in units called decibels (dB). The potential impacts of underwater sounds associated with dredging operations have come under increasing scrutiny by regulatory agencies.

San Juan Bay has functioned as an international harbor since pre-colonial times. Over the last 300 years, San Juan Harbor has evolved to accommodate the growing shipping industry as larger vessels continued to arrive. At the same time, recreational and other commercial boat traffic and industrial noise has continued to increase. Several sources of ambient noise are present in San Juan Bay. The ambient noise level of an area includes sounds from both natural (wind waves, fish, tidal currents, mammals) and artificial (commercial and recreational vessels, dredging, pile driving, etc.) sources. Tidal currents produce hydrodynamic sounds, which are most significant at very low frequencies (< 100 Hz). Vessel traffic, including vessels passing the immediate study area, generate sounds that can travel considerable distances, in frequencies ranging from 10 to 1000Hz. Sea state (surface condition of the water characterized by wave height, period, and power) also produces ambient sounds above 500 Hz. As a commercial and industrial area, San Juan Bay experiences a wide range of noise from a variety of industrial activities. Biological sounds associated with mammals, fishes, and invertebrates can also generate broadband noise in the frequency of 1 to 10 kHz with intensities as high as 60 to 90 dB.

San Juan Harbor has the typical noise characteristics of a busy harbor including recreational and commercial vessel traffic, dredging vessels and dockside facilities. Noise sources for vessels include cranes, whistles and various motors for propulsion. Dockside noise sources include cranes, trucks, cars, and loading and unloading equipment. In addition to the noise in the water/marine environment, noise can impact the human environment. Background noise exposures change during the course of the day in a gradual manner, which reflects the addition and subtraction of distant noise sources. Ambient noise represents the combination of all sound within a given environment at a specified time. Humans hear sound from 0-140 dB. Sound above this level is associated with pain.

High intensity sounds can permanently damage fish hearing (Nightingale and Simenstad 2001). These sounds have been documented to be continuous and low frequencies (< 1000 Hz) and are within the audible range of listed species of both whales (7Hz–22 kHz) and sea turtles (100-1000Hz) (Clarke et al. 2002).

Noise has been documented to influence fish behavior. Fish detect and respond to sound by utilizing cues to hunt for prey, avoid predators, and for social interaction. Fish produce sound when swimming, mating, or fighting and also noise associated with swimming. Fish use a wide range of mechanisms for sound production, including scraping structures against one another, vibrating muscles, and a variety of other methods. Sounds produced by spawning fishes, such as sciaenids, are sufficiently loud and characteristic for them to be used by humans to locate spawning locations.

Relative to exposure to anthropogenic noise, NOAA guidelines define two levels of harassment for marine mammals: Level A based on a temporary threshold shift (190 dB for pinnipeds and 180 dB for cetaceans), and Level B harassment with the potential to disturb a marine mammal in the wild by causing disruption to behavioral patterns such as migration, breeding, feeding, and sheltering (160 dB for impulse noise such as pile driving and 120 dB for continuous noise such as vessel thrusters)

(<u>http://www.nwr.noaa.gov/Marine-Mammals/MM-sound-thrshld.cfm</u>). According to Richardson et al. (1995) the following noise levels could be detrimental to marine mammals:

Prolonged exposure of 140 dB re 1 μ Pa/m (continuous man-made noise), at 1 km can cause permanent hearing loss. Prolonged exposure of 195 to 225 dB re 1 μ Pa/m (intermittent noise), at a few meters or tens of meters, can cause immediate hearing damage.

At the time this document was prepared, NOAA had released a draft report that provides guidance for assessing the effects of anthropogenic sound on marine mammal species under the jurisdiction of NMFS (NOAA 2013). The guidance will replace the current thresholds used by NOAA as described above. NOAA compiled, interpreted, and synthesized best available science to update the threshold levels for temporary and permanent hearing threshold shifts. Different target species for protection have widely divergent tolerance levels for sounds (owing to different hearing sensitivities, hearing integration times, etc.). Due to the complexity and variability of marine mammal behavioral responses, NOAA will continue to work over the next years on developing additional guidance regarding the effects of anthropogenic sound on marine mammal behavior (http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm).

FUTURE WITHOUT-PROJECT CONDITION

San Juan Bay is within an urban setting and noises related to recreational and commercial vessel traffic, dredging vessels, and dockside facilities would continue similar to the existing conditions.

2.2.11 COASTAL BARRIER RESOURCES

EXISTING CONDITION

REACH 1 & 3 – WEST SAN JUAN BAY and CONDADO LAGOON

The Coastal Barrier Resources Act (CBRA) was enacted by Congress in 1982. The CBRA was implemented to prevent development of coastal barriers that provide quality habitat for migratory birds and other wildlife and spawning, nursery, nesting, and feeding grounds for a variety of commercially and recreationally important species of finfish and shellfish. As a deterrent to development, Federal insurance is not available for property within designated high-hazard areas. These high-hazard areas are called Coastal Barrier Resources System (CBRS) units.

CBRS units are areas of fragile, high-risk, and ecologically sensitive coastal barriers. Development conducted in these areas is ineligible for both direct and indirect Federal expenditures and financial assistance. Along with CBRS units are otherwise protected areas (OPAs). OPAs are national, state, or local areas that include coastal barriers that are held for conservation or recreation. The only Federal funding prohibition within OPAs is Federal flood insurance.

There are three CBRS units located near San Juan Bay, PR-87 Punta Vacia Talega and PR-87P Punta Vacia Talega OPA approximately 13-19 km east and PR-86P Punta Salinas OPA approximately 6 km west (Figure 2-10).

FUTURE WITHOUT-PROJECT CONDITION

The CBRS units and OPAs will continue to be protected from development without a project pending no changes in the current regulations.



Figure 2-5. West San Juan Bay and Condado Lagoon Vicinity Coastal Barrier Resource System Units.

2.2.12 CULTURAL AND HISTORIC RESOURCES

EXISTING CONDITION

Cultural resources include prehistoric and historic sites, structures, districts, or any other physical evidence of human activity considered important to a culture, a subculture, or a community for scientific, traditional, religious, or any other reason. Several Federal laws and regulations protect these resources, including the National Historic Preservation Act of 1966 (NHPA), the Archaeological and Historic Preservation Act of 1974 (54 U.S.C. §300101 et. seq.), and the Archaeological Resources Protection Act of 1979 (16 U.S.C. §§470aa-470mm). Additionally, NEPA requires that Federal agencies consider the "unique characteristics of the geographic area such as proximity to historic or cultural resources" and "the degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources" (40 CFR 1508.27[b]). Documentation of historic properties and cultural resources is important for this project, as the cultural resources in the San Juan area are significant to the history of Puerto Rico, the broader Caribbean, the United States, and world events. The area is rich in precolonial and historic human activity, with the potential for significant resources from the last several thousand years.

The analysis of impacts to cultural resources relies on existing information primarily from documents prepared by the Puerto Rico State Historic Preservation Officer (SHPO), GIS data of resources from SHPO, and properties listed in the National Register of Historic Places (NRHP). Additional information was reviewed from shipwreck databases and data from the the Instituto de Cultura Puertorriqueña. The information on known and mapped resources was augmented by sites visits, documentation from previous cultural resources reports in the vicinity of the project, and reviews of historic maps and aerial photography to assess potential for additional, unrecorded resources.

Following the NHPA, the area of potential effects (APE) is defined as the areas where structural measures are implemented, and nonstructural measures are applied to historic properties as defined in 36 C.F.R. §800.16(I); the same area is used here for the broader category of cultural resources. Within this area, an adverse effect alters to the qualities of a historic property qualifying it for inclusion in or eligibility for the

San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT NRHP (36 CFR 800.16(i)). The effects may be direct or indirect. Examples of effects include visual intrusions, alterations of setting, noise, vibrations, viewsheds, and physical impacts of construction. The direct effects associated with the proposed project include all ground-disturbing activities, including the construction and staging zones, and areas where permanent features may severely disrupt the historic character of an area. Indirect effects may occur where the actions enable other effects, which may be later in time or removed by distance. These may include increased development or changes in land use that may reasonably be associated with an action. Adverse indirect effects of conceptual plans are more difficult to identify, but would include project features than may adversely affect the accessibility of a historic district and lead to its decline, create the circumstance for new development in areas that would disturb archaeological sites, or cause the eventual re-alignment of the federal navigation channel into areas with shipwrecks.

The proposed project reaches surround San Juan Harbor and Condado Lagoon, and are historically linked to San Juan. San Juan has been a significant port dating back to the end of the fifteenth century and the European exploration and settlement of the New World. Christopher Columbus landed on the west coast of Puerto Rico at Boquerón Bay in 1493, naming the area San Juan Bautista. At this time, the indigenous population measured approximately 60,000 people, a group modern archaeologists refer to as Taíno. Spanish colonization of the island did not occur until 1508 when Juan Ponce de León established a permanent settlement with the permission of the Taíno chiefdom of Guainía (Jiméz de Wagenheim 1998). The first settlement, Caparra, is located in Guaynabo, south of the reaches of the proposed project. The port serving Caparra is thought to be located within the reaches of the proposed project, beneath the current port facilities.

Ponce de León also explored the northern coast of the island and established *Puerto Rico* (Rich Port) at present day San Juan to export the island's gold. The Spanish subjection and maltreatment of the indigenous population led to a Taíno revolt in 1511. However, due to military subjugation, disease, and abuse from the Spanish, the native population was reduced by 75 percent in 1515. In order to replace the native workforce of the island's gold mines, the Spanish began importing enslaved Africans and indigenous people from nearby islands (Jiméz de Wagenheim 1998).

By 1521, the islet adjacent to *Puerto Rico* became the central Spanish settlement of San Juan and the island itself had come to be called Puerto Rico. Through the second half of the sixteenth century, San Juan became increasingly strategic for the export of sugarcane and ginger, and as a military outpost for Spain's colonial empire. In order to reinforce the military defenses of Puerto Rico, the Santa Catalina fortress (present-day *La Fortaleza*) was built and construction began on *El Morro* Castle. The city was fortified well enough to rebuke the attack of Sir Francis Drake in 1595. George Clifford, 3rd Earl of Cumberland, attacked and took the city in 1598; however, Spanish forces arrived shortly to rescue the island from the British. In 1625 Dutch forces attacked the city of San Juan, but the Spanish repelled the forces from *El Morro*. After this attack, the Spanish began improving their waterside fortifications, including the initial construction of the City Wall in 1634 (Krivor 2017).

During the eighteenth century, the ruling Bourbon court introduced trade and administrative reforms that stimulated agricultural development, military improvements, and population growth (Jiméz de Wagenheim 1998). City fortifications, including walls and moats, were constructed between 1789 and 1798. *El Morro* was expanded and updated to defend San Juan against warships during this period, and was successfully utilized to resist a British naval invasion in 1797 (Giusti 2014).

During the beginning of the nineteenth century, Spain loosened its grip on Puerto Rico resulting in increased trade with foreign nations. Native Puerto Ricans (*Criollos*) sought political autonomy and gradually transformed the island to a sugarcane and coffee plantation-based economy (Jiméz de Wagenheim 1998). As Puerto Rico engaged in the global economy, San Juan was the center of economic development. The growth was not universal, as the droughts and disease led to the dissolution of the historic Guaynabo municipality in 1875. During the nineteenth century, Cataño was established as a shipping hub. The village originally stretched along the shoreline, with transports connecting the south shore of the harbor with San Juan. The remainder of the shoreline remained primarily mangroves.

The Spanish American War led to changes in the area of the proposed project. The San Juan region experienced rapid development after the Spanish American War ended in July 1898 with the cession of Puerto Rico to the United States (Acosta 2014) and the subsequent collapse of the sugar industry. USACE and the San Juan Harbor Board engaged in multiple projects worked to improve the harbor, using dredged material to create land in the project reaches.

In 1940, the U.S. Army established a terminal along the southern shore of San Juan Harbor. The area to the east was then filled in the 1950s, creating Puerto Nuevo. During the twentieth century, much of the surrounding area of the proposed project saw considerable development. The southern shore of Condado Lagoon, long the location of a major transportation route, developed as a primary land route into San Juan. During the nineteenth and twentieth century this area was developed as San Juan grew, going from what was once the edge of the city into it current fully-urbanized form.

Previous efforts to identify cultural resources have documented archaeological sites, historic structures, and historic districts near the proposed project alternatives. The data for Cataño include few resources. The review of resources and investigations in the municipio conducted by the SHPO in 2016 found only four resources, but noted one is listed on the National Register of Historic Places (NRHP) (OECH 2016). All four of the recorded resources are located near alternatives considered in this study.

Two resources are located near the Caño Aguas Frias. The archaeological site Ruinas Hacienda Palmas (CN0100001) is the remains of a 1843 hacienda that produced sugar. This surrounding fields were used for sugar cane, and the hacienda had a mill and other related structures. No evidence of the archaeological site was seen during a field reconnaissance of the mapped location of this resource, with the area noted as being a highly disturbed transmission line corridor. Los Tendales de Hacienda Palmas (CN0100002) does not have a formal report on file, but is recorded as a historic archaeological site. Neither of these sites has been found eligible for listing in the NRHP.

Primera Iglesia Evangélica Luterana (CN0200002) is located in eastern Cataño, south of San Juan Harbor. This church was constructed in 1917, and was designated a historic landmark by the Puerto Rican legislature in 2004. The Distrito Destilería Bacardí (CN0200001) is a historic district listed in the NRHP (entry 10000524). These are the grounds of the Bacardi rum distillery, the largest rum distillery in the world. It has operated since 1947, with various supporting structures constructed during subsequent years. The significance of this resource comes from its association with Puerto Rican economic, cultural, and social development, with Streamline Moderne and Art Deco architecture.

In the portions of the project within Guaynabo, no previous resources have been documented. This may be attributed to the disturbed nature of much of area associated with fill events along the coast, though

the evidence left behind by historic terraforming activities to create the port infrastructure may now be considered an archaeological site, and may have buried archaeological sites.

Within the portions of the project alternatives in San Juan Municipio, there are a number of resources, buildings and structures located around the Condado Lagoon. At the western end of the lagoon, there are two recorded historic properties. These are a bridge across the Caño San Antonio and the terminus of the historic advanced defense line for San Juan. The NRHP-listed San Antonio Railroad Bridge is the former railroad bridge crossing from the mainland onto San Juan islet, later converted into a pedestrian bridge (entry 09000789). As part of the NRHP-listed Línea Avanzada (SJ0100013, NRHP entry 97001136), a remnant bridgehead is recorded east of the railroad bridge on the north side of the Caño, marking the end of fortifications. Both of these resources are over 200 meters from the proposed project. Near the southern terminus of the bridges from San Juan islet to Santurce, archaeological site SJ-5 (SJ0100005) has been recorded as a prehistoric shell midden.

Additional historic structures have been recorded in the Miramar area, though all well away from the southern coast where the project features are proposed. The closest, Asilo de Niñas de Miramar (NRHP entry 85002908) is located over 100 meters inland. The first row of structures facing the southern edge of lagoon have not been recorded in the databases reviewed by the USACE. Along the northern shore, there are two NRHP-listed structures. The Hotel Condado Vanderbilt (SJ0200057, NRHP entry 08001110) is a significant structure related to the development of the tourism industry in Puerto Rico constructed in 1919. The Edificio Miami (SJ0200038, NRHP entry 84003169) is an art deco building from 1936 that was the first private apartment building constructed in the Santurce area, and possibly the first apartment building constructed in Puerto Rico.

FUTURE WITHOUT-PROJECT CONDITION

Without a project the extensive cultural and historic resources of the San Juan metropolitan area would continue to be protected under several Federal laws and regulations similar to the existing conditions descriptions. Existing revetments and sea walls may continue to protect historic properties from inundation, though the vulnerabilities to coastal storms documented in this report may not be mitigated.



Figure 2-6. NRHP properties in the vicinity of the Recommended Plan (archaeological sites not depicted due to the sensitivity of information).

San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

2.2.13 AESTHETICS

EXISTING CONDITION

Aesthetic resources are perhaps more difficult to define than aesthetics itself. USEPA (1973) stated the following:

"A. G. Alexander Baumgarten (1714-62) is credited with coining the word AESTHETIC, in his work Aesthetica (dated 1750), to denote "that branch of science which deals with beauty" (Klien, 1966). Like beauty, then, the word has no clear and agreed-on definition that is operative--it remains a term that designates a vague concept..."

In the context of large infrastructure projects, aesthetics generally involves personal and subjective evaluations of the acceptability of visual scenes. The subject is often approached in terms of a "viewshed", which is the scene of the proposed project and consequences as viewed from various locations. Since the project involves a large landscape, this section will be addressed from a regional San Juan Harbor aspect. San Juan Harbor is a historic seaport and has been associated with vessels of increasing size for hundreds of years. A scenic setting is provided by the harbor and river and the numerous vessels common to these waters, including commercial and recreational boats as well as vessels calling on the Port. The estuarine environment provides opportunities for boating and fishing, as well as an escape from the faster pace of land-based activities. Several boat ramps and marinas are located in San Juan Bay. The project is situated in an urban/commercial setting.

FUTURE WITHOUT-PROJECT CONDITION

In the FWOP condition/No Action Alternative, one potential effect could be inundation and sedimentation around WSJB and CL which could continue to affect local aesthetics. These include roadways and railways, infrastructure, vehicular traffic, industrial complexes, residential structures and hotels/tourist district (Condado Lagoon).

2.2.14 RECREATION

There are many opportunities for recreation within the study area. Recreation is described within specific planning reaches in the text below, as well as in **Table 2-3 and Figure 2-7**.

EXISTING CONDITION

<u>Condado Lagoon</u>: The area around Condado Lagoon is used for a variety of recreational purposes. The bridges (Avenida Ashford and Avenida Munoz Rivera) across the entrances to the lagoon on the northwest sides have wide pedestrian lanes which are used for walking, running, and biking. A local beach area to the northwest of the lagoon is also used for walking, swimming and fishing – visitors typically will park at the Plaza Hotel and pay for parking, ride bikes, or use a transportation service. Jaime Benitez National Park is a small beach/park located to the southeast of the lagoon, and is used for walking, swimming and fishing. There is an existing public riverwalk (approximately 0.5 miles) along the southern shoreline of Condado Lagoon which is used for gathering, walking, running, and biking, and provides a walking connection between the bridges and Jaime Benitez National Park. The lagoon itself is popular for swimming, kayaking, paddle-boarding and canoeing. A smaller sidewalk exists along the northeast shoreline but is generally not accessible to the public.

<u>West San Juan Bay 1</u>: Parking for La Esperanza beach (located just outside of this reach) runs along the eastern side. Areas along the eastern shoreline are also used for boating and jet skiing. Casa Bacardi (the Bacardi Factory) is located in this area and attracts many visitors to the vicinity. Area Recreativa is a park located inland and is used for picnics, walking, running, biking, tennis, gathering, basketball, and playgrounds.

<u>West San Juan Bay 2</u>: Various parks in this region provide existing recreational opportunities. Parque de Pelota Las Vegas is used for baseball as well as gathering. Cataño Football Field is used for walking, running, football and gathering. Pedro Cepeda Park and Baseball Park is used for baseball and gathering. Finally, Ciénaga Las Cucharillas Important Bird Area is an estuarine system adjacent the Malaria canal, has the highest diversity of waterbirds within the San Juan Bay estuary, and attracts sight seers and bird watchers.

<u>West San Juan Bay 3</u>: There is a promenade along the northern shoreline of Cataño, known in the community as the Malecón. This is an important area in the community and provides approximately 0.90 miles for walking, running, biking, gathering, events, and also houses the Cataño Convention Center and Cataño Ferry Terminal. There are also boat docks to allow boat access, including the Cataño Boat ramp. A parking lot in this area allows a means for visitors to access these features. The Coliseo Cosme Beitia Salamo is a park that provides basketball and volleyball courts, as well as parking. Bayview Public Park along the northwest is used for gathering and walking. La Puntilla, in the southeast, also supplies parking in the area and has several boat docks along the shoreline.

<u>West San Juan Bay 4</u>: This area is primarily industrial. There are no known recreational features.

Reach	No.	Name	Recreation Types
CONADO LAGOON	1	Unknown	Beach/park, walking, swimming, fishing, etc
	2	Smaller Sidewalk	Walking, running
	3	Jaime Benitez National Park	Beach/park, walking, swimming, fishing etc
	4	Larger Riverwalk	Walking, running, biking, gathering
	5	Bridge	Walking, running, biking
	6	Beach	Beach, swimming, biking
	*	Lagoon	Kayaking, Paddle-boarding, Canoeing
WSJB 1	1	Parking for La Esparanza Beach	parking
	2	La Esperanza Park	Picnic, walking, gathering
	3	Area Recreativa	Picnic, walking, running, biking, tennis, gathering, basketball, playground
	4	Unknown	parking, boating, jet skiing
WSJB 2	1	Parque de Pelota Las Vegas	Baseball, gathering
	2	Cataño Football Field	Walking, running, football, gathering
	3	Baseball Park	Baseball, gathering
	4	Pedro Cepeda Park	Baseball, gathering
	1	Malecon	.90 mile of seawalk, walking, running, biking boat access, some docks, gathering
WSJB 3	2	Parking Lot	parking
	3	Coliseo Cosme Beitia Salamo	Parking, basketball, volleyball
	4	Cataño Boat Ramp	Parking, boating
	5	Bayview Public Park	Walking, gathering
	6	La Puntilla Parking	parking

Table 2-3. Existing Recreation in the Study Area.



Figure 2-7. Existing Recreation in the Study Area.

FUTURE WITHOUT-PROJECT CONDITION

Recreation opportunities within the study area would continue.

2.2.15 EXISTING PROJECTS

EXISTING CONDITIONS

Refer to the graphic overview for the general location of these projects with respect to the study area. See Chapter 1 for descriptions of each project.

- <u>Caño Martín Peña Ecosystem Restoration Project</u>
- <u>Rio Puerto Nuevo Flood Control Project</u>
- <u>San Juan Harbor, Puerto Rico Project</u>
- <u>San Juan Harbor Federal Navigation Project Under Section 1135 for Work at La Esperanza</u>
 <u>Peninsula</u>

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

These projects will continue to function and operate as intended. However, increased sea level change could exacerbate coastal flooding in areas adjacent to these projects.

2.3 PHYSICAL ENVIRONMENT (CONDITIONS)

2.3.1 SEA LEVEL CHANGE

To incorporate the direct and indirect physical effects of projected future sea level change on design, construction, operation, and maintenance of projects, USACE has provided guidance in the form of Engineering Regulation (ER) 1100-2-8162 and Engineering Pamphlet (EP) 1100-2-1. Three scenarios are required by ER 1100-2-8162: a Baseline (or "Low") scenario, which is based on historic sea level rise and represents the minimum expected sea level change; an Intermediate scenario; and a High scenario representing the maximum expected sea level change.

EXISTING CONDITIONS

Based on historical sea level measurements taken from NOS gauge 9755371 San Juan Bay, PR, the historic level change rate was determined using the updated published SLC from sea http://www.corpsclimate.us/ccaceslcurves.cfm. At San Juan Bay, PR gauge 9755371, the MSL trend updated for 2018 is 2.04 mm/year (0.0066929 feet/year) with a 95% confidence interval of +/- 0.39 mm/year (0.0012795 feet/year) based on monthly MSL data from 1962 to 2018 which is equivalent to a change of 0.67 ft in 100 years. The SLC value of 0.0066929 feet/yr was applied to the low, intermediate, and high SLC curves.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

Following procedures outlined in ER 1110-2-8162 and EP 1100-2-1, low, intermediate, and high sea level rise values were calculated over the 50-year planning horizon and for the 100-year adaptation horizon using the official USACE sea level change calculator tool. Projections for sea level rise are based on a start date of 1992, which corresponds to the midpoint of the current National Tidal Datum Epoch of 1983-2001. In the future, sea level rise could be expected to increase by 0.58 (low), 1.26 (intermediate), and 3.39 feet (high) by year 2079 with respect to the above mentioned epoch for San Juan, Puerto Rico (Station ID 9755371) (**Figure 2-8**). Future SLC is expected to exacerbate the impacts of coastal flooding and wave attack as those forces would be occurring at a higher starting water level in the future as sea level rises.



Figure 2-8. Relative Sea Level Change for San Juan, Puerto Rico.

2.3.2 STORM INTERACTIONS WITHIN THE PHYSICAL ENVIRONMENT

This study assesses coastal flood risk from extreme high water events that result from storm surge, waves, tides and sea level change and combinations of these forces. The section below describes existing physical conditions and expected future conditions, in absence of a project. It is a general excerpt of the more detailed description, which can be found in **Appendix A, Engineering.**

2.3.2.1 STORM EFFECTS

EXISTING CONDITIONS

The backbay portion of the San Juan Metro Area is influenced by tropical systems generally during the summer and fall and by northeasters during the late fall, winter, and spring. Although hurricanes typically generate larger waves and storm surge, northeasters can have a greater cumulative impact on the area due to longer storm duration and greater frequency of event occurrence. Periodic and unpredictable hurricanes and coastal storms, with their intense breaking waves and elevated water levels, can cause significant damage to the shoreline and backbay assets.

San Juan Metro is located in an area of significant storm activity. **Figure 2-9** shows historic tracks of hurricanes and tropical storms from 1851 to 2019 as recorded by the National Hurricane Center (NHC), categorized by various colors. Hurricanes are represented by the yellow, orange, and purple tracks, tropical storms are represented by the green tracks, tropical depressions are represented by the blue, and extra-tropical storms are represented by grey tracks. These hurricane data are available from NOAA (<u>https://oceanservice.noaa.gov/news/historical-hurricanes/</u>). The shaded circle in the center of this figure indicates a 100-nautical mile radius drawn from the center of the study area (San Juan). Based on NHC records, 119 tropical storms have passed within this 100-mile radius over the 169-year period of record.

In recent years, a number of storms have significantly impacted the study area including Hugo (1989), Georges (1998), Maria (2017), Irma (2017), and extra-tropical storm Riley (2018). Damages from these storms, as well as from more distant storms causing indirect impacts, included damage from winds, waves, and elevated water levels.



Figure 2-9. Historic Tropical Storm Tracks (1851-2019, 100-mile radius).

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

Storms would be expected to generally continue similar patterns as in the existing conditions. Storm surge, as a result of hurricanes and storms, would continue to cause damages in the San Juan Metro Area.

San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT In addition, future sea level change is expected to worsen the damage driving forces of extreme water levels, waves, and astronomical tides in the study area within existing and FWOP conditions.

2.3.2.2 STORM SURGE EFFECTS

EXISTING CONDITIONS

Storm surge is defined as the rise of the ocean surface above its astronomical tide level due to storm forces. Surges occur primarily as a result of atmospheric pressure gradients and surface stresses created by wind blowing over a water surface. Strong onshore winds pile up water near the shoreline, resulting in super-elevated water levels along the coastal region and inland waterways. In addition, the lower atmospheric pressure which accompanies storms also contributes to a rise in water surface elevation. Extremely high wind velocities coupled with low barometric pressures (such as those experienced in tropical storms, hurricanes, and very strong northeasters) can produce very high, damaging water levels. In addition to wind speed, direction, and duration, storm surge is also influenced by water depth, length of fetch (distance over water), wave setup, and frictional characteristics of the nearshore sea bottom. **Figure 2-10** shows a general graphic depicting storm surge.



Figure 2-10. Generalized graphic showing storm surge influences.

The annual exceedance probability (AEP) is the probability of occurrence of an event within any given year. The AEP for storm surge events can provide insight into the vulnerabilities of a given location through the comparison of flooding caused by the event with the existing topography of an area. **Table 2-4** provides the peak storm surge heights of the mean AEP events for the San Juan Metro area, and include the effects of astronomical high tide and wave setup. The table displays AEP events from FEMA, which illustrates significantly larger elevations, for events equal to or greater than the 2% AEP, compared to the same NOAA events. The NOAA gauge at San Juan, PR (9755371) shows lower elevations for events equal to or above a 2% AEP event because the period of record (approximately 42 years) is too small; indicating additional recorded data is needed to accurately represent the larger events.

Annual Exceedance Probability (AEP)	NOAA Peak Storm Surge Height (ft- PRVD02)*	FEMA Peak Storm Surge Height (ft- PRVD02)*
20%	1.79	0.85
10%	1.90	1.87
2%	2.29	3.94
1%	2.49	4.92
0.4%	-	6.43
0.2%	-	7.71

Table 2-4. FEMA and NOAA Peak Storm Tide Elevations.

*Mean AEP events

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

It could be possible that the historical NOAA water levels from the past will occur in the future, although this may underestimate the risk. In order to account for this uncertainty, stronger storms that may not have occurred on record in the study area but could plausibly occur in the future were generated synthetically using FEMA data, and are included in the storm suite used to model FWOP damages. In addition, future sea level change is expected to worsen the damage driving forces of extreme water level events and is incorporated into the FWOP conditions.

2.3.2.3 WAVES

EXISTING CONDITIONS

In addition to the influence from incident waves on total water level, direct wave impact on structures can be a principal damage driving force. Wave height, period, and direction, in combination with tides and storm surge, are the most important factors influencing the behavior of the shoreline. The San Juan Metro study area is exposed predominantly to short period wind-waves with periodic exposure to longer period storm swells within certain portions of the study area. However, the majority of the back bay study area is protected by Isla de Cabras and Old San Juan land masses fronting the Atlantic Ocean, which dissipate most of the ocean-driven waves. The remaining wind-driven waves within San Juan Bay and ocean-driven waves, through San Juan Bay Inlet, are generally depth limited as they approach the shoreline, thus limiting the size and associated period of the waves.

In the Cataño area, the wind-driven waves within the San Juan Bay and ocean-driven waves through San Juan Bay Inlet are generally depth limited as they approach the shoreline, limiting their wave height. Periodic damage to upland development, within specific portions of the backbay shoreline, is partially attributable to large storm waves produced primarily by northeasters during the late fall, winter, and early spring months and tropical disturbances, including hurricanes, during the summer months. Storm passage (northeasters and tropical storms) is frequent for the study area; even without landfall, a storm system passing within several hundred miles may cause increased waves that can impact the area.

Wave directions are generally from the east and northeast. A seasonal breakdown of wave heights shows that higher wave heights are more frequent in the late fall, winter, and early spring months (November through March) and tend to originate from the northeast and east equally. These larger wave heights can be attributed to the northeasters occurring along the east coast of North America inherently driving larger waves southeast towards the study area. Late spring, summer, and early fall waves (April through October), are smaller and originate predominantly from the east.

Long period, storm-generated swells are common throughout the year. The late fall, winter, and spring months (November to April) have slightly larger periods indicating the influence of Northeasters throughout this time period.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

Waves would be expected to generally continue similar patterns as in the existing conditions. The Cataño shoreline in particular would continue to experience damages from waves, and wave contributions to storm surge would continue to cause damages in the San Juan Metro Area. In addition, future sea level change is expected to worsen the damage driving forces of waves, in which the maximum possible wave height can increase in conjunction with the increasing depth caused by sea level change. Larger wave heights can then further contribute to the total water level.

2.3.2.4 ASTRONOMICAL TIDES & CURRENTS

EXISTING CONDITIONS

Astronomical tides are created by the gravitational pull of the moon and sun and are well understood and predictable in magnitude and timing. The National Oceanic and Atmospheric Administration (NOAA) regularly publishes tide tables for selected locations along the coastlines of the Unites States and selected locations around the world. These tables provide times of high and low tides, as well as predicted tidal amplitudes.

Tides in San Juan, Puerto Rico are affected by mixed semidiurnal tidal fluctuations of the Atlantic Ocean, meaning two high and low tides at different elevations occur per tidal day. The study obtained tidal datums for San Juan, La Puntilla from NOAA tide station 9755371 in San Juan Bay, Puerto Rico. The NOAA gauge contains data from 11/29/1977 to present (12/31/2019). Tidal datums are summarized in **Table 2-5** and are referenced to the Puerto Rico Vertical Datum of 2002 (PRVD02) and Mean Sea Level (MSL), and are based on tidal analysis periods of 01/01/1983 to 12/31/1987 and 01/01/1990 to 12/31/2001. The PRVD02 vertical datum is the official vertical datum of Puerto Rico and is referenced to the MSL of NOAA tide station at San Juan (9755371). The mean tide range, the difference between Mean High Water (MHW) and Mean Low Water (MLW), equals 1.11 ft and the great diurnal range, the difference between Mean Higher High Water (MHHW) and Mean Lower Low Water (MLLW) is 1.58 ft.

Tidal Datum	Elevation (ft-PRVD02)
Mean Higher-High Water (MHHW)	0.81
Mean High Water (MHW)	0.54
Puerto Rico Vertical Datum of 2002 (PRVD02)	0.00
Mean Sea Level (MSL)	0.00
Mean Low Water (MLW)	-0.56
Mean Lower-Low Water (MLLW)	-0.77

Table 2-5. Tidal Datums for San Juan, La Puntilla (9755371).

Along the Atlantic and Caribbean coasts of Puerto Rico, the currents are greatly influenced by the trade winds. In general, there is a west drift caused by prevailing east trade winds; the velocity averages about 0.23 miles per hour and is said to be strongest near the island. With variable winds or light trade winds it is probable that tidal currents are felt at times along the Atlantic and Caribbean coasts of Puerto Rico (NOAA, 2019).

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

Tides would be expected to generally continue similar patterns as in the existing conditions. Storm surge, with tide contributions, would continue to cause damages in the San Juan Metro Area. Frequent tidal flooding (noted as an incidental problem in terms of this study's objectives) would be expected to continue to cause damages and negative effects to the community and environment in the Condado Lagoon area. Future sea level change is expected to worsen the damage driving forces caused by storm surge and astronomical tides in the study area within existing and FWOP conditions.

2.3.2.5 WINDS

EXISTING CONDITIONS

Local winds can contribute to storm surge and the generation of small-amplitude, short period, waves that are important contributors to assets damage throughout the back bay region. The study area lies within the tropical trade wind zone, resulting in moderate winds from easterly directions most of the time. Easterly winds range from 13.2 mph to 16.7 mph throughout the year based on WIS station #61019 from 1980-2014. Elevated wind speeds from the north-northeast in winter months occur during passage of northeasters which can cause extensive storm surge and shorefront damage. Occasionally the area is impacted by the passage of tropical storms that can generate devastating winds, waves, and storm surge, which can cause direct damage to coastal structures and infrastructure.

Wind conditions in Puerto Rico are seasonal. During winter and spring months (December through May) frontal weather patterns driven by cold Arctic air masses can extend as far south as Puerto Rico; these events are referred to as "Northeasters". While Northeasters often result in wave conditions that cause extensive erosion and increased wave setup on the north coast of Puerto Rico, the south coast of Puerto Rico experiences little impact from these events.

During summer and fall months (June through November) tropical waves often develop into tropical storms and hurricanes, which can generate devastating winds, waves, and storm surge.

In the vicinity of San Juan winds are predominantly from the east throughout all months, although throughout the winter and spring months the secondary wind direction is generally from the northeast and throughout the summer and fall months the secondary wind direction generally is from the southeast. Additionally, daily breezes onshore and offshore result from differential heating of land and water masses. These diurnal winds typically blow perpendicular to the shoreline and have less magnitude than the trade winds and northeasters. While these breezes play a significant role in local weather patterns, they are not an appreciable cause of nearshore damage and erosion.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

Winds would be expected to generally continue similar patterns as in the existing conditions. Storm surge, with contributions from wind, would continue to cause damages in the San Juan Metro Area.

2.3.2.6 TOPOGRPAHY

EXISTING CONDITIONS

Topography refers to graphic delineation in detail of natural features to show their relative positions and elevations. To accomplish this, this study used a Digital Elevation Model (DEM) which consists of arrays of regularly spaced land surface elevation values referenced to a horizontal reference datum. The DEM (FEMA, 2018) in **Figure 2-11** shows low surface elevations in the study area, which makes the surrounding areas vulnerable to damages from storm surge and sea level change.



Figure 2-11. DEM showing low surface elevations and FEMA flood zones AE and VE.

FEMA establishes flood zones to communicate hazards to the public. Every zone is classified according to its level of risk and the potential severity of flood events. Per FEMA, flood hazard areas identified on the Flood Insurance Rate Map are identified as a Special Flood Hazard Area (SFHA). SFHA are defined as the area that will be inundated by the flood event having a 1% chance of being equaled or exceeded in any given year. The 1-percent annual chance flood is also referred to as the base flood or 100-year flood, and is the regulatory requirement for the elevation or floodproofing of structures. The base flood elevation (BFE) varies along the perimeter of San Juan Bay with a maximum BFE at Cataño of 4.0 m (13.12 ft). Flood zones and their meanings are depicted in **Figure 2-12**.





FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

Topography is expected to generally remain as it is in existing conditions. Sea level change will likely cause a shift landward of the flood zones. As a result, flood zones may be altered over time, if conditions warrant.

2.3.3 GEOLOGY EXISTING CONDITIONS

The study area is located within the shallow marine shelf that surrounds the Commonwealth of Puerto Rico. Puerto Rico is a volcanic island located within the boundaries of the Caribbean and North American tectonic plates. The island is predominantly composed of volcanic and plutonic rock of Jurassic to Eocene age overlain by limestone and other sedimentary deposits of Oligocene to Recent age. Since the island is wedged between two active tectonic plates seismic activity is prevalent resulting in earthquakes, tsunamis and landslides.

Sediments of Holocene and Pleistocene overlie limestone of Tertiary age. The limestone is found at depths varying from 25 feet to more than 100 feet in depth. Periods of fluctuating sea levels occurred during the glacial periods at the end of the Neogene period exposing the limestone allowing for weathering and erosion to occur. Shallow lagoons formed in depressions along the coast and sediments including silt and clay were deposited on the bottom of San Juan Bay and Condado Lagoon. To date, fine grained carbonate and siliciclastic sediments are transported from upland areas by streams and are deposited into the lagoons.

San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT Existing boring information shows that for the most part the soil profile consists of soft clay over clays of varying stiffness, underlain by limestone of varying depths. Some of the borings encountered silty and clayey sands with intermittent limestone layers, or layers of soft sand. One of the borings closest to Condado lagoon is located in shallow water and encountered a peat layer from 14.6 to 27.1 feet MLW. More detailed information can be found in **Appendix A, Engineering.**

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

It is likely that the geological conditions will remain as they are in the future.

2.4 BUILT ENVIRONMENT

2.4.1 EXISTING STRUCTURES AND INFRASTRUCTURE

The San Juan Metro Area is located on the northeast coast of Puerto Rico, with approximately 40 to 50 miles of fronting shoreline and is heavily developed with homes, businesses, and condominiums. Cataño and La Esperanza are located on the west side of San Juan Harbor. Condado Lagoon is located to the east of San Juan Harbor.

2.4.1.1 REACH 1 – WEST SAN JUAN BAY

EXISTING CONDITIONS

This reach describes an area which is approximately 9 square miles, and which is located to the West and South of San Juan Harbor. This reach contains portions of the municipalities of Toa Baja, Cataño, Guaynabo. This area experiences not only coastal flooding but it has also experienced wave attack from waves approaching through the harbor (in the Cataño area, WSJB-3). This reach contains approximately 18,000 assets, of which 16 are identified as critical infrastructure, one of which is a major hurricane and Tsunami evacuation route (PR-165)¹⁷, in addition to 14 schools and 4 assembly points (Tsunami Program Map Tool, <u>http://prddst.uprm.edu/apps/prtmp</u>/). Reach 1 is subdivided into 4 reaches, described below.

West San Juan Bay 1

This reach contains an estimated 2,201 assets. The features described in the following text are shown in **Figure 2-13**, where the reaches are outlined in green. WSJB 1A contains approximately 421 assets and also houses the Palo Seco Power Plant. The canal itself spans roughly 50 ft wide at the mouth. PR 870 is immediately north of the Cano Aguas Frias entrance and is protected with 2 to 4 ft of riprap.

WSJB 1B contains approximately 1,781 assets, and includes the Casa Bacardi Factory, an important economic engine within the community. PR-165 is a major evacuation route in the area. Structures are generally built as concrete, slab on grade construction. There are no protective measures within the area to reduce the risk of storm surge or sea level rise.

¹⁷ GIS data is from FEMA Caribbean Division and was collected in 2016 & 2017.



Figure 2-13. Built Environment in WSJB 1A and WSJB 1B.

West San Juan Bay 2

This reach contains an estimated 6,623 assets, which include critical infrastructure as shown in **Figure 2-14**, where the reach is outlined in orange. Structures are generally built as concrete, slab on grade construction. PR-165 is a major evacuation route in the area. There is an existing sluice gate at the Malaria Canal entrance, which is currently inoperable and kept closed. Temporary FEMA pumps are also located at the mouth of the Malaria Canal, which pump rainfall runoff around the sluice gate. There are no protective measures within the area to reduce the risk of storm surge or sea level rise.



Figure 2-14. Built Environment in WSJB 2.

*Critical Infrastructure Key: Shelters (Orange Triangles); Hospital ("H"); Emergency Management Office (Green Triangles); State Police Department (Dark Blue Pentagon); Fire Department (Red Pentagon); Evacuation Route (yellow).

West San Juan Bay 3

This reach contains an estimated 8,726 assets, which include critical infrastructure as shown in **Figure 2-15**, where the reach is outlined in blue. Structures are generally built as concrete, slab on grade construction. PR-165 is a major evacuation route in the area.

The northern Cataño shoreline has structures such as non-engineered rock revetments and sheet-pile seawalls with concrete caps, and is generally described below in numerical order as shown in **Figure 2-15**, moving west to eat in the reach.

- 1. Rock revetment (approximately 3 ft above the waterline, consisting of rock that is approximately 2 to 4 ft in diameter) fronts the shoreline east of La Esperanza Park to the marina at Centro Agropecuario Cataño.
- 2. Gabion fronts the shoreline at marina at Centro Agropecuario Cataño.

- 3. The marina at Centro Agropecuario Cataño is protected by a 400 ft long by 40 ft wide emergent breakwater 200 ft offshore, containing rock that is approximately 2 to 4 ft in diameter.
- 4. The seawall is higher in crest elevation moving east along the shoreline. The sheet pile seawall contains a concrete cap approximately 3 ft above the waterline. The seawall toe is fronted by 1 to 2 ft riprap.
- 5. The central portion of Cataño generally consist of sheet pile seawalls with a concrete cap 3 to 5 ft above the waterline. Riprap which is 1 to 3 ft in diameter generally protects the seawall toe. Rainwater runoff pipes located within portions of the seawall may be susceptible to surge and wave attack inundation since some pipes do not contain backflow preventers. Area shown is just in front of the convention center.
- 6. The eastern side of Cataño generally contains 2 to 4 ft non-engineered riprap. South of that, the shoreline generally has seawalls and toe riprap. The seawalls generally protrude approximately 3 to 5 ft above the waterline and the riprap rock diameter ranges from 1 to 3 ft.
- 7. Port infrastructure is located along the lower eastern shoreline of the reach, including the Puma Energy pipeline.

The features described along Cataño are in good condition although some of the riprap does not seem to be designed appropriately as it is mixed with various armor stone sizes and slabs of concrete. The existing structures are under-designed in terms of the top elevation of structures to perform effectively for reducing storm surge.



Figure 2-15. Built Environment in WSJB 3.

*Critical Infrastructure Key: Shelters (Orange Triangles); Hospital ("H"); Emergency Management Office (Green Triangles); State Police Department (Dark Blue Pentagon); Fire Department (Red Pentagon); Evacuation Route (yellow); Convention Center (Pink Triangle).

West San Juan Bay 4

This reach contains approximately 429 assets, consisting mainly of port infrastructure on north side and industrial/ residential structures on south part, with slab on grade construction. **Figure 2-16** shows the area, where the purple outline marks the reach boundary. PR-2 is a major evacuation route in the area. There is an existing seawall that runs along both sides of the Bechara Canal, which is a part of the USACE Rio Puerto Nuevo project. The existing seawall in WSJB 4 is in fair condition but is under-designed in terms of the top of the structure elevation for perform effectively for reducing storm surge.

Figure 2-16. Built Environment in WSJB 4.



*Critical Infrastructure Key: State Police Department (Dark Blue Pentagon); Evacuation Route (yellow)

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The conditions described above would be expected to continue. The low ground elevations in combination with structures and infrastructure predominately built as concrete structures at the ground level will continue to make it a high risk area because of its vulnerability to repeated coastal flooding with associated damages, as well as negative effects to the resiliency of the communities. There are no coastal flood protection measures in reaches WSJB-1A and -1B and there are currently no plans in place to design or construct them. The locations and low elevations of the individual features in Cataño and WSJB-4 contribute to ineffectiveness at providing long term coastal flooding damage reduction. As sea level rise increases over the 50 year period of analysis flooding of these areas would be expected to become more frequent with higher stages, and the result would be more damages with even less resiliency.

2.4.1.2 REACH 3 – CONDADO LAGOON

This reach encompasses an area which is approximately .5 square mile, located to the East of San Juan Harbor and bordering the Condado Lagoon. This reach is within the San Juan municipality and suffers from storm surge and tidal influences from Condado Lagoon. This area serves as a major throughway to communities evacuating from the west, and contains a Tsunami and Hurricane evacuation route, PR-26, identified as critical infrastructure. There is one shelter located within the immediate area of risk. Roads

and vehicles are largely impacted by frequent tidal flooding (noted as an incidental problem in terms of this study's objectives), as reported by residents. This reach is also at risk from sea level change.

EXISTING CONDITIONS

This reach contains a high density of structures, with an estimated 1,222 assets. Structures are a mix of high rise and concrete, slab on grade construction.

Condado Lagoon's shoreline consists primarily of vegetation (red and black mangroves), concrete seawalls, and nearshore sea grasses. The seawall on the east side of the lagoon is generally 3 feet above the waterline with noted rainwater runoff openings in the seawall. Additionally, there is a partially failed seawall at the end of Calle Joffre (1). The under-designed seawall is approximately 1 foot above the waterline and has partially failed. There is a riverwalk along the southern shoreline (2) which is higher in elevation. These features can be seen in **Figure 2-17**.

Figure 2-17. Condado Lagoon Built Environment.



San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT
FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The conditions described above would be expected to continue. The low ground elevations in combination with structures and infrastructure predominately built as concrete structures at the ground level will continue to make it a high risk area because of its vulnerability to repeated coastal flooding with associated damages, as well as negative effects to the resiliency of the communities. There is one partial failed seawall which also under designed in terms of the top elevation the structure – both of these qualities contribute to its ineffectiveness at providing long term coastal flooding damage reduction. As sea level rise increases over the 50 year period of analysis, coastal flooding of these areas would be expected to become more frequent with higher stages, and the result would be more damages with even less resiliency.

2.4.2 HURRICANE EVACUATION ROUTES AND ZONES

2.4.2.1 REACH 1 – WEST SAN JUAN BAY

EXISTING CONDITIONS

This reach contains evacuation zones A and B, as defined in the Puerto Rico Hurricane Evacuation Study, October 2018. PR-165 is both a Tsunami and Hurricane evacuation route for the area. There are 6 shelters within the study reach.

2.4.2.2 REACH 3 – CONDADO LAGOON

EXISTING CONDITIONS

This reach contains evacuation zone A. This area serves as a major throughway to communities evacuating from the west, and contains a Tsunami and Hurricane evacuation route, PR-26. There is one shelter within the study reach.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

The Puerto Rico Hurricane Evacuation Study, Behavioral Study, Final Report March 2014 offers insight as to evacuation practices from survey questions asked. When asked, "*Have you or your household ever evacuated for a hurricane?*" only 15% said yes. When asked what storm was responsible for their evacuation, most often mentioned was Hurricane Georges (made landfall in Puerto Rico in 1998 as Category 3 hurricane), followed by Hurricane Hugo (Category 3 in 1989) and Hurricane Hortense (Category 1 in 1996). Most (85%) with evacuation experience had stayed at the home of a relative or friend within their municipality and about 10% reported going to a public shelter. Only one left Puerto Rico.

When asked, *"If you had to evacuate, where would you most likely go? Would you go to the home of a relative or friend, another property you own, a public shelter, a hotel, or someplace else?"* answers indicate that 66% of the San Juan Metro Area residents would evacuate to the home of a friend or relative and 20% would evacuate to a public shelter, with 3% evacuating to a hotel, 1% to a church, and 9% were reported as "other" or "did not know". In the same survey for the San Juan Metro Area, 55% of those

surveyed reported they were very likely to evacuate for a Category 1 or 2 hurricane with no official recommendation and 70% reported they were very likely to evacuate for a Category 3 or higher hurricane if they were ordered to leave. The same survey concluded the most important source of hurricane information are as follows: local radio 41%, cable TV 24%, local TV 20%, internet 6% and miscellaneous 9%.

2.4.3 LIFE SAFETY

EXISTING CONDITIONS

There is an existing Puerto Rico Evacuation Plan, in the report titled the "Puerto Rico Hurricane Evacuation Study Vulnerability Analysis", prepared for the Federal Emergency Management Agency (FEMA) in October 2018. In it, evacuation zones are identified as well as shelters. It is assumed that the recommendations in it will be carried out by government officials prior to hurricanes and storm events. It is also assumed that evacuation orders would be in place as required, and to increase life safety and reduce the risk of life loss.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

In the future, it is assumed that prior to hurricanes and storm events, evacuation orders would be in place as required, and followed by communities to increase life safety and reduce the risk of life loss. The nonfederal sponsor may or may not pursue measures such as local outreach and evacuation plan/notification improvement in order to ensure that residents continue to understand evacuation plans, receive notification of evacuation orders, and follow evacuation orders.

2.5 SOCIO-ECONOMIC ENVIRONMENT

EXISTING CONDITIONS

The parameters used to describe the demographic and socioeconomic environments include trends in population, employment, and income distribution for the Commonwealth of Puerto Rico and the forty municipalities that make up the San Juan-Carolina-Caguas Metropolitan Statistical Area (MSA). Additional details may be found in the Economics Appendix.

Historical Population and Population Projections

The U.S. Census data indicates that the population of Puerto Rico increased from 1950 to 2000, a net increase of 1,597,907. This constitutes an average annual increase of 1.5 percent, or 31,958 per year during that period. The 2010 census shows a population of 3,725,789, a net loss of 82,821 or a 2.2% decline from the 2000 census. According to the statistics presented by the Puerto Rico Statistics Institute regarding U.S. Community Survey estimates, the population of Puerto Rico is expected to continue its downward trend in the period from 2010 to 2050. The decline in population is projected to reach 737,000 or 19.8% over the 40 year period. This constitutes an average annual decline of 0.5 percent, or 18,423

people per year. A surge in the out-migration of its citizens explains much of this decline, with nearly one-third of those born in Puerto Rico living on the U.S. mainland in 2013.¹⁸

San Juan-Carolina-Caguas MSA

In all, there are 78 municipalities of the Commonwealth of Puerto Rico. The largest MSA is the San Juan-Carolina-Caguas MSA with a total population of 2,350,126 in 2010, approximately 63.0% of the total population of Puerto Rico. Approximately two out of every three people in Puerto Rico live within the San Juan-Carolina-Caguas MSA. In 2015 the population of the municipality of San Juan was 355,074, the most populous municipality in Puerto Rico.

Population Density

Puerto Rico is 10 times more densely populated than the United States as a whole. Based on the 2015 population estimate, population density in Puerto Rico is 988 people per square mile or 362 people per square kilometer. This makes Puerto Rico the fourth most densely populated state or territory in the United States. It is behind only Washington, District of Columbia (10,589 people per square mile); New Jersey (1,210 people per square mile); and Rhode Island (1,006 people per square mile).

Figure 2-18 presents, at a glance, the 2010 Census Profile for the U.S. Territory of Puerto Rico including population distribution by race, population distribution by gender and age, population density, and the decennial population from 1970 to 2010.

¹⁸ Based on 2013 data from the United Nations and U.S. Census Bureau as reported by the Pew Research Center in the August 11, 2014 article entitled "Puerto Rican Population Declines on Island, Grows on U.S. Mainland" by D'Vera Cohn, Eileen Patten and Mark Hugo Lopez.

Figure 2-18. Commonwealth of Puerto Rico 2010 Demographic Profile (Source: United States Census Bureau, 2010 Decennial Census.



Employment and Income

The economy of Puerto Rico is relatively concentrated in (1) educational services, healthcare and social assistance services, and (2) retail trade. According to the U.S. Census 2011-2015 American Community Survey (ACS) 5-Year Estimates, Puerto Rico employment totaled 1,063,350 on average with over 37% of jobs attributable to these two sectors combined.

The San Juan-Carolina-Caguas MSA industry sectors yield employment distributions similar to those in Puerto Rico overall. Also of note, the arts, entertainment, and recreation, and accommodation and food services sector ranks fourth in terms of the percentage of people employed in the San Juan-Carolina-Caguas MSA, which is consistent with San Juan Harbor's prominence as a Caribbean cruise port and with the importance of tourism on the island.

According to the U.S. Census Bureau's 2010-2014 ACS, the median household income in 2010-2014 for Puerto Rico was on average \$19,686. Of the three municipalities directly adjacent to San Juan Harbor, both San Juan (\$22,266) and Guaynabo (\$34,450) had median household incomes greater than that of Puerto Rico overall, while the median household income in Cataño (\$18,625) was less than that of Puerto Rico overall.

FUTURE WITHOUT-PROJECT CONDITIONS (NO-ACTION ALTERNATIVE)

Current trends would be expected to continue in the future without-project conditions.

2.6 OVERVIEW OF INTERACTIONS OF THE FOUR ENVIRONMENTS (ENVIRONMENTAL, PHYSICAL, BUILT & ECONOMIC)

This section describes how the interactions of the four environments described in the above sections create problems and necessitate the study of solutions. This discussion includes where the coastal flooding is most prone to occur, which is directly linked to the problems, opportunities, and objectives, as well as the locations of measures during alternative formulation, all of which are described in Chapter 3. **Figure 2-19** shows a graphic representation of where problems occur (shown as arrows) within the study reaches, and can be used as a reference during this section for descriptions of coastal flooding in each reach. The storm surge (FEMA, 2018) for a category 1 hurricane is shown in red in the figure. This report analysis does not focus solely on a category 1 hurricane; however, this graphic is meant to illustrate where the lowest category of hurricane begins to inundate the low-lying elevations first.



Figure 2-19. Susceptibility to Storm Surge, shown at low elevation entry points.

Regarding the duration of inundation in the study area, the length of time an area is inundated by storm surge depends on the specific reach topography and the magnitude of event that occurs. Inundation durations at specific locations is beyond the capability of the economics model. For context purposes, the storms in the storm database which were used as input for the Corps certified model G2CRM for this study could potentially inundate areas between 0 - 4 days. For reference, Hurricane Maria produced surge levels between 0.5-ft and 2.4-ft for approximately half a day according to NOAA gauge 9755371.

Summary descriptions about water levels and broad qualitative effects to all the environments are described in the sections below. Following this section, quantitative potential estimates as G2CRM output for the specific reaches can be found in Section 2.7 and **Appendix C, Economic Analysis.**

2.6.1 CONDADO LAGOON

There is a high density of structures in this area, as well as the presence of high rises (many of which are hotels), and evacuation routes. This area supports recreation and tourism. Key environmental resources in the lagoon include seagrasses and mangroves.

The sources of coastal flooding into Condado Lagoon are from the Atlantic Ocean. The area will initially flood through the northeastern side of the lagoon in the low-lying elevations, and as the surge increases, the coastal flooding will propagate further east as well as towards the north side of the planning reach. The south side of Condado Lagoon will flood during the higher surge events. The coastal flooding results in damages to the built environment of structures and infrastructure, as well as inaccessibility for vehicles on roads One additional and ancillary problem to note in this area is frequent tidal flooding (noted as an incidental problem in terms of this study's objectives), in addition to coastal flooding from hurricane and storm events as described earlier. In many cases, frequent tidal flooding from the lagoon, affecting water quality and negatively affecting the natural environment. All of these problems negatively affect the community's ability to return to normal daily life, as well as affecting tourism and recreation. These in turn negatively affect the economic environment and overall negatively affect the resilience of this community.

For visual context of the reader, the below figures display existing elevations below the 1% Annual Exceedance Probability (AEP) and 0.2% AEP events (with 50% assurance) plus intermediate sea level change at year 2079. The following elevation maps were created in May 2021 using the best available data at the time this report was written. It may or may not accurately reflect existing conditions.



Figure 2-20. Condado Lagoon - Existing Elevations Below the 1% AEP Event with Int SLC (2079).



Figure 2-21. Condado Lagoon - Existing Elevations Below the 0.2% AEP Event with Int SLC (2079).

2.6.2 WEST SAN JUAN BAY 1A

This area contains a lower density of structures and also houses the Palo Seco power plants. Key environmental resources in the area include mangroves along the Caño Aquas Frias. This reach contains two sources of potential flooding: through the Caño Aguas Frias along the south side of WSJB-1A and from the Atlantic Ocean into the north side of the model area. Flooding will first occur on the south side of WSJB-1A through the Caño Aguas Frias and eventually inundates the north side of the area from the Atlantic Ocean, which damages structures. In discussions with the power plants, problems with storm surge have not been experienced in past storms. The flooding causes damages to the built environment of structures and infrastructure. These in turn negatively affect the economic environment, and overall negatively affect the resilience of this community.

2.6.3 WEST SAN JUAN BAY 1B

WSJB 1B contains a high density of structures and includes the Casa Bacardi Factory, an important economic engine and popular tourist destination within the community. PR-165 is a major evacuation route in the area. Key environmental resources in the area include seagrasses, freshwater wetlands, and mangroves. WSJB-1B contains three sources of potential flooding: through the Caño Aguas Frias along the north side of WSJB-1B, through La Esperanza Park on the east side of the reach, and through Malaria Canal just south of the area. Flooding will first occur on the east side of WSJB-1B and higher surge events will flood into the north side of the reach through the Caño Aguas Frias and the south side of WSJB-1B through the Caño Aguas Frias and the south side of WSJB-1B through the Malaria Canal. The flooding causes damages to important assets in the built environment.

All of these problems negatively affect the community's ability to return to normal daily life, as well as affecting tourism and recreation. These in turn negatively affect the economic environment, and overall negatively affect the resilience of this community.

For visual context of the reader, the below figures display existing elevations below the 1% Annual Exceedance Probability (AEP) and 0.2% AEP events (with 50% assurance) plus intermediate sea level change at year 2079.



Figure 2-22. WSJB 1A and 1B - Existing Elevations Below the 1% AEP Event with Int SLC (2079).



Figure 2-23. WSJB 1A and 1B Existing Elevations Below the 0.2% AEP Event with Int SLC (2079).

2.6.4 WEST SAN JUAN BAY 2

This reach contains a high density of structures, as well as evacuation routes. Key environmental resources in the area include freshwater wetlands and mangroves. The flooding sources into WSJB-2 are through the Malaria Canal and the Caño Aguas Frias. At the entrance of the Malaria Canal, the existing gate remains closed. Storm surge will propagate into the area following the overtopping of the existing gate. Flooding would occur along the east and west sides of the Malaria Canal and propagates into the area as the surge increases. Larger storm surge events could also flood through the Caño Aguas Frias and into the northwest side of WSJB-2. The flooding causes damages to important assets in the built environment. Freshwater wetlands are impacted as storm surge brings salt water into the areas during storm events. All of these problems negatively affect the community's ability to return to normal daily life, as well as affecting tourism and recreation. These in turn negatively affect the economic environment, and overall negatively affect the resilience of this community.

For visual context of the reader, the below figures display existing elevations below the 1% Annual Exceedance Probability (AEP) and 0.2% AEP events (with 50% assurance) plus intermediate sea level change at year 2079.







Figure 2-25. WSJB 2 - Existing Elevations Below the 0.2% AEP Event with Int SLC (2079).

2.6.5 WEST SAN JUAN BAY 3

There is a high density of structures in the area, as well as evacuation routes. The waterfront area houses important community structures, including a pedestrian boulevard (known as the "malecon"), convention center and the ferry terminal. Key environmental resources in the area include mangroves and seagrasses. Storm surge along with the influence of waves will cause flooding into WSJB-3 through San Juan Harbor. Flooding will initially occur through the San Fernando Canal, which is located to the east, and within the northeast region of the area. As the surge increases, the flooding will propagate further into WSJB-3 through the north and southeast sides of the area. Storm-generated waves will pass through the San Juan Harbor Inlet causing increases in flooding due to wave setup and wave runup. The flooding and wave attack cause damages to important assets in the built environment. All of these problems negatively affect the community's ability to return to normal daily life, as well as affecting tourism and recreation. These in turn negatively affect the economic environment, and overall negatively affect the resilience of this community.

For visual context of the reader, the below figures display existing elevations below the 1% Annual Exceedance Probability (AEP) and 0.2% AEP events (with 50% assurance) plus intermediate sea level change at year 2079.



Figure 2-26. WSJB 3 - Existing Elevations Below the 1% AEP Event with Int SLC (2079).



Figure 2-27. WSJB 3 - Existing Elevations Below the 0.2% AEP Event with Int SLC (2079).

2.6.6 WEST SAN JUAN BAY 4

This area contains port infrastructure on north side and industrial/ residential structures on south part. Key environmental resources in the area include seagrasses and mangroves. The sources of flooding into WSJB-4 are from the Bechara, the San Juan Harbor, and the Margarita Canal. The area will initially flood through the Bechara, which is a tidally influenced channel that goes through the center of the model area from the San Juan Harbor on the north side, underneath the port, and out the south side of the area. As the surge increases, the flooding will propagate further into the interior of WSJB-4A and WSJB-4B through the Bechara. The San Juan Harbor will produce flooding into the northeast region into WSJB-4B and the Margarita Canal will flood the southside of the area into WSJB-4A and WSJB-4B. The flooding causes damages to important assets in the built environment. All of these problems negatively affect the community's ability to return to normal daily life, as well as affecting tourism and recreation. These in turn negatively affect the economic environment, and overall negatively affect the resilience of this community.

For visual context of the reader, the below figures display existing elevations below the 1% Annual Exceedance Probability (AEP) and 0.2% AEP events (with 50% assurance) plus intermediate sea level change at year 2079.



Figure 2-28. WSJB 4 - Existing Elevations Below the 1% AEP Event with Int SLC (2079).



Figure 2-29. WSJB 4 - Existing Elevations Below the 0.2% AEP Event with Int SLC (2079).

2.7 MODELING OF THE FUTURE WITHOUT-PROJECT CONDITIONS WITH G2CRM

This study takes an inventory of existing physical conditions as described above and uses various models and analyses to verify existing conditions and then projects it out over 50 years in the USACE certified economic model Generation 2 Coastal Risk Model (G2CRM) to determine a probable future condition, in the absence of a project. This section describes an overview of the process.

G2CRM is a computer model that implements an object-oriented Probabilistic Life Cycle Analysis (PLCA) model using event-driven Monte Carlo Simulation (MCS). The model is based on driving forces (storms) that affect a coastal region (study area). The study area is comprised of individual sub-areas of different types that may interact hydraulically and may be protected by coastal defense measures that serve to shield the areas and the assets they contain from storm damage (USACE, 2018b). To determine the damages for a specific event and time G2CRM compares the total water level (sum of the storm surge, SLC, tide, and potential wave inputs) to asset first floor elevations within the FWOP condition or Protective System Element (PSE) elevations and then first floor elevations within future with-project (FWP) conditions. The model integrates engineering and economic interactions of the elements below as storms occur during the 50-year period of analysis.

Within the specific terminology of G2CRM, the important modeled components are:

- **Driving forces** storm hydrographs (surge and waves) at locations, as generated externally from high fidelity storm surge and nearshore wave models such as ADCIRC and STWAVE.
- **Modeled areas** (MAs) areas of various types (coastal upland, unprotected area) that comprise the overall study area. The water level in the modeled area is used to determine consequences to the assets contained within the area.
- **Protective system elements** (PSEs) the infrastructure that defines the coastal boundary be it a coastal defense system that protects the modeled areas from flooding (levees, closure structures, etc.), or a locally developed coastal boundary comprised of bulkheads and/or hardened shoreline.
- Assets spatially located entities that can be affected by storms. Damage to structure and contents is determined using damage functions. For structures, population data at individual structures allows for characterization of loss of life for storm events.

2.7.1 MODEL ASSUMPTIONS

Key model assumptions are shown below in Table 2-6.

Input Field	Assumption / Model Input			
Storm Suite	ADCIRC/STWAVE ¹⁹ storm suite chosen from South Atlantic Comprehens			
	Study (SACS) modeled events at Cataño. G2CRM contains 12 tropical storms			
	from ADCIRC/STWAVE and 3 extra-tropical storms.			
Storms per Season	Analyzed wave data from Wave Information Study (WIS) station 61019. The			
	analysis classified a "storm" as the average significant wave height of the			
	entire dataset plus two standard deviations (10.6 ft).			
Tide	National Oceanographic and Atmospheric Administration (NOAA) tide			
	station 9755371. (San Juan Bay, PR)			
Relative Storm	Relative storm probability is based off the Federal Emergency Management			
Probability	Administration (FEMA) annual exceedance probabilities (AEP) event			
	elevations.			
Sea Level Rise	USACE intermediate curve is used for plan formulation based on 5-yr and			
	19-yr mean sea level moving average trends. The analyses will run the low			
	and high sea level change (SLC) curves within G2CRM to compare damages			
	to the proposed design for the evaluation of risk and potential adaptation			
	of project features. The SLC rate was determined from NOAA gauge			
	9755371. G2CRM follows SLC guidance for ER 100-2-8162 and EP 1100-2-1.			
Reaches				
Reach Specification	Reaches were determined using the extent of the FEMA 2018 0.2% annual			
	exceedance value, NOAA sea level rise (SLR) viewer (6' above mean higher			
	high water (MHHW)), and the ADCIRC/SWAN Cat 5 MOM w/ 1m SLR.			

Table 2-6. Key Model Assumptions.

¹⁹ ADCIRC/STWAVE is an advanced model for waves and tides.

Development of	Reaches were divided into Planning Reaches and subsequent Model Areas			
Planning Reaches and	based on the separability from possible sources of coastal flooding for input			
Model Areas	into G2CRM. The team used the digital elevation model (DEM) and the			
	NOAA SLR Viewer to determine model separability based on the location of			
	various flood sources.			
Protective System				
Elements (PSE)				
PSE	PSEs were delineated at model area extents to protect portions of the model			
	area subject to low elevations. For FWOP the top elevation is the lowest			
	ground elevation of the PSE. For future with-project (FWP) the top elevation			
	will change depending on the alternative.			
Damage Elements	The damage element inventory contains 19,675 damageable structures			
Foundation Type	Foundations generally concrete stem-wall.			
Construction Type	Assumed mostly masonry construction types.			
Structure Rebuild Times				
Number of Rebuild	Unlimited rebuild times assumed.			
Times				
Rebuild assumptions	Assume not built to higher elevation.			
Structure Values	Developed by real estate team to determine depreciated values of a sample			
	of the population.			
Content Values	Developed by real estate team to determine depreciated values of a sample			
	of the population.			
Structure Elevation	Developed using geospatial information system (GIS) using DEM and asset			
Data	locations.			
Damage Functions	North Atlantic Comprehensive Coastal Study (NACCS) – structure			
	(residential, multi-story, high rise)			
Vehicle Damages	Vehicle damages will be included in damage assessment.			
First Floor Elevation	Assumed between 0-6" off the ground.			
Structure Raising	Assumed no structure raising at this time.			
Other Benefits				
Life Loss Prevention	Prevention of life loss will be evaluated.			
Modeling Simulations				
Number of Iterations	5-iterations for initial plan formulation; 50-iterations for refined benefits.			
	This was selected to provide stable simulation with negligible variability in			
	output.			
Discount Rate	2.75% (FY2020 discount rate)			
Start Year	2020			
Base Year	2029			
End of 50 year period of	2079			
analysis				
Life Cycle Duration	60 years.			

2.7.2 G2CRM MODEL INPUT OVERVIEW - ENGINEERING HYDRODYNAMICS

More detailed information regarding the discussions below can be found in Appendix A, Engineering.

2.7.2.1 DRIVING FORCES

Within the G2CRM model, the still water depth is comprised of three water level components: storm surge; sea level change contribution; and astronomical tide contribution less the relevant ground elevation (water-side ground elevation at protective system element, or representative unprotected model area ground elevation).

Meteorological driving forces are storm hydrographs (surge and waves) at locations, as generated externally from high fidelity storm surge and nearshore wave models such as ADCIRC and STWAVE (USACE, 2018). Additionally the number of storms per year and relative storm probability are incorporated into G2CRM and further described below.

STORM HYDROGRAPHS

To develop tropical storm hydrographs, the Engineer Research and Development Center (ERDC) coupled ADCIRC and STWAVE. ADCIRC is a two-dimensional hydrodynamic model that conducts short- and long-term simulations of tide and storm surge elevations and velocities in deep-ocean, continental shelves, coastal seas, and small-scale estuarine systems. STWAVE is a steady-state, finite difference, spectral model based on the wave action balance equation.

The study team selected 19 tropical storms from the South Atlantic Coastal Study (SACS) storm suite and Coastal Hazard System (CHS), using the water level based AEP events from FEMA. Of the 19 tropical events ran in ADCIRC/STWAVE the team selected 12 to represent the storm suite for G2CRM input. These 12 selected tropical events ranged from 33.3% to 0.2% AEP events in relation to the FEMA AEP events.

To represent higher frequency and longer duration extra-tropical (ET) events, the team selected two events from Ocean Weather Inc.'s (OWI) operational (historical) storms from 1979 through 2017. Since the operational storms from OWI did not include events after 2017, the team added an additional ET storm (Riley) to the storm suite.

STORMS PER SEASON

To determine the storm event generation G2CRM first selects the tropical and extra-tropical events to occur through each season within the year. The study area is subject to tropical system storm surge from June through November. Surge from extratropical storms may affect the area any time of the year, but generally occur from December through May. Extratropical storms are frontal weather patterns driven by cold Arctic air masses that extend as far south as Puerto Rico. Extratropical storms have a higher frequency of occurrence compared to tropical storms but will produce less storm surge. This study implemented three storm seasons within each year; January through May as an extra-tropical season, June through November as a tropical season, and lastly December as an extra-tropical season.

G2CRM then uses the Poisson distribution to randomly select the number of storms to occur within each season based on the average number of storms in a season input. To determine the number of tropical and extra-tropical storm occurrences this study analyzed wave data from WIS station 61019. The study used wave heights instead of distance from the study area to more accurately define what is classified as

a storm impacting the study area; to ensure all events impacting the study area, no matter how far away, are accounted for. The analysis classified a "storm" as the average significant wave height of the entire dataset plus two standard deviations (10.6 ft). The analysis applied a decluster time of five days to eliminate any duplicate events and then applied a peak-over-threshold of the wave height classified as a "storm" (10.6 ft). To determine what events were tropical or extra-tropical the analysis used the NOAA Historical Hurricane Tracks (North Atlantic Basin) and filtered through the data. **Table 2-7** displays the storm occurrences per year for extra-tropical and tropical events.

Table 2-7. Storms per Season.

Extra-Tropical Storm Season (JAN to MAY)	Tropical Storm Season (JUN to NOV)	Extra-Tropical Storm Season (DEC)
6.8	1.6	0.6

RELATIVE STORM PROBABILITY

Following G2CRM's storms per season selection it then chooses the storms that occur within each season by randomly selecting storms out of the available storm suite using bootstrap sampling with replacement (higher probability storms are chosen more often). To determine the relative storm probability based on surge the study analyzed water level data from the NOAA gauge (9755371) at San Juan and compared to the FEMA 2009 return period curve²⁰. It could be argued that the historical NOAA water levels from the past will occur in the future, although this may underestimate the risk. The FEMA results provide an opportunity to evaluate impacts of stronger synthetic storms that may not have occurred on record, but could occur in the future. Therefore a decision was made to use the FEMA return period elevations since they more accurately represent the larger events.

ASTRONOMICAL TIDES & SEA LEVEL CHANGE

The tide contribution to total water level is calculated internally within G2CRM based on an astronomical tide calculation using standard harmonic methods to determine the tide at a given tide station on a given date/time.

G2CRM takes into account the water level contribution associated with sea level change (SLC). Sea level change is calculated per Corps policy and guidance. Each model run can make use of one of the three Corps-defined sea level change scenario curves: low, intermediate, or high. User input is required for the base sea level change rate.

2.7.2.2 PLANNING REACHES

Planning reaches are areas that comprise the overall study area. The water level in the planning reach was used to determine consequences to the assets contained within the area (USACE, 2018). The team divided the study area into 6 planning reaches (Reference **Figure 1-3, Chapter 1**), and subsequent model areas based on their separability from various flood sources for input into G2CRM. The team used the DEM and the NOAA SLR Viewer to determine model separability based on the location of various flood sources.

²⁰ SACS data was not considered because the statistics (to determine the relative storm probability) was not complete at the time of the analysis.

2.7.2.3 PROTECTIVE SYSTEM ELEMENTS (PSES)

The team originally developed the PSEs to encompass the entire planning reach extent adjacent to the flood source, based on the DEM and NOAA SLR Viewer. The team established this assumption as a worst case scenario. The study team later refined the exact locations and PSE lengths to remove high elevation areas following the development of the design elevations and completion of FWOP.

2.7.3 G2CRM MODEL INPUT OVERVIEW – ECONOMIC

More detailed information regarding the discussions below can be found in Appendix C, Economic Analysis.

2.7.3.1 STRUCTURE INVENTORY & DAMAGE FUNCTIONS

The structure inventory was developed using several data sources.²¹ The building polygons were horizontally projected and aligned based on the DSM and aerial images. The dataset was not complete meaning that some of the polygons were manually digitized. The DTM was subtracted from the DSM in order to obtain the heights. The Zonal Statistics tool was then implemented to determine the number of floors based on a conditional if statement. A sample of 30 polygons per area of interest were randomly selected to compare the statement value and the real value using Google Maps Aerial Image. In addition, Google Maps was used in order to assign the occupancy type descriptions for each polygon. The building square footage was determined using the building polygons and a sample of 30 polygons were randomly selected in order to determine the error in the estimate. The DTM was also used along with the building footprints to determine the building grade elevation. The final products were developed with the following information in the attribute table: Description, Occupancy Type, Floor Numbers, Area in Sq.Ft., and Grade Elevation. The damage element inventory contains 19,675 damageable structures.

Damages functions were used from the North Atlantic Coast Comprehensive Study (NACCS) and adapted for the local study area.

2.7.4 FUTURE WITHOUT-PROJECT MODEL RESULTS

The G2CRM model results verified that areas identified as vulnerable to experience storm surge damages would likely experience damages over a 50-year period. As mentioned earlier in the report, East San Juan Bay, Reach 2, was screened out during this phase. It is included in the discussion below for the purposes of showing results of the analysis and why it was not carried into further analysis in the study.

2.7.4.1 FUTURE WITHOUT-PROJECT DAMAGES BY OCCUPANCY

G2CRM was used to estimate damages and costs for the following categories:

²¹ Data sources: Puerto Rico US Geological Survey (USGS) 2015 1m x 1m LiDAR Digital Elevation Model (DEM) and Digital Surface Model (DSM) & Humanitarian OpenStreetMap Team (HOTOSM) Puerto Rico Buildings (OpenStreetMap Export)

- <u>Structure Damage</u>: Economic losses resulting from the structures situated within a low-lying area prone to flooding from coastal storms and hurricanes. Structure damages account for approximately 61.7% of the total FWOP damages
- <u>Content Damage</u>: The material items housed within the structures that are potentially subject to damage. Content damages make up approximately 38.3% of the total FWOP damages.

West San Juan Bay consists of 17,973 separable damage elements with an overall estimated value of \$3.14B, with structure and content valuations of \$2.21B and \$933M respectively. East San Juan Bay consists of 480 separable damage elements with an overall estimated value of \$476M, with structure and content valuations of \$342M and \$134M respectively. Condado Lagoon consists of 1,222 separable damage elements with an overall estimated value of \$208M, with structure and content valuations of \$169M and \$39M respectively.

Table 2-8 provides greater detail on the composition of the average FWOP damages by category and damage element type based on the *AssetDamageDetail.csv* model output files.

Damage Element Type	Average PV	Average PV	Total Loss PV	Percent of
	Structure Loss	Contents Loss		Total Loss
AUTOMOBILE	\$71,199,545	\$0	\$71,199,545	0.56%
COMMERCIAL	\$798,441,189	\$373,655,901	\$1,172,097,177	9.14%
COMMUNITY	\$30,245,163	\$3,521,071	\$33,766,215	0.26%
GOVERNMENT	\$715,964,605	\$305,209,998	\$1,021,174,586	7.96%
HOSPITAL	\$2,058,973	\$246 <i>,</i> 596	\$2,305,570	0.02%
MULTI-FAMILY	\$66,542,224	\$20,937,050	\$87,479,261	0.68%
RESIDENCES				
OTHER	\$7,157,974	\$0	\$7,157,974	0.06%
SINGLE FAMILY	\$6,221,273,566	\$4,204,746,869	\$10,426,020,514	81.32%
RESIDENCES	SIDENCES			
Total	\$7,912,883,239	\$4,908,317,485	\$12,821,200,842	100.00%

Table 2-8. Distribution of FWOP Damages by Category and Type.

2.7.4.1.1 SINGLE FAMILY RESIDENCES (SFR)

Single family residences consist of 1-3 story structures of varying construction type and value. This category accounts for the majority of the damage elements in the study area. 81.23% of the total FWOP damages are associated with the direct damages to these structures and their contents. This damage element type is well distributed across the study area, but has a high concentration in West San Juan Bay.

2.7.4.1.2 MULTI-FAMILY RESIDENCES (MFR)

Multi-family residences consist of multi-story structures of varying construction type and value. This category accounts for 0.68% of the total FWOP damages. There is a high concentration of this damage element type in Condado Lagoon as well as West San Juan Bay sub-reach 2.

2.7.4.1.3 COMMERCIAL (COM)

Damages associated with commercial structures and their contents make up 9.14% of the overall FWOP damages. Types of structures associated with this damage element include retail, banks, entertainment, parking and recreation. This damage element type is well distributed across the study area.

2.7.4.1.4 GOVERNMENT (GOV)

Damages associated with Government buildings and their contents make up 7.96% of the overall FWOP damages

2.7.4.1.5 HOSPITAL (HOSP)

Damages associated with hospitals and their contents make up only 0.02% of the overall FWOP damages. There were 5 structures within this category.

2.7.4.1.6 OTHER DAMAGE ELEMENTS

The remaining structures include AUTO, COMM and OTHER damage element types. The damages associated with these structures and their contents make up a combined 0.88% of the overall FWOP damages

2.7.4.2 FUTURE WITHOUT-PROJECT DAMAGES OVER REACHES BY FLOOD WATER LEVEL

2.7.4.2.1 REACH 1 WEST SAN JUAN BAY

The figure below shows the maximum storm stages, with both incremental damages (green bars) and cumulative damages (black line) caused at different stages. The majority of damages are caused by stages of 2 feet (\$820M), with cumulative damages occurring up to 8 feet.



Figure 2-30. West San Juan Bay - Damages by Maximum Storm Stage.

2.7.4.2.2 REACH 2 EAST SAN JUAN BAY

The figure below shows the maximum storm stages, with both incremental damages (green bars) and cumulative damages (black line) caused at different stages. Damages begin to occur at a stage of 1 foot, with cumulative damages occurring up to 8 feet. The majority of damages in this area are caused by stages of 8 feet (\$14.4M).



Figure 2-31. East San Juan Bay - Damages by Maximum Storm Stage.

2.7.4.2.3 REACH 3 CONDADO LAGOON

The figure below shows the maximum storm stages, with both incremental damages (green bars) and cumulative damages (black line) caused at different stages. The majority of damages are caused by stages of 2 feet (\$14.2M), with cumulative damages occurring up to 8 feet.



Figure 2-32. Condado Lagoon - Damages by Maximum Storm Stage.

The damages for each reach, reported in dollars for in present value (PV) and in average annual equivalent dollars (AAEQ), are shown below in **Table 2-9.** As the table shows, PV and AAEQ damages for most reaches is generally high, and if it assumed an implemented project could reduce most or all of the damages, it could be assumed that the benefit to cost ratio would be greater than 1. However, the exception is in the East San Juan Bay Reach 2. Here, present value damages are approximately \$26.6M. Very rough costs of potential projects for implementation were approximately \$80M. With coordination with the non-federal sponsor and key facilities in the area, a decision was made to not carry this reach forward for further analysis, as the cost of a project would be magnitudes higher than the benefits that could be obtained. It should be noted that structures and critical infrastructure in this area are generally set back and at a higher elevation than other reaches.

The remaining reaches of Condado Lagoon and West San Juan Bay 1-4 were carried forward for further analysis. Using the initial inventory and forecast of information within this chapter as baseline conditions, Chapter 3 explores possible solutions using the USACE plan formulation process.

Planning Reach	# Assets	Estimated Value	PV Damages	AAEQ Damages
CL	1222	\$208.6M	\$48.7M	\$1.8M
WSJB-1	2201	\$538.8M	\$120.6M	\$4.5M
WSJB-2	6623	\$966.4M	\$373.9M	\$13.8M
WSJB-3	8726	\$1.4B	\$1.9B	\$70.8M
WSJB-4	429	\$273.2M	\$84.7M	\$3.1M
ESJB	480	\$476.8M	\$26.6M	\$98 4.4 K

Table 2-9. Damages for Each Planning Reach, in the future without a project condition²².

²² Results are based on 5-iteration model runs in G2CRM, and are a good representation of damages for plan formulation. Fifty-iteration model runs in G2CRM are used for refined benefits in Chapter 4.



3 **PLAN FORMULATION**

3.1 PLAN FORMULATION RATIONALE

The purpose of this feasibility study is to develop an implementable and acceptable plan to change the future condition and address specific problems and opportunities²³ in the study area.

Using the initial inventory and forecast of information within Chapter 2 as baseline conditions, this chapter explores possible solutions using the USACE plan formulation process.

The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, established by the U.S. Water Resources Council on March 10, 1983, have been developed to guide the formulation and evaluation studies of the major Federal water resources development agencies. These principles and guidelines are commonly referred to as the "P&G," and will be cited throughout the plan formulation sections of this report.

Benefits and effects of all four accounts(P&G 1983) were considered during the plan formulation process, and are summarized below. Per guidance in the memorandum from the Assistant Secretary of the Army (ASA) (Civil Works), dated 5 January 2021, Comprehensive Documentation of Benefits in Decision Document, this analysis identifies, analyzes, and maximizes all benefits in the NED, RED, OSE. This analysis qualitatively describes the impacts associated with the RED and OSE accounts to include impacts to life safety and local and regional economies and NED benefits are quantified to the fullest extent reasonably possible.

- <u>National Economic Development (NED) account</u>: Includes consideration of a measure's potential to meet the planning objective to reduce storm damages, as well as decrease costs of emergency services, lower flood insurance premiums, and considers project costs. Costs and benefits used to fully evaluate the NED objective are not calculated at this stage; however, estimates can be made to gauge the overall cost-effectiveness of a measure for this initial screening. Effects of sea-level change and a measure's adaptability to such change were considered under the National Economic Development (NED) account.
- Environmental Quality (EQ) account: Considers ecosystem restoration, water circulation, noise level changes, public facilities and services, aesthetic values, natural resources, air and water quality, cultural and historic preservation, and other factors covered by the National Environmental Policy Act (NEPA).
- 3. <u>Other Social Effects (OSE) account:</u> Includes considerations for the preservation of life, health, and public safety; community cohesion and growth; tax and property values; and, the displacement of businesses and public facilities. For evaluation purposes, the OSE account is inclusive of the planning objectives to maintain recreation and maintain a safe evacuation route, and the planning constraint to avoid conflict with legal requirements.

²³ A problem is an existing undesirable condition to be changed. An opportunity is a chance to create a future condition that is desirable.

4. <u>Regional Economic Development (RED) account:</u> Considers the potential impacts on the local economy including employment, income, and sales volume.

The NED plan must also be evaluated in consideration of the P&G criteria of completeness, effectiveness, efficiency, and acceptability. Each alternative plan is formulated in consideration of these four criteria:

- a. <u>Completeness</u>: Extent to which the plan provides and accounts for all necessary investments or actions to ensure realization of the planning objectives
- b. Effectiveness: Extent to which the plan contributes to achieving the planning objectives
- c. <u>Efficiency</u>: Extent to which the plan is the most cost-effective means of addressing the specified problems and realizing the specified opportunities, consistent with protecting the nation's environment
- d. <u>Acceptability</u>: Workability and viability of the alternative plan with respect to acceptance by Federal and non-federal entities and the public, and compatibility with existing laws, regulations, and public policies.

3.2 SCOPING*

3.2.1 STUDY SCOPING PROCESS

The National Environmental Policy Act (NEPA) scoping period for the study was initiated by letter dated October 16, 2018. Public and interagency meetings were then held November 8, 2018 in San Juan. Comments and feedback received were primarily concerning sea turtles, manatees, coral reefs/benthic resources, fish habitat, public safety, recreation and tourism. Pertinent correspondence associated with this NEPA scoping process is included in **Appendix G**. For additional information on the NEPA scoping process please refer to Section 6.1.

As described in Section 1.4, this study was re-scoped to address coastal flooding in the San Juan Metro Area. Out of the 6 reaches identified, 2 reaches were ultimately carried forward for further analysis.

The reduced study area includes Reach 1, known throughout this report as the West San Juan Bay (WSJB) reach, and Reach 3, known throughout this report as Condado Lagoon (CL) reach. The combined study area encompasses roughly 9.5 square miles of area and contains approximately 22 structures identified as critical infrastructure, in addition to approximately 14 schools, and major hurricane and tsunami evacuation routes.

After this re-scoping two additional public meetings were held on June 20, 2019 in Cataño and San Juan.

REACH 1 – WEST SAN JUAN BAY

This reach is comprised of an area approximately 9 square miles, which is located to the West and South of San Juan Harbor. This reach contains portions of the municipalities of Cataño, Guaynabo, and San Juan. This area experiences not only coastal flooding from storm surge, as well as being at risk for sea level change, but the Cataño shoreline in particular experiences wave attack from waves approaching through the harbor. This reach contains approximately 16 structures identified as critical infrastructure, one of

San Juan Metro Area Coastal Storm Risk Management Study

FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

which is a major hurricane and Tsunami evacuation route (PR-165)²⁴, in addition to 14 schools and 4 assembly points (Tsunami Program Map Tool, <u>http://prddst.uprm.edu/apps/prtmp/</u>).

This reach was further delineated into 5 planning reaches, based on geographic features and source/direction of storm surge. Throughout this report, they are called WSJB-1a, WSJB-1b, WSJB-2, WSJB-3, and WSJB-4 (**Figure 3-1**).

REACH 3 – CONDADO LAGOON

This reach encompasses an area which is approximately .5 square miles, located to the east of San Juan Harbor and bordering Condado Lagoon. This reach is within the San Juan municipality and suffers from storm surge and tidal influences from Condado Lagoon. In addition to the primary problem of coastal flooding, frequent tidal flooding is reported by residents (noted as an incidental problem in terms of this study's objectives). This area also serves as a major throughway to communities evacuating from the west, and houses major Tsunami and Hurricane evacuation route PR-26. This reach is also at risk from sea level change. This reach remains as one planning reach, and is called CL-1 throughout this report.

Figure 3-1. Six Planning Reaches in the Study Area.



²⁴ GIS data is from FEMA Caribbean Division and was collected in 2016 & 2017.

3.3 PROBLEMS AND OPPORTUNITIES*

Problems and opportunities have been identified in several ways, including coordination with the sponsor (Department of Natural and Environmental Resources - DNER), municipalities, as well as scoping letter comments received from local residents and stakeholders, GIS data, reports from other agencies, and other USACE reports.

3.3.1 PROBLEMS AND OPPORTUNITIES

3.3.1.1 PROBLEMS

The problems in the study area are explained in more detail in Chapter 1, Chapter 2, and Section 2.6. They include key problems related to coastal flooding, and are listed below.

- Coastal flooding from hurricanes and storms causes damage to structures, vehicles, and critical infrastructure, including Tsunami and Hurricane evacuation route, PR-165 and PR-26.
- Coastal flooding from hurricanes and storms results in inaccessibility to critical infrastructure, including evacuation routes before, during and after storm events.
- Wave attack during hurricanes and storms causes damages to waterfront structures and infrastructure in Cataño, in the WSJB-3 planning reach.
- Sea level rise will cause increased risk of coastal flooding.
- Coastal flooding from hurricanes and storms can cause standing water and results in public safety risks.
- Frequent tidal flooding events in Condado Lagoon (noted as an incidental problem in terms of this study's objectives) results in damages, public safety concerns, , and accessibility concerns.
- Note that different sources of coastal flooding create the problems described above. For Condado Lagoon, the source of inundation is from Condado Lagoon. For West San Juan Bay, the source of flooding is San Juan Bay.

3.3.1.2 OPPORTUNITIES

Opportunities are positive conditions in the study area that may result from implementation of a Federal project and are listed as follows:

- Reduce risk to life-safety.
- Maintain or improve existing natural resources.
- Maintain or improve recreational opportunities.
- Reduce tidal flooding (noted as an incidental problem in terms of this study's objectives).
- Incidental improvement in water quality.
- Maintain or improve the aesthetic qualities.
- Use or re-purpose material for beneficial purposes.

3.4 OBJECTIVES3.4.1 FEDERAL OBJECTIVES

The Federal objective of water and related land resources planning is to contribute to national economic development (NED) consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net economic benefits that accrue in the study area and the rest of the nation.

The Federal objective is to maximize net benefits to the nation, and as such, it does not seek to identify specific targets within objectives. The planning process includes formulation of alternative plans to maximize benefits relative to costs.

3.4.2 PLANNING OBJECTIVES

The overarching goal of this study is to formulate alternatives for coastal storm risk management to determine if Federal participation in reduction of the damage to assets caused by storm surge within the study area is warranted and economically justified.

The overarching strategy is to identify the NED/Recommended Plan for each planning reach, in line with the Federal objectives described above, and recommend an overarching Recommended Plan comprised of each reach's NED/Recommended Plan, showing incremental justification, to allow for comprehensive storm surge risk reduction within the San Juan Metro Area.

Although the key objectives are generally the same in each planning reach, it is important to note that the planning reaches represent unique communities within the San Juan Metro Area. While each planning reach has been defined as a separate unit, the goal is to provide a cohesive storm risk reduction plan for the communities at risk of storm surge within the San Juan Metro Area.

Specific study objectives have been developed to provide a means of determining whether individual management measures are capable of solving the study area's problems while taking advantage of the opportunities identified and avoiding the constraints. The following study objectives have been developed based on the problems, opportunities, goals, and Federal objectives.

- 1. Reduce risk of damages to assets as a result of coastal flooding combined with sea level rise (intermediate scenario) from 2029 to 2079.
- 1a. Reduce risk of damages to assets from wave attack during hurricanes and storms from 2029 to 2079.
- 2. Increase community resilience in the area from 2029 to 2079.

A summary of problems, objectives, and opportunities are shown for each reach in Figure 3-2.

	WEST SAN JUAN BAY WSJB-1a,1b,2, 3, 4 WSJB-3		CONDADO LAGOON CL-1
PRIMARY PROBLEMS: DAMAGES TO ASSETS (STRUCTURES, CRITICAL INFRASTRUCTURE, VEHICLES) FROM –	Coastal Flooding	attack attack	Coastal Flooding
OTHER PROBLEMS: Inaccessibility to critical infrastructure, public health & safety risk, sea level rise	\checkmark	\checkmark	\checkmark
OPPORTUNITIES			
1. Reduce risk to life-safety and public health.	\checkmark	\checkmark	\checkmark
2. Maintain or improve existing natural resources.	\checkmark	\checkmark	\checkmark
3. Maintain or improve recreational opportunities.	\checkmark	\checkmark	\checkmark
4. Reduce tidal flooding.	N/A	N/A	\checkmark
5. Incidental improved effects to water quality.	N/A	N/A	\checkmark
6. Maintain or increase aesthetics of community.	\checkmark	\checkmark	\checkmark
7. Use or re-purpose material beneficially.	\checkmark	\checkmark	\checkmark
OBJECTIVES			
1. Reduce risk of damages as a result of coastal flooding combined with sea level rise (intermediate scenario) from 2029 to 2079	\checkmark	\checkmark	\checkmark
1a. Reduce risk of damages from wave attack during hurricanes and storms from 2029 to 2079.	N/A	\checkmark	N/A
2. Increase community resilience in the area from 2029 to 2079	\checkmark	\checkmark	\checkmark

Figure 3-2. Summary of Problems, Opportunities, and Objectives for the Planning Reaches.

3.4.3 USACE RESILIENCE INITIATIVE

The second objective of this study speaks to resilience. In EP 1100-1-2 USACE Resilience Initiative Roadmap 16 Oct 17, USACE has identified four key principles of resilience from the many definitions of resilience that exist. These principles – Prepare, Absorb, Recover, and Adapt – exemplify the temporal aspects and actions that are inherent to the process of building community resilience capacity.

Prepare: The study will communicate the results of analyses, which will help communities anticipate future coastal flooding elevations with sea level rise. By identifying what those future coastal flooding with sea level rise elevations could be, the study will focus on identifying measures and alternatives which increase preparedness of the community before hurricanes and storms.

Absorb: This study focuses on solutions that will absorb coastal flooding and wave attack impacts associated with storms in order to reduce damages to communities.

Recover: This study strives to find a solution which not only reduces damages, but also will reduce the risk of safety concerns in the communities during coastal flooding events, and allow quicker recovery before, during and after storms.

Adapt: This study will offer recommendations for monitoring to inform when adaptations to solutions may need to occur and to what extent.

3.4.3.1 FEDERAL ENVIRONMENTAL OBJECTIVES

USACE strives to balance the environmental and development needs of the nation in full compliance with the National Environmental Policy Act (NEPA) and other authorities provided by Congress and the Executive Branch. Public participation is encouraged early in the planning process to help define problems and environmental concerns relative to the study. Therefore, significant environmental resources and values that would likely be impacted, favorably as well as adversely, by an alternative under consideration are identified early in the planning process. All plans are formulated to avoid to the fullest extent practicable any adverse impact on significant resources. Significant adverse impacts that cannot be avoided are mitigated as required by Section 906(d) of WRDA 1986.

This is an integrated feasibility report and environmental document. As with a separate NEPA document, it discusses and documents the environmental effects of the recommended plan and summarizes compliance with Federal statutes and regulations.

3.4.3.2 ENVIRONMENTAL OPERATING PRINCIPLES

Consistent with the NEPA, USACE has formalized its commitment to the environment by creating a set of "Environmental Operating Principles" applicable to all its decision making and programs. These principles foster unity of purpose regarding environmental issues and ensure that environmental conservation and preservation, and restoration are considered in all USACE activities. Section 6.6.26 includes a discussion of the USACE Environmental Operating Principles and how the study addresses them.

3.4.3.3 CAMPAIGN PLAN OF THE U.S. ARMY CORPS OF ENGINEERS (USACE)

The USACE Campaign Plan (UCP) is USACE's strategic change decision document. It is fully nested with the Army Campaign Plan (ACP) and National Goals and Objectives. As such, it drives and aligns strategic change; anticipates and shapes our future operating and fiscal environments; unites all of USACE with a common vision, purpose, and direction; and responsively adapts to mission and "battle space" changes. USACE Campaign Plan goals and objectives are listed in the FY18-22 USACE Campaign Plan (UCP). The four campaign plan goals and their associated objectives also build on prior strategic planning efforts. The four goals of the Campaign Plan are:

- **Goal 1:** Support National Security
- **Goal 2:** Deliver Integrated Water Resource Solutions
- **Goal 3:** Reduce Disaster Risk
- Goal 4: Prepare for Tomorrow

3.4.4 STATE AND LOCAL OBJECTIVES

The Puerto Rico Department of Natural and Environmental Resources (DNER) is responsible for the administration of Puerto Rico's coastal trust lands, the maritime terrestrial zone, territorial waters and submerged lands thereunder through PR Law 23, Art.5(h). DNER also serves as the lead agency for the implementation of the Puerto Rico Coastal Zone Management Program (PRCZMP). The PRCZMP was adopted in 1978 as the coastal element of the Island-wide Land Use Plan. This plan is a partnership between the United States Federal Government through the National Oceanic and Atmospheric Administration (NOAA) and the Government of Puerto Rico (DNER and PR Planning Board). The principles

of the PRCZMP include developing guidance for public and private development within the coastal zone, active management of coastal and marine resources, promoting scientific research, education and public participation, as well as coordinating state and federal actions. The Coastal Zone Management Act requires that each Federal agency conducting, supporting, or undertaking development activities that are in, or directly affect, the coastal zone of a state shall insure that the project is, to the maximum extent practicable, consistent with approved state management plans.

3.4.4.1 LOCAL COMPREHENSIVE PLANNING

The comprehensive planning approach provided in the US Navy's Climate Change Planning Handbook (2017) was adapted in the Coastal Engineering Handbook written for Puerto Rico by Tetra Tech, Inc. It follows a four stage process to establish scope, identify and screen alternatives, calculate benefits and costs of action alternatives, and assemble a portfolio of action items.

3.5 CONSTRAINTS

3.5.1 PLANNING CONSTRAINTS

A constraint is a restriction that limits the extent of the planning process; it is a statement of effects that alternative plans should avoid. Constraints are designed to avoid undesirable changes between without and with-project future conditions. All studies must avoid conflict with Federal regulations, as stated in Federal law, USACE regulations, and executive orders. Additionally, as with all studies, any proposed solutions cannot increase the risk to life safety beyond what already exists or will exist in the future without a project. There are no specific planning constraints for this study area.

3.5.2 LOCAL CONSTRAINTS

Local and state laws do not constrain NED formulation. However, they may be considered in the selection of a Locally Preferred Plan (LPP).

3.6 MANAGEMENT MEASURES

The following sections represent an excerpt of the plan formulation process for a brief overview. However, **Appendix E, Plan Formulation** should be referenced for those wishing to read the full plan formulation analysis.

Plan formulation is the process of developing alternative plans to address a given problem. The Corps uses a 6 step planning process: 1) Plan identification, 2) Inventory existing conditions and forecast future conditions, 3) Formulate alternatives, 4) Evaluate alternatives, 5) Compare alternatives, and 6) Choose an alternative.

This process of identifying management measures begins at step 3 in the plan formulation process. A management measure is an action that can be implemented at a specific geographic site to address one or more planning objectives.

An alternative plan includes one or more management measures to address the problem. Alternative plans can differ by types of measures, or how measures are combined or defined, including dimensions, quantities, materials, locations or implementation time frames.

3.6.1 IDENTIFICATION OF MANAGEMENT MEASURES

Management measures were selected to accomplish at least one of the planning objectives for this study, which were formulated based on the problems. All possible measures were considered, including those beyond the authority of USACE to implement. Coastal storm risk management measures consist of three basic types: structural, nonstructural, and natural or nature-based features. The plan formulation process will result in an array of feasible coastal storm risk management alternatives that may consist of a variety of structural, nonstructural, and natural/nature-based measures. The following is a summary of the types of management measures considered.

Structural coastal storm risk management measures are man-made, constructed measures that counteract a flood event in order to reduce the hazard or to influence the course or probability of occurrence of the event. This includes gates, levees, and seawalls that are implemented to reduce risk of damage to assets, while maintaining public safety.

Nonstructural coastal storm risk management measures are permanent measures applied to a structure and/or its contents that prevent or provide resistance to damage from flooding. Nonstructural measures differ from structural measures in that they focus on reducing the consequences of flooding instead of focusing on reducing the probability of flooding. Relocation, floodproofing (wet and dry), home elevation, and flood warning systems are examples of nonstructural measures.

Natural and nature-based coastal storm risk management measures work with or restore natural processes with the aim of wave attenuation and storm surge reduction. Examples are submerged breakwaters that can also act as an artificial reef, elevated living shorelines and addition of vegetation for redundancy of coastal risk reduction functions.

The following measures were identified and considered for all 6 planning reaches (WSJB-1a, WSJB-1b, WSJB-2, WSJB-3, WSJB-4, and CL-1). As detailed analysis continued in this report, measures were then screened out or carried forward for sub-reaches delineated by direction of the water flow hazard within each reach. Objectives for both reaches included reduction of risk of damages to assets due to coastal flooding with sea level rise. In WSJB-3, an additional objective was to reduce risk of damages to assets due to wave attack during hurricanes and storms. Measures appropriate to address these objectives are outlined in the discussions below.

MEASURES - TO REDUCE STORM SURGE (SS) RISK (WSJB-1, 2, 3, 4, CL-1)

<u>STRUCTURAL</u>

These measures serve the purpose of raising up the elevation of existing strategic low points, to reduce the risk of flooding from a respective water elevation as a result of storm surge combined with sea level rise.
<u>S-1 (SS): Seawall/Floodwall:</u> Seawalls and floodwalls are interchangeable at this phase of the study in terms of the function they provide. Seawalls and floodwalls are delineated further in this report in terms of design footprint (i.e.: Seawalls use a slightly wider footprint than floodwalls when backfill and/or toe protection is included). Seawalls/floodwalls in the study area could be constructed either seaward of existing seawalls, to protect historic value as well as to avoid disruption of engineering structural integrity of the existing seawall function, or landward, to provide access to existing waterfront features. <u>COMBINABILITY</u>: This measure is dependent on the incorporation of S-6²⁵ and could be combined with other measures. This is mutually exclusive of S-2, but could be adjacent to S-2.

<u>S-2 (SS): Levee:</u> Levees are embankments constructed along a waterfront to reduce the risk of flooding in relatively large areas, with typical slopes ranging from 1V:2H to 1V:5H, depending on construction material. They are typically constructed by compacting soil into a large berm that is wide at the base and tapers toward the top. Grass or some other type of non-woody vegetation is usually planted on the levee to add stability to the structure. Levees may be constructed in urban areas; however, large tracts of real estate are usually required due to the levee width and required setbacks. <u>COMBINABILITY</u>: This measure is dependent on the incorporation of S-6 and could be combined with other measures. This is mutually exclusive of S-1 but could be adjacent to S-1.

<u>S-3 (SS): Storm Surge Barrier, Large:</u> In most cases, the barrier consists of a series of movable gates that stay open under normal conditions but are closed when storm surge is expected to exceed a certain predetermined level. Storm surge barriers are often chosen as a preferred alternative to closing off waterways completely and may also reduce the required length of flood risk management measures adjacent to and/or behind the barriers. Storm surge barriers range in scale from small/local sluice gates reducing risk to a small coastal inlet to very large barrier systems that are designed to reduce risk to a large estuary or bay and consist of a series of coastal dikes, gates, and in some cases navigation locks. Storm surge barriers must be tied into high ground, whether it be existing high ground, a seawall, levee or other. Specifically, a storm surge barrier of this magnitude would be placed across San Juan Harbor and across the inlet of Condado Lagoon. <u>COMBINABILITY</u>: This measure would need to be combined with S-1 or S-2 due to a requirement to tie into high ground, assuming there will not be naturally existing high ground available. This is mutually exclusive of S-4.

<u>S-4 (SS): Discharge Structure:</u> This measure refers to a smaller storm gate, sluice gate, box culvert or other type of discharge structure to close off risk of storm surge in smaller canals. Specifically, this type of structure could be used in the Mosquito Canal/Malaria Canal or Northern Canal. <u>COMBINABILITY</u>: This measure would need to be combined with S-1 or S-2 due to a requirement to tie into high ground, assuming there will not be naturally existing high ground available. This is mutually exclusive of S-3.

<u>S-5 (SS): Pump Stations:</u> Pump stations can be used to redirect water in low lying elevations to more appropriate locations. They generally have a sustained operation and maintenance commitment as well as associated costs. This measure represents larger pump stations that would be used to prevent storm surge, rather than smaller pumps that would be used in combination with structural measures to assist in outflow of runoff. <u>COMBINABILITY</u>: This could be a stand- alone alternative, or it could be combined with other measures.

²⁵ Structural measures, such as seawalls and levees tend to trap rainfall runoff associated with storms on the landward side. S-6 represents culverts or pumps and would allow outflow of water from behind the landward side of the structure to carry the water to seaward sides, ensuring that functions to meet appropriate rainfall runoff needs are met.

<u>S-6 (SS): Inland Hydrology</u>: Structural measures, such as seawalls and levees tend to trap rainfall runoff associated with storms on the landward side. Gravity outlets, such as culverts, in some cases can be installed along the length of the structure. In cases where significant runoff may be trapped behind the structure, ponding areas and pump stations may be required. This measure must be combined with other structures such as levees and seawalls to allow outflow of water from behind the landward side of the structure to carry the water to seaward sides, ensuring that functions to meet appropriate rainfall runoff needs are met. This measure will address the need for adequate rainfall runoff with other measures, and will be developed further and refined as needed for planning purposes. <u>COMBINABILITY</u>: This measure must be combined with S-1, S-2, S-7, NNBF-2 or NNBF-3.

<u>S-7 (SS): Retention basin</u>: This measure would involve land buyout to create a water retention basin in low areas to temporarily impound water and offset flooding impacts elsewhere. <u>COMBINABILITY</u>: This measure would need to be dependent on NS-7 to ensure sufficient available land, and also would need to be combined with S-6 to address inland hydrologic needs for rainfall runoff.

<u>NON-STRUCTURAL</u>

<u>NS-1 (SS): Improved evacuation plan:</u> The Puerto Rico Hurricane Evacuation Study was released in October 2018, and references evacuation zones. Conclusions from surveys conducted in the Puerto Rico Hurricane Evacuation Study, Behavioral Study, Final Report March 2014 generally indicated that residents would be more likely to evacuate out of the evacuation zone to higher ground if directed to do so. This would be a measure implemented by the non-federal sponsor. <u>COMBINABILITY</u>: This measure would need to be combined with other structural or NNBF measures that would reduce coastal flooding.

<u>NS-2 (SS): Improved public notification systems</u>: Warning systems can limit damages of an event due to increased preparedness and ensure evacuation directives are messaged to the community. This would be a measure implemented by the non-federal sponsor. <u>COMBINABILITY</u>: This measure would need to be combined with other structural or NNBF measures that would reduce coastal flooding.

<u>NS-3 (SS): Improved public outreach about coastal flooding risk:</u> Measures to convey storm surge risk to communities could help community better understand how it could affect them during a storm. An example used in other areas is storm surge posts, which visually show the storm surge stages which could be expected in various areas associated with category 1-5 storms. This would be a measure implemented by the non-federal sponsor. <u>COMBINABILITY</u>: This measure would need to be combined with other structural or NNBF measures that would reduce coastal flooding.

<u>NS-4 (SS): Re-Zoning</u>: Re-zoning could apply to phasing out development in low lying areas over time. This would be a measure implemented by the non-federal sponsor. <u>COMBINABILITY</u>: This measure would need to be combined with other structural or NNBF measures that would reduce coastal flooding.

<u>NS-5 (SS): Floodproofing (Dry):</u> Dry floodproofing involves making building and site modifications to prevent water from entering during a flooding event. Dry floodproofing methods would be to seal flood prone structures from water with door and window barriers, small scale rapid deployable floodwalls, or sealants. Dry floodproofing is generally feasible up to 3 feet and is prohibited in FEMA VE zones. <u>COMBINABILITY</u>: Due to limited risk reduction (only up to 3 feet), this measure would need to be combined

with other measures. This measure would need to be combined with other structural or NNBF measures that would reduce coastal flooding.

<u>NS-6 (SS): Floodproofing (Wet):</u> Wet floodproofing involves making a series of modifications to a structure to allow an enclosed area below the base flood elevation to flood. The method of floodproofing reduces risk to the building but not to the contents of the building. <u>COMBINABILITY</u>: This measure could be a standalone alternative or could be combined with other measures.

<u>NS-7 (SS): Acquisition of land and structures (Buyout):</u> This measure would allow storm surge to flood into low lying elevations. Structures within the area vulnerable to damage would be identified for acquisition. Structures on the acquired parcels would be demolished and natural areas restored. Such parcels would become public property and would reduce the number of structures vulnerable to storm damages. <u>COMBINABILITY</u>: This measure could be a stand-alone alternative or could be combined with other measures.

<u>NS-8 (SS): Elevate critical infrastructure</u>: This measure, in combination with other measures, could reduce damages to critical infrastructure by building them to higher elevations. <u>COMBINABILITY</u>: This measure would need to be combined with other structural or NNBF measures that would reduce coastal flooding.

<u>NS-9 (SS): Elevate structures:</u> This measure, in combination with other measures, could reduce damages to structures by building them to higher elevations. <u>COMBINABILITY</u>: This measure could be a stand-alone alternative or could be combined with other measures.

<u>NS-10 (SS): Relocation of Critical Infrastructure:</u> This measure would allow the area to continue to flood from storm surge, while relocating critical infrastructure to a higher elevation to reduce risk of critical damage. Critical infrastructure that is vulnerable to storm damage in the study are would be identified, and where feasible, such structures would be moved further landward on their parcels to escape the vulnerable area. <u>COMBINABILITY</u>: This measure would need to be combined with other structural or NNBF measures that would reduce coastal flooding.

<u>NS-11 (SS): Relocation of critical evacuation route only:</u> This measure would allow the area to continue to flood from storm surge, while relocating critical evacuation routes to a higher elevation to reduce risk of critical damage. <u>COMBINABILITY</u>: This measure would need to be combined with other structural or NNBF measures.

<u>NS-11 (SS): Elevate local roads:</u> This measure, in combination with other measures, could reduce damages to roadways by building them to higher elevations. This measure would be especially applicable in the Condado Lagoon area, where tidal flooding impacts road access often. <u>COMBINABILITY</u>: This measure would need to be combined with other structural or NNBF measures.

NATURAL AND NATURE-BASED FEATURES

<u>NNBF-1 (SS): Greenways:</u> Use undeveloped land or purchase land which is susceptible to flooding to function as additional natural storage/retention during coastal storm and/or heavy rain events. <u>COMBINABILITY</u>: This measure would need to be combined with other structural or NNBF measures that would reduce coastal flooding.

<u>NNBF-2 (SS): Elevated Living Shoreline:</u> This measure would be similar to a levee, however it would have two transitional berms at lower elevations. It would include placement of fill, stone, and vegetation, to reduce risk of storm surge flooding depths by providing a more natural raised elevation. It could provide additional benefits to create an effective buffer, provide valuable habitat and improve water quality. This measure is envisioned to be better suited for areas with less available land and would be planted with vegetation suited for brackish/salt water habitats/environments. <u>COMBINABILITY</u>: This measure would need to be combined with S-6 to address inland hydrologic needs for rainfall runoff.

<u>NNBF-3 (SS): Horizontal ("Tiered") Levee:</u> This measure would be similar to the elevated living shoreline, however it would have three transitional berms at lower elevations. It would include placement of fill, stone, and vegetation, to reduce risk of storm surge flooding depths by providing a more natural raised elevation. It could provide additional benefits to create an effective buffer, provide valuable habitat and improve water quality. This measure is envisioned to be better suited for areas with more available land and would be planted with vegetation suited for freshwater/marsh habitats/environments. <u>COMBINABILITY</u>: This measure would need to be combined with S-6 to address inland hydrologic needs for rainfall runoff.

MEASURES – TO REDUCE WAVE ATTACK (WA) RISK (PLANNING REACH WSJB-3)

<u>STRUCTURAL</u>

<u>S-1: Seawall/Floodwall (WA):</u> In addition to the function of a seawall/floodwall for risk reduction as a result of storm surge, a seawall also can function for wave attack. Reference the description for seawall (SS). <u>COMBINABILITY</u>: This measure would need to be combined with S-6 (SS) to address rainfall runoff. This is a duplicative measure that can cover both SS and WA. This measure is not dependent on NNBF-1 (WA) but if combined with it, the height of this measure could be potentially reduced.

<u>S-2: Revetment (WA):</u> This measure would involve placement of large rock, designed to withstand the wave environment, seaward of structures which are most vulnerable to storm damages. The engineered structure would have a sloped profile designed to dissipate wave energy before it reaches the protected structures. The revetment could be covered by a dune or some degree of beach fill for additional protection and for aesthetic reasons. Construction would be from the beach, with intermittent access from roads. Impacts to the nearshore resources during construction would be avoided. <u>COMBINABILITY</u>: This could be a stand-alone alternative, or combined with S-1 but it is mutually exclusive of NNBF-1(WA) and NNBF-2 (WA).

NON-STRUCTURAL

<u>NS-1 (WA): Acquisition of land and structures (Buyout):</u> Structures within the area vulnerable to damage would be identified for acquisition. Structures on the acquired parcels would be demolished and natural areas restored. Such parcels would become public property and would reduce the number of structures vulnerable to storm damages. <u>COMBINABILITY</u>: This measure would need to be combined with other structural or NNBF measures that would reduce coastal flooding.

<u>NS-2 (WA): Relocation of Critical Infrastructure:</u> This measure would allow the area experience wave attack while relocating infrastructure to a higher elevation to reduce risk of critical damage. Structures vulnerable to storm damage in the study are would be identified, and where feasible, such structures would be moved further landward on their parcels to escape the vulnerable area. <u>COMBINABILITY</u>: This

measure would need to be combined with other structural or NNBF measures that would reduce coastal flooding.

<u>NS-3 (WA): Improved public outreach</u>: Measures to convey risk from the wave action risk to communities could help community better understand how it could affect them during a storm. Signs in the area could be a means to convey information. This would be a measure implemented by the non-federal sponsor. <u>COMBINABILITY</u>: This measure would need to be combined with other structural or NNBF measures that would reduce coastal flooding.

NATURAL AND NATURE-BASED FEATURES

<u>NNBF-1 (WA): Submerged/Emergent Breakwaters:</u> Offshore breakwaters reduce the amount of wave energy reaching the shoreline, and in this case, would reduce risk of damage to the storm surge measure. The breakwaters would be constructed of large rock with foundation materials to prevent subsidence. The breakwaters would be trapezoidal in profile and would be placed parallel to the shoreline in shallow water. The breakwater would be constructed in segments, separated from each other, to prevent infilling between the beach and the breakwater. The elevation and length of each breakwater segment and the distance between segments would be designed considering the local wave and sediment transport characteristics. This measure could benefit the environmental resources in the area, with the rock mimicking natural reefs adjacent to the study area, and potentially creating foraging habitat for benthic species. Mangroves could grow on top of the breakwaters as well for additional habitat and foraging opportunities for birds. <u>COMBINABILITY</u>: This measure would need to be combined with other storm surge measures to fulfill both the storm surge and wave attack reduction objectives.

<u>NNBF-2 (WA): Emergent Island</u>: This type of island would be elevated from the water and would act as a barrier island to the shoreline area. It would serve the same function as a breakwater, but it would be engineered with appropriate earthen materials. This measure could benefit the environmental resources in the area, with the rock on the outer face of the island potentially creating foraging habitat for benthic species. Mangroves and other plant species could grow on top of the islands as well for additional habitat and foraging opportunities for birds. <u>COMBINABILITY</u>: This measure would need to be combined with other storm surge measures to fulfill the storm surge and wave attack objectives.

<u>NNBF-3 (WA): Mangrove/Vegetation Fringe</u>: Mangroves have been shown to reduce wave action during coastal storm events, however, it is not measurable in terms of stand-alone benefits for the purposes of this analysis. Therefore, this measure would need to be combined with another measure which is measurable in terms of benefits, and would provide additional benefit/redundancy to that measure. Mangroves provide additional habitat and foraging opportunities for birds. <u>COMBINABILITY</u>: This measure would need to be combined with other wave attack and storm surge measures.

3.7 EVALUATION AND COMPARISON OF MEASURES

During this stage, the study process followed the third and fourth steps of the planning process for measures, which is evaluation and comparison. The following text describes this process in more detail.

3.7.1 PLANNING CRITERIA SCORING

Criteria to evaluate study measures were derived from the specific project objectives, ability to meet long term considerations, the four P&G accounts, as well as constraints. Planning criteria are shown in **Figure 3-3**. During this process, the interdependency, as well as the exclusivity of measures, was identified. This process served to eliminate some measures from further consideration. Costs and benefits were not calculated at this stage.

Figure 3-3. Planning Criteria for Screening of Measures.

Planning Criteria for Measures
 Meet planning objectives
 Reduce flood damages (coastal flooding + SLR)
 Reduce wave attack (only applies to WSJB3) Improve community access (or faty to critical infrastructure before, during
 Improve commonly access/safety to chical initiasitocrore before, adning, after storm (resilience) (coastal flooding + SLR)
 Longterm Considerations
 Response/Ease of adaptability to sea level rise
 Sustainability (ie: operation cost and maintenance responsibility)
 Planning Constraints
Cannot violate Federal regulations or laws
Cannot incur greater life safety risk compared to FWOP
 Evaluate Planning & Guidance 4 Accounts
 National Economic Development (NED)
Environmental Quality (EQ)
 Other Social Effects (OSE)
 Regional Economic Development (RED)
*Each planning criteria is worth up to 2 points under evaluation. Any measures which violate either
constraint are automatically ineligible to be carried forward. All measures must have 11 points or
greater to be carried forward.

In order to provide a metric for appraisal of the various management measures, a numeric score was applied by judging a measure's ability to meet planning objectives, meet long term considerations, avoid constraints, and to contribute to each of the four P&G accounts. The management measures were evaluated and rated as follows: 0 = does not meet criteria, 1 = partially meets criteria, and 2 = fully meets criteria. If the total rating equaled a number greater than 11, the measure met at least over half of the objectives and constraints, and was carried forward for further analysis. If the total rating was equal to or less than 11, the measure was not considered further.

3.7.2 SCREENING OF MEASURES

A detailed evaluation can be found in the matrices and text for comparison and evaluation of measures, located in **Appendix E, Plan Formulation.** The results of the evaluation that was performed are summarized in **Figure 3-4**. Measures shown with a dashed red line were screened out and the remaining measures were carried forward for formulation of alternatives.

Figure 3-4.	Measures	Considered	and Ev	valuated,	with S	Screening	Results	(Coastal	Flooding a	nd N	Nave
Attack).											



3.7.3 ALTERNATIVE FORMULATION

3.7.3.1 FORMULATION STRATEGY

The overarching strategy is to identify the NED plan for each planning reach, and recommend an overarching Recommended Plan comprised of each reach's NED plan, showing incremental justification, to allow for comprehensive storm surge risk reduction within the San Juan Metro Area.

Planning reaches as described in this report were configured in ways such that they would be selfcontained units of cost and benefits, or separable elements. This means that benefits accrued in each planning reach would be derived from alternatives only in that reach. Measures that met criteria to be carried forward were combined using the combinability thought process as described earlier, as well as refined geographical elevation information, existing site conditions, and professional engineering judgment as to the most feasible combinations per reach. The P&G four accounts (OSE, EQ, NED, RED) were also considered prior to formulation of the alternatives, and are discussed below.

3.7.3.2 OTHER SOCIAL EFFECTS

Key areas of focus were considered in the Other Social Effects (OSE) account. In this account, life safety considerations were paramount, and the robustness of measures in terms of life safety considerations were most fully considered. Life safety was the most paramount criteria in areas where life safety was assessed to be high risk. High risk areas were assessed to be WSJB-1B and WSJB-3. Other focus areas of

consideration included design heights, which looked at the most realistic scenarios in terms of water level under annual exceedance probabilities, as well as life safety, and public acceptability of height of structures. Another focus area included environmental resources, and consideration of the effects varying measures would have on the surrounding environment. The final focus area was available land. In an urban setting, available land is important and as such, the footprints of various measures would need were considered.

LIFE SAFETY CONSIDERATIONS

There is an existing Puerto Rico Evacuation Plan and in the future in absence of a Federal project, it is assumed that the Evacuation Plan will be carried out by government officials. It is also assumed that evacuation orders would be in place as required and followed by communities prior to hurricanes and storm events to increase life safety and reduce the risk of life loss.

When considering potential alternatives and the effects they may have after construction, however, the assumptions when comparing the future without-project condition to the future with-project condition may change. Building new features to reduce damages to structures will reduce the risk of damage to structures and should also increase life safety as well; however, evacuation plans and evacuation orders should still be followed. However, if evacuation plans are not followed, in the case of failure of a structure, water piled behind the structure would have the potential to put life safety at risk. This risk was carefully considered during the plan formulation process. In areas where life safety may be at a higher risk due to factors such as low lying elevations, structures on grade (rather than raised), and existing waterways in the area, certain measures are lower risk than others. In these areas of high risk to life safety, T-wall floodwalls and seawalls are considered to be more robust than elevated living shorelines and would receive higher scores during comparison and evaluation. For living shorelines, levees and floodwalls/seawalls, inland hydrology features would have to be implemented as associated features to ensure that rainfall runoff would continue to drain properly through the new feature to ensure continued life safety.

DESIGN HEIGHT CONSIDERATIONS

The team performed due diligence to ensure that likely scenarios were forecast during preliminary design, to provide reasonable assurance that the top of the feature would not be overtopped. To produce riskbased design elevations for the desired measures the study team followed ECB 2019-15 and ER 1105-2-101. ER 1105-2-101 states the assurance, also known as conditional non-exceedance probability, is based on the uncertainty in the flow and stages associated with a given exceedance probability event. This study utilized the 90% Confidence Intervals (CI) from Federal Emergency Management Administration (FEMA) to incorporate the total water level uncertainty. To represent the design elevation, the study used the 90% CI of the 1% AEP event with mean higher high water (MHHW) and the intermediate sea level Change (SLC) out to the end of the assumed period of analysis (2079). The team analyzed the stage-damage output from the future without-project (FWOP) G2CRM model runs to confirm that the design elevations would provide sufficient damage reduction to each planning reach. The team assumed the average design elevation to be between 7 and 9 feet PRVD02 during this stage of the planning process. . To incorporate sea level change, the intermediate curve (1.26 feet) was chosen for plan formulation, based on trends for 5-year and 19-year MSL moving average (Reference Section 2.3.2). Sensitivities for the high SLC curve were conducted after the Recommended Plan was determined (See Chapter 4).

PUBLIC ACCEPTABILITY

Public acceptability was an important consideration within the communities in the study area. One aspect of this is the height of the feature. The team performed due diligence during the engineering analysis and preliminary design as discussed earlier, to provide reasonable assurance that the top of the feature would not be overtopped. However, the team also took into account existing community features as much as possible and kept public acceptability and aesthetics of the viewshed in mind. Another key aspect of public acceptability, as discussed in Chapter 2, is that many of the reaches in the study area offer important opportunities for community gathering and recreation. Maintaining access to those opportunities was also kept in mind during formulation. The feedback obtained during public meetings, the public review comment period, and additional follow up meetings with municipalities was crucial during the plan formulation process to balance public acceptability, reduction of coastal flooding, and economic optimization.

URBAN SETTING AND LAND CONSIDERATIONS

Several alternatives have wide variations in terms of the bottom width, or footprint they would require, translating to needed land in a higher urban setting. For example, floodwalls may need only about 10 feet of land, whereas the elevated living shoreline may need 100 feet. Available land and avoidance of excessive land acquisition was considered with along with several other factors as mentioned during plan formulation.

3.7.3.3 ENVIRONMENTAL QUALITY CONSIDERATIONS

The environmental quality account considers non-monetary effects on ecological, cultural, and aesthetic resources. Under this account, the preferred plan should avoid or minimize environmental impacts and maximize environmental quality in the project area to the extent practicable considering other criteria and planning objectives. For the purposes of alternatives analysis, all action plans were compared to the future without-project condition (i.e., NEPA No Action), which factors in 50 years of sea level change (to 2079). Effects for each alternative were evaluated below in **Table 3-3** and were carefully considered during plan formulation and for selection of the Recommended Plan .

Similar to the land considerations discussed above, effects to environmental resources in the area were also dependent in some cases on the footprint of the various alternatives, with tradeoffs as well in some cases. Key resources which were considered were mangroves, SAV, and freshwater wetlands. For example, a floodwall will use less land and therefore also have less effects to surrounding species, but it may not contribute to the quality of the natural environment. An elevated living shoreline will use more land, having more potential effects to existing surrounding species, but will then also support long-term vegetation and habitat as a part of that feature as well. During plan formulation throughout the alternatives analysis, creation of habitat, avoidance of impacts to habitat, as well as loss of habitat (resulting in mitigation) were accounted for, factored into plan selection, and are documented in this report.

3.7.3.4 ECONOMIC CONSIDERATIONS

The national economic development (NED) is considered in terms of the function of the feature and how well it will reduce the risk of damages to structures, thus providing monetary savings or benefits to the

nation when compared to the costs of constructing and maintaining the feature. Similarly, regional economic development (RED) is considered in terms of how the feature may contribute to the local community.

3.7.3.5 SUMMARY OF CONSIDERATIONS UNDER THE FOUR P&G ACCOUNTS

The P&G accounts with focused considerations as described above were compared and evaluated for formulation of alternatives, as shown in **Figure 3-5.** In this figure, certain measures are grouped together which share common design characteristics and functions, for ease of reading and rationale of how and why measures were formulated into alternatives. The breakwater measures serve the function to reduce damages associated with wave attack (Cataño area only, WSJB-3). Floodwall/seawall measures can be used to reduce wave attack and coastal flooding. If a floodwall/seawall is to be used with a breakwater, the floodwall/seawall could be built to a lower elevation. If a floodwall/seawall is built without a breakwater, the tradeoff would be that it would have to be more robust and built to a higher elevation in combination with revetment. All other measures serve the function of reducing damages associated with coastal flooding. Specific considerations for breakwater design can be found in **Appendix A, Engineering**. In addition to the structural and natural and nature-based feature measures shown, the non-structural measure of acquisition of land and structures (buyout) in strategic areas which are flooded to certain elevations was also carried forward. Additionally, non-structural measures that the non-federal sponsor and local communities would carry out were also carried forward, such as improved public outreach about coastal flooding, improved evacuation plans and notification systems, and evaluations of re-zoning over time as needed. These were carried forward as recommendations to the non-federal sponsor and local communities only and would not be carried out as part of the federal project. While there are evacuation plans in place and they would not need to be redone as a result of a Federal project, this report recommends that the non-federal sponsor pursue measures such as local outreach and evacuation plan/notification improvements. This is because in order to maintain life safety, with or without a project, it is important that residents continue to understand evacuation plans, receive notification of evacuation orders, and follow evacuation orders.





3.8 THE FOCUSED ARRAY OF ALTERNATIVES

Using the key information as described above in concert with ground elevations and key flooding sources leading to the highest risk of damages, the focused array of alternatives was formulated and is provided below in **Table 3-1** and graphically in **Figure 3-6** and **Figure 3-7**. All alternatives in the focused array include inland hydrology measures, to allow to outflow of rainfall runoff. The no-action alternative is also carried forward into the final array. Although this alternative does not include any Federal action or involvement in storm damage reduction as outlined within this report, it provides a comparison for all other alternatives.

Although the key objectives are generally the same in each planning reach, it is important to note that the planning reaches represent unique communities within the San Juan Metro Area. While each planning reach has been defined as a separate unit, the goal is to provide a cohesive storm risk reduction plan for the communities at risk of storm surge within the San Juan Metro Area. Details on the engineering modeling and preliminary design assumptions for all alternatives at this stage of the focused array can be found in **Appendix A, Engineering.**

Alternative	Description	
No-action	No federal involvement in storm damage reduction as outlined in this report.	
	CONDADO LAGOON REACH (CL-1)	
CL1-Alt 1	Full Seawall/Floodwall	
CL1-Alt 2	Full Elevated Living Shoreline	
CL1-Alt 3	Seawall/Floodwall north + Elevated Living Shoreline south	
	WEST SAN JUAN BAY (WSJB-1A)	
WSJB1A-Alt 1	Seawall/Floodwall + Levee	
	WEST SAN JUAN BAY (WSJB-1B)	
WSJB1B-Alt 1	Seawall/Floodwall + Levee + Elevated living shoreline	
WSJB1B-Alt 2	Seawall/Floodwall + Levee	
	WEST SAN JUAN BAY (WSJB-1A + WSJB-1B)	
WSJB1A+1B-Alt 1 Discharge Structure + Seawall/Floodwall + Levee + Elevated living shoreline		
	WEST SAN JUAN BAY (WSJB-2)	
WSJB2-Alt 1	Levee + Seawall/Floodwall	
WSJB2-Alt 2	Horizontal ("Tiered") levee + Seawall/Floodwall	
WSJB2-Alt 3	Discharge Structure + Levee + Seawall/Floodwall	
WSJB2-Alt 4	Discharge Structure + Horizontal ("Tiered") Levee + Seawall/Floodwall	
WSJB2-Alt 5	Buyout in low lying elevations	
	WEST SAN JUAN BAY (WSJB-3)	
WSJB3-Alt 1	Seawall/Floodwall + Higher T-wall floodwall + Revetment	
WSJB3-Alt 2	Seawall/Floodwall + Breakwater	
WSJB3-Alt 3	Seawall/Floodwall + Emergent Island	
WSJB3-Alt 4	Seawall/Floodwall + Living Shoreline + Breakwater	
	WEST SAN JUAN BAY (WSJB-4)	
WSJB4-Alt 1	Seawall/Floodwall in low elevations	
WSJB4-Alt 2	Seawall/Floodwall + Levee in low elevations	

Table 3-1. Focused Array of Alternatives.

3.8.1 EVALUATION AND COMPARISON OF THE FOCUSED ARRAY

During this phase, the focused array of alternatives were qualitatively compared and evaluated against criteria. An environmental analysis was also conducted under NEPA to compare and evaluate the final array for a set of environmental factors, prior to determination of the NED Plan or the Recommended Plan. Finally, a quantitative economic evaluation of costs and benefits was performed. Those three evaluations are found in the discussions below. The results are visually summarized in **Figure 3-6** and **Figure 3-7** and provided as a graphic reference while reading the following discussions.

Figure 3-6. Focused Array of Alternatives for the San Juan Metro Area (CL, WSJB-1A, WSJB-1B).



Figure 3-7. Focused Array of Alternatives for the San Juan Metro Area (WSJB-2,WSJB-3, WSJB-4).



San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

3.8.1.1 PLANNING CRITERIA SCORING

Criteria to evaluate the study alternatives consisted of meeting specific project objectives, evaluations under the four P&G accounts, long term consideration, as well as avoiding constraints, and required evaluation criteria of completeness, efficiency, effectiveness and acceptability. The alternatives, including the no-action alternative, were considered, evaluated, and scored. Scoring was assigned and rated as follows: 0 = does not meet criteria, 1 = partially meets criteria, and 2 = fully meets criteria. If the total rating equaled a number greater than 14, the study alternative partially met, at least, over half of the objectives and constraints and was carried forward for further analysis. If the total rating was less than 14, the study alternative scored above 14. Screening matrices showing the criteria and evaluations can be found in **Appendix E, Plan Formulation.** The following information summarizes key considerations.

THE FOUR P&G ACCOUNTS

- National Economic Development (NED): For each alternative, the quantitative assessment of NED was documented, relative to the other alternatives. Alternatives that had negative net benefits were noted as such.
- Environmental Quality (EQ): For each alternative, EQ was considered, including tradeoffs of avoidance of resources, estimated acreages of impacts, and creation of additional habitat. Acreage impact estimates during this phase for each alternative were estimated by using Geographic Information System (GIS) to display alternative footprints layered over environmental resources. Impact estimates are documented in the matrices for alternative comparison and evaluation, located in Appendix E, Plan Formulation.
- Other Social Effects (OSE): For each alternative, OSE was considered in terms of life safety as the
 most paramount criteria in areas where life safety was assessed to be high risk, as described
 earlier. This is described further in Section 3.8.2 below. Other considerations as described earlier
 were design height, public acceptability, and impact to existing urban development (ie: footprint
 of the feature).
- Regional Economic Development (RED): For each alternative, RED was considered in terms of economic infusion during construction and in terms of resilience.

CONTRIBUTION TO PLANNING OBJECTIVES

- Reduce the risk of damages from coastal flooding with sea level rise (intermediate scenario) from 2029 to 2079: For each alternative, the effectiveness of its ability to reduce damages was considered.
- Increase community resilience in the area from 2029 to 2079: For each alternative, the effectiveness of its ability to increase resilience for the community was considered.

 Reduce the risk of damages from wave attack from 2029 to 2079: For each alternative in the WSJB-3 reach only, the effectiveness of its ability to reduce damages in concert with a measure to reduce coastal flooding was considered.

LONG-TERM CONSIDERATIONS

- Long-term ease of use/adaptability to sea level rise: For each alternative, an assessment adaptability of features, including risk of sea level rise, was considered.
- Sustainability (ie: Lower operation and Maintenance): For each alternative, the operation and maintenance estimated requirements were considered for ease of use and long term cost and commitment of maintenance.

AVOID CONSTRAINTS

- Avoid conflict with applicable state and Federal regulations: For each alternative, ability to avoid conflicts with applicable state and Federal regulations was considered.
- Cannot increase life loss compared to the FWOP conditions: Each alternative was previously formulated to ensure life safety and to ensure life loss would not be made worse under the proposed alternative. The alternatives were modeled in G2CRM to confirm that no adverse effects to life loss would be incurred compared to the future without-project conditions; as a result, each alternative meets this criteria and is noted in the matrix. Additional life safety refinements were performed after this initial assessment, and are described in Section 3.10 in this Chapter.

RESPONSE TO EVALUATION CRITERIA

- Completeness: For each alternative, ability of the alternative to provide a complete response to the problem was considered.
- Effectiveness: For each alternative, ability of the alternative to a be cost effective solution was considered.
- Efficiency: For each alternative, ability of the alternative to a be an efficient solution to meet project objectives was considered.
- Acceptability: For each alternative, ability of the alternative be acceptable to the public were considered.

3.8.1.2 KEY CONSIDERATIONS FOR LIFE SAFETY IN HIGH RISK AREAS

During the plan formulation analysis, an additional analysis called a Qualitative Risk Analysis (QRA) was performed with a focus on reducing risk to life safety, in accordance with Engineering and Construction Bulletin (ECB) 2019-15 and Planning Bulletin (PB) 2019-04. That analysis showed that certain reaches were more prone to risk to life safety with certain measures, and that life safety considerations, balanced with public acceptability, cost, and economic justification, were needed in order to maintain a low risk to life

safety should a breach ever occur. It also showed that other optimizations to refine scale and avoid environment effects could be made in other areas where a conservative approach had previously been taken. The following paragraphs provide the broad rationale for the optimizations which were subsequently made to the selected plans in some reaches. Additionally, more information on the detailed rationale and a summary of the QRA can be found in **Appendix A**, **Engineering**, **Section 5 and 6.3**, **respectively**.

WEST SAN JUAN BAY 1B

The analysis showed that that Alternative 1, specifically the elevated living shoreline portion of the plan, had more potential to experience failure if overtopped, which could also incur risk to life safety. The team used this information to balance life safety, public acceptability, cost and economic justification to modify the preliminary design. Alternative 2 includes a seawall/floodwall rather than an elevated living shoreline, which would be considered to be more robust than an elevated living shoreline.

WEST SAN JUAN BAY 3

The analysis showed that there was a higher risk of overtopping in this area should a storm greater than the 1/100 AEP event occur (which is what the original height of the features was preliminarily designed for) and the overtopping itself could incur risk to life safety; it also showed that the elevated living shoreline had more potential to experience failure if overtopped, which could also incur risk to life safety. Therefore, Alternative 2, which includes a seawall/floodwall, would be considered to be more robust in terms of life safety than Alternative 4, which includes a living shoreline.

3.8.1.3 ENVIRONMENTAL MINIMIZATION AND AVOIDANCE MEASURES*

The first step in mitigation planning involves employing efforts to avoid adverse impacts. After development of the initial array of alternatives, the PDT coordinated with resource agencies who participated during the PDT meetings. These meetings focused on the primary resources (fish habitat, SAV, hardbottom, wetlands, and cultural resources,) that could be impacted by the proposed alternatives.

Fish Habitat, SAV, Hardbottom, Wetlands. The USACE will avoid and minimize effects to these resources by limiting CSRM measure construction within these areas to the minimum required to meet the project purpose. Many areas could be avoided, and their extents would be determined during the PED Phase of the project when detailed, site-specific surveys would be conducted. Therefore, environmental impacts can be minimized by limiting CSRM measure footprints. In addition, construction adjacent the coral reefs at the entrance to San Juan Bay and Condado Lagoon would not occur. The reduction of impacts includes a minimized footprint and the potential for decreased indirect effects. These considerations were factored into plan formulation process, in the environmental quality account, as described above as well as under NEPA, as shown in **Table 3-2** below.

Cultural Resources. The USACE has conducted a review of recorded resources located near the proposed project features. The USACE will conduct surveys to refine the locations of resources as the features are

designed to ensure avoidance and minimization of effects to cultural resources from the construction and implementation of the alternatives. If avoidance is not possible, USACE will develop mitigation measures with the SHPO with input from the Instituto de Cultura Puertorriqueña and other interested parties. The terms detailing how USACE will ensure additional measures to protect cultural resources are in a Programmatic Agreement (PA) which was signed by USACE and SHPO. The PA can be found in **Appendix H, Cultural Resources**. As project designs are refined and optimized, impacts to cultural resources will continue to be minimized and avoided in some cases. Because the USACE cannot fully determine how the project may affect historic properties prior to finalization of this feasibility study, a PA will be used to ensure compliance with Section 106 of the National Historic Preservation Act of 1966 (NHPA). Specifically, the scope and diversity of potential effects of the project and constraints of the USACE planning policy make a PA for compliance with Section 106 essential. The PA will allow the USACE to complete the necessary archaeological surveys during the PED phase of the project, and it will also allow any additional inventories and mitigation to be completed after measures have been clearly defined and sited. Consultation and coordination with all interested parties is ongoing and will be finalized prior to project implementation.

Table 3-2. Summary of Environmental Effects of the Recommended Plan and the No Action Alternative.

ALTERNATIVE	Condado Lagoon	WSJB-1B	WSJB 2	WSJB-3	WSJB-4
ENVIRONMENTAL					
FACTOR					
GENERAL					
ENVIRONMENTAL					
SETTING					
(refer to Sections 2.1					
and 5.1.1)					
Wetlands	Construction of the	Construction of the	Construction of the	Construction of the CSRM measures could	Construction of the CSRM
	elevated living shoreline	CSRIVI measures could	Silice Gate could	directly affect approximately 5.37 acres of	measures could directly affect
	could directly affect	directly affect	directly affect	existing mangroves.	approximately 1.26 acres of
	approximately 3.11	approximately 10.02	approximately 2.32		existing mangroves and 0.83
	acres of existing	acres of existing	mangroups and 2 EQ		wetlands
	mangroves.	acros of polystring	acros of palustring		wetianus.
		acres of parustrine	acres of parasitine		
Water Quality	Elevated living shoreline	Construction of the	Construction of the	Construction of the CSRM measures may	Construction of the CSRM
water Quanty	construction in the	CSRM measures may	Sluice Gate may result	result in direct but minor impact to local	measures may result in direct
	water may result in	result in direct but	in direct but minor	water quality. Sedimentation may	but minor impact to local water
	direct but minor impact	minor impact to local	impact to local water	increase in the local area due to the	guality. Sedimentation may
	to local water quality.	water quality.	quality. Sedimentation	construction. although BMPs (best	increase in the local area due to
	Sedimentation may	Sedimentation may	may increase in the	management practices) would be used to	the construction, although
	increase in the local area	increase in the local area	local area due to the	avoid and minimize these impacts.	BMPs (best management
	due to the construction,	due to the construction,	construction, although	Turbidity monitoring would be conducted	practices) would be used to
	although BMPs (best	although BMPs (best	BMPs (best	during construction to maintain 10 NTU	avoid and minimize these
	management practices)	management practices)	management practices)	above background standard or	impacts. Turbidity monitoring
	would be used to avoid	would be used to avoid	would be used to avoid	temporarily shut down; No long-term	would be conducted during
	and minimize these	and minimize these	and minimize these	impacts anticipated.	construction to maintain 10
	impacts. Turbidity	impacts. Turbidity	impacts. Turbidity		NTU above background
	monitoring would be	monitoring would be	monitoring would be		standard or temporarily shut
	conducted during	conducted during	conducted during		down; No long-term impacts
	construction to maintain	construction to maintain	construction to		anticipated.
	10 NTU above	10 NTU above	maintain 10 NTU above		
	background standard or	background standard or	background standard or		
	temporarily shut down;	temporarily shut down;	temporarily shut down.		
	No long-term impacts	No long-term impacts	No long-term impacts		
	anticipated.	anticipated.	anticipated.		
			Operation including		
			discharges from the		
			Malaria Control Canal		
			gate would remain the		
			responsibility of DNFR in		
			compliance with NPDFS		
			permit		
			PRR040000/04000F and		
		1			1

San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT **No-Acton Plan**

In the future without-project (FWOP)/noaction alternative existing mangroves and palustrine emergent wetlands would continue to be affected by SLR and storm surge.

In the FWOP/no-action alternative there could be degradation of water quality from inundation and sedimentation due to SLR and storm events. This could result to effects to listed corals adjacent the entrance to San Juan Bay and Condado lagoon and along the north coast.

		1	1		
			DA permit SAJ-2013-		
			03237.		
Air Quality	Anticipated air quality	Anticipated air quality	The adverse impacts to	The adverse impacts to air quality due to	The adverse impacts to air
	impacts resulting from	impacts resulting from	air quality due to	emissions from construction activities are	quality due to emissions from
	construction equipment	construction equipment	emissions from	anticipated to be minor and temporary.	construction activities are
	emissions and other	emissions and other	construction activities		anticipated to be minor and
	construction activities	construction activities	are anticipated to be		temporary, and are anticipated
	are expected to be	are expected to be	minor and temporary.		to be less than significant
	minor and temporary.	minor and temporary.			
Threatened and	KEY for acronyms:				
Endangered Species	NE=No Effect,				
	MANLAA=May Affect,				
	but is Not Likely to				
	Adversely Affect,				
	MALAA=May Affect, but				
	it Likely to Adversely				
	Affect				
Fish	Construction of the	Construction of the	Construction of the	Construction of the CSRM measures is	Construction of the CSRM
-Nassau Grouper	elevated living shoreline	CSRM measures is	Sluice Gate is expected	expected to have no effect on these	measures is expected to have
-Scalloped	is expected to have no	expected to have no	to have no effect on	species.	no effect on these species.
Hammerhead Shark	effect on these	effect on these species.	these species.		
-Giant Manta Ray	overfished and oceanic				
	species.				
Swimming Sea Turtles	Construction of the	Construction of the	Construction of the	Construction of the CSRM measures	Construction of the CSRM
-Loggerhead	elevated living shoreline	CSRM measures	Sluice Gate MANLAA	MANLAA these species. Monitoring and	measures MANLAA these
-Leatherback	MANLAA these species.	MANLAA these species.	these species.	shutdown during construction required	species. Monitoring and
-Green	Monitoring and	Monitoring and	Monitoring and	(See 5.1.6.3).	shutdown during construction
-Hawksbill	shutdown during	shutdown during	shutdown during		required (See 5.1.6.3).
	construction required	construction required	construction required		
	(See 5.1.6.3).	(See 5.1.6.3).	(See 5.1.6.3).		
Antillean Manatee	Construction of the	Construction of the	Construction of the	Construction of the CSRM measures	Construction of the CSRM
	elevated living shoreline	CSRM measures	Sluice Gate MANLAA	MANLAA this species. Standard	measures MANLAA this species.
	MANLAA this species.	MANLAA this species.	this species. Standard	construction conditions to be employed	Standard construction
	Standard construction	Standard construction	construction conditions	including monitoring and shutdown during	conditions to be employed
	conditions to be	conditions to be	to be employed	construction (See 5.1.6.4).	including monitoring and
	employed including	employed including	including monitoring		shutdown during construction
	monitoring and	monitoring and	and shutdown during		required (See 5.1.6.4).
	shutdown during	shutdown during	construction (See		
	construction (See	construction required	5.1.6.4).		
	5.1.6.4).	(See 5.1.6.4).			
Listed Corals	Construction of the	Construction of the	Construction of the	Construction of the CSRM measures would	Construction of the CSRM
-Elkhorn	elevated living shoreline	CSRM measures would	Sluice Gate would have	have NE on these species. Turbidity	measures would have NE on
-Staghorn	would have NE on these	have NE on these	NE on these species.	monitoring and shutdown during	these species. Turbidity
-Pillar	species. Turbidity	species. Turbidity	Turbidity monitoring	construction required (See 5.1.4 and	monitoring and shutdown
-Lobed Star	monitoring and	monitoring and	and shutdown during	5.1.6.5).	during construction required
-Mountainous Star	shutdown during	shutdown during			(See 5.1.4 and 5.1.6.5).

The FW	OP/no-action alternative would likely
have no	effect to air quality.
The FW	OP/no-action alternative would likely
have no	o effect to Nassau grouper, scalloped
hamme	rhead shark, or giant manta ray.
The FW	OP/no-action alternative would likely
have no	effect to swimming sea turtles.
The FW have no	OP/no-action alternative would likely effect to Antillean manatees.
In the F be degra inundati storm e listed co Bay and coast.	WOP/no-action alternative there could adation of water quality from ion and sedimentation due to SLR and vents. This could result to effects to orals adjacent the entrance to San Juan Condado lagoon and along the north

-Boulder Star	construction required	construction required	construction required		
-Rough Cactus	(See 5.1.4 and 5.1.6.5).	(See 5.1.4 and 5.1.6.5).	(See 5.1.4 and 5.1.6.5).		
Puerto Rican Boa	Construction of the	Construction of the	Construction of the	Construction of the CSRM measures	Construction of the CSRM
	elevated living shoreline	CSRM measures	Sluice Gate MANLAA	MANLAA this species. Required	measures MANLAA this species.
	MANLAA the Puerto	MANLAA this species.	this species. Required	implementation of USEWS standard	Required implementation of
	Rican boa Required	Required	implementation of	conditions (See 5.1.6.6)	LISEWS standard conditions
	implementation of	implementation	LISEWS standard		(See 5 1 6 6)
			conditions (Soo E 1 6 6)		(566 5.1.0.0).
	conditions (see 5.1.6.6).	conditions (see 5.1.6.6).			
Essential Fish Habitat	Construction could	Construction could	Construction could	Construction could affect EFH including	Construction could affect EFH
	affect EFH including	affect EFH including	affect EFH including	SAV, estuarine water column, estuarine	including estuarine water
	SAV, estuarine water	SAV, estuarine water	estuarine water column,	scrub shrub (mangroves) (See 5.1.3 and	column, estuarine scrub shrub
	column, and estuarine	column, estuarine scrub	estuarine scrub shrub	5.1.5). CSRM measures would provide	(mangroves), and palustrine
	scrub shrub	shrub (mangroves), and	(mangroves), and	habitat (See Appendix F).	emergent wetlands (See 5.1.3
	(mangroves) (See 5.1.3	palustrine emergent	palustrine emergent		and 5.1.5).
	and 5.1.5). Elevated	wetlands (See 5.1.3 and	wetlands (See 5.1.3 and		
	living shoreline would	5.1.5). CSRM measures	5.1.5).		
	provide habitat (See	would provide habitat			
	Appendix F).	(See Appendix F).			
Birds	Temporary disturbance	Construction could	Temporary disturbance	Temporary disturbance during	Temporary disturbance during
	during construction	affect birds and bird	during construction	construction Mangrove habitat	construction Mangrove and
	Mangrove babitat	habitat including	Mangrove and	notentially directly affected CSRM	nalustring emergent wetland
	notontially directly	mangrovos	nalustrino omorgont	massures would provide babitat (See E 1.7	babitat potentially directly
	offected Elevated living	nalustrino amorgant	watland habitat	and Appendix []	affected
	anected. Elevated living	palustrine emergent	wetiand nabitat	and Appendix FJ.	anecieu.
	shoreline would provide	wetlands. CSRIVI	potentially directly		
	habitat (See 5.1.7 and	measures would provide	affected.		
	Appendix F).	habitat (See 5.1.7 and			
		Appendix F).			
SAV	Construction could	Construction could	No effects anticipated.	Construction could affect SAV (See 5.1.3	No effects anticipated.
	affect SAV (See 5.1.3	affect SAV (See 5.1.3		and 5.1.5). CSRM measures would provide	
	and 5.1.5). Elevated	and 5.1.5). CSRM		habitat (See Appendix F).	
	living shoreline would	measures would provide			
	provide habitat (See	habitat (See Appendix			
	Appendix F).	F).			
Hardbottom Habitat	No direct impacts	No direct impacts	No direct impacts	No direct impacts anticipated. Impact	No direct impacts anticipated.
	anticipated. Impact	anticipated. Impact	anticipated. Impact	estimates will be revised as necessary	Impact estimates will be revised
	estimates will be revised	estimates will be revised	estimates will be revised	once updated field surveys can be	as necessary once updated field
	as necessary once	as necessary once	as necessary once	conducted BMPs including turbidity	surveys can be conducted
	undated field surveys	undated field surveys	undated field surveys	monitoring required during construction	surveys can be conducted.
	can be conducted BMPs	can be conducted	can be conducted RMDs		
	including +urbidity		including +urbidity		
	monitoring turbidity		monitorian turbidity		
	monitoring required		monitoring required		
	auring construction.		auring construction.		
			BMPs including turbidity		
			monitoring required		
			during construction.		

The FWOP/no-action alternative would likely have no effect to Puerto Rican boas.

In the FWOP/no-action alternative there could be degradation of water quality from inundation and sedimentation due to SLR and storm events. This could result to impacts to EFH.

In the FWOP/no-action alternative there could be inundation and loss of bird habitat due to SLR and storm events.

In the FWOP/no-action alternative there could be degradation of water quality from inundation and sedimentation due to SLR and storm events. This could result to impacts to SAV.

In the FWOP/no-action alternative there could be degradation of water quality from inundation and sedimentation due to SLR and storm events. This could result to impacts to hardbottom habitat.

Invasive Species	Construction of the	Construction of the	Construction of the	Construction of the proposed CSRM	Construction of the proposed
•	elevated living shoreline	proposed CSRM	Sluice Gate would not	measures would not cause additional	CSRM measures would not
	would not cause	measures would not	cause additional threats	threats from invasive species; BMPs	cause additional threats from
	additional threats from	cause additional threats	from invasive species;	required during construction to avoid the	invasive species; BMPs required
	invasive species; BMPs	from invasive species;	BMPs required during	spread and help control invasive species.	during construction to avoid the
	required during	BMPs required during	construction to avoid		spread and help control invasive
	construction to avoid	construction to avoid	the spread and help		species.
	the spread and help	the spread and help	control invasive species.		
	control invasive species.	control invasive species.			
Environmental Justice	Construction of the	Construction of the	Construction of the	Construction of the proposed elevated	Construction of the proposed
	proposed elevated living	proposed elevated living	proposed elevated living	living shoreline is not anticipated to have a	elevated living shoreline is not
	shoreline is not	shoreline is not	shoreline is not	disproportionately high and adverse	anticipated to have a
	anticipated to have a	anticipated to have a	anticipated to have a	impact on low income or minority	disproportionately high and
	disproportionately high	disproportionately high	disproportionately high	communities or cause negative secondary	adverse impact on low income
	and adverse impact on	and adverse impact on	and adverse impact on	effects. Beneficial effect to the overall area	or minority communities or
	low income or minority	low income or minority	low income or minority	anticipated from sustainable storm	cause negative secondary
	communities or cause	communities or cause	communities or cause	damage reduction measures Would	effects Beneficial effect to the
	negative secondary	negative secondary	negative secondary	benefit all populations in the area via	overall area anticipated from
	effects. Beneficial effect	effects. Beneficial effect	effects. Beneficial effect	reduction in damages as a result of back	sustainable storm damage
	to the overall area	to the overall area	to the overall area	hav flooding.	reduction measures. Would
	anticipated from	anticipated from	anticipated from		benefit all populations in the
	sustainable storm	sustainable storm	sustainable storm		area via reduction in damages
	damage reduction	damage reduction	damage reduction		as a result of back bay flooding.
	measures. Would	measures. Would	measures. Would		
	benefit all populations	benefit all populations	benefit all populations		
	in the area via reduction	in the area via reduction	in the area via reduction		
	in damages as a result of	in damages as a result of	in damages as a result of		
	back bay flooding.	back bay flooding.	back bay flooding.		
Noise	Minor adverse impacts	Minor adverse impacts	Minor adverse impacts	Minor adverse impacts to wildlife due to	Minor adverse impacts to
	to wildlife due to	to wildlife due to	to wildlife due to	displacement from construction noise:	wildlife due to displacement
	displacement from	displacement from	displacement from	Temporary and minor impact to human	from construction noise:
	construction noise:	construction noise:	construction noise:	populations due to the construction	Temporary and minor impact to
	Temporary and minor	Temporary and minor	Temporary and minor	activities.	human populations due to the
	impact to human	impact to human	impact to human		construction activities.
	populations due to the	populations due to the	populations due to the		
	construction activities.	construction activities.	construction activities.		
HTRW	Construction of the	Construction of the	Construction of the	Construction of the proposed CSRM	Construction of the proposed
	elevated living shoreline	proposed CSRM	proposed Sluice Gate	measures would not cause additional	CSRM measures would not
	would not cause	measures would not	would not cause	threats from HTRW: Additional	cause additional threats from
	additional threats from	cause additional threats	additional threats from	investigations could be required in PED.	HTRW: Additional
	HTRW: Additional	from HTRW: Additional	HTRW: Additional	BMPs required during construction to	investigations could be required
	investigations could be	investigations could be	investigations could be	avoid the spread and help control	in PED. BMPs required during
	required in PED_BMPs	required in PED_BMPs	required in PED_BMPs	hazardous substances.	construction to avoid the
	required during	required during	required during		spread and help control
	construction to avoid	construction to avoid	construction to avoid		hazardous substances
	the spread and help	the spread and help	the spread and help		
	control hazardous	control hazardous	control hazardous		
	substances	substances	substances		
	substances.	Substances.	substances.		

San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

In the FWOP/no-action alternative control of	
invasive species would continue to be governed by regulation.	
In the FWOP/no-action alternative flooding	
from SLR and storm damage would continue to effect low income and minority communities	
around San Juan Bay.	
In the FWOP/no-action alternative noise levels would continue to reflect that of an active	
harbor and large metropolitan area around San	
Juan Bay.	
In the FWOP/no-action alternative control of	
HIRW would continue to be governed by regulation.	

Aesthetics	Elevated living	Nature-based CSRM	No effect to area wide	Nature-based CSRM measures could	Nature-based CSRM measures
	shorelines could benefit	measures could benefit	aesthetics; Not out of	benefit local area aesthetics; Not out of	could benefit local area
	local area aesthetics;	local area aesthetics;	character for the San	character for the San Juan area.	aesthetics; Not out of character
	Not out of character for	Not out of character for	Juan area.		for the San Juan area.
	the San Juan area.	the San Juan area.			
Coastal Barrier	No effect to CBRS units	No effect to CBRS units	No effect to CBRS units	No effect to CBRS units as they are too far	No effect to CBRS units as they
Resources	as they are too far away	as they are too far away	as they are too far away	away to be affected.	are too far away to be affected.
	to be affected.	to be affected.	to be affected.		
Cultural and Historic	The direct effects of	The direct effects of	The direct effects of	The direct effects of construction may	The direct effects of
Resources	construction and	construction and	construction and	impact historic properties and indirect	construction and indirect
	indirect effects of	indirect effects of	indirect effects of	effects of project implementation through	effects of project
	project implementation	project implementation	project implementation	disturbance of the ground and alterations	implementation may impact
	may impact historic	may impact historic	may impact historic	of viewsheds. Additional investigations	historic properties through
	properties through	properties through	properties through	will be required in PED.	disturbance of the ground and
	disturbance of the	disturbance of the	disturbance of the		alterations of viewsheds.
	ground and alterations	ground and alterations	ground and alterations		Additional investigations will be
	of viewsheds. Additional	of viewsheds. Additional	of viewsheds. Additional		required in PED.
	investigations will be	investigations will be	investigations will be		
	required in PED.	required in PED.	required in PED.		

In the FWOP/no-action alternative local aesthetics would continue to reflect those of an active harbor and San Juan metropolitan area around San Juan Bay.

In the FWOP/no-action alternative CBRS units would continue to be governed by regulation.

In the FWOP/no-action alternative impacts to historic properties are not anticipated.

3.8.1.4 ECONOMIC EVALUATION (COSTS & BENEFITS)

Preliminary costs and economic benefits were compared for each alternative. Preliminary costs included rough estimates for construction, estimated environmental mitigation costs, real estate costs. During the economic analysis, additional economic costs are incorporated which include operation and maintenance as well as interest during construction. All costs were then annualized over 50 years at the Federal discount rate, and compared to the annualized economic benefits from the G2CRM model. The economic benefits presented below show the reduction of damages from coastal flooding. The results are displayed in **Table 3-3**.

Several alternatives had negative net benefits and a benefit to cost ratio less than 1. These alternatives are: CL Alt 1 and 2; WSJB-1A Alt 1; WSJB-1A + WSJB-1B Alt 1(1a +1b).

Planning Reach	Alt	Description	AAEQ NED Benefits	AAEQ NED Costs	AAEQ Net NED Benefits	BCR
No-Action			\$0	\$0	\$0	0
	Alt 1	Full Seawall/Floodwall	\$1,615,029	\$2,765,543	-\$1,150,513	0.58
	Alt 2	Full Elevated Living Shoreline	\$1,615,029	\$1,173,503	\$441,526	1.38
CL	Alt 3	Seawall/Floodwall north + Elevated Living Shoreline south	\$1,615,029	\$2,213,702	-\$598,673	0.73
WSJB-1A	Alt 1	Seawall/Floodwall + Levee	\$845,901	\$1,366,053	-\$520,152	0.62
WSJB-1B	Alt 1	Seawall/Floodwall + Levee + Elevated living shoreline	\$2,489,862	\$1,551,049	\$938,813	1.61
	Alt 2	Seawall/Floodwall + Levee	\$2,489,862	\$1,776,316	\$713,546	1.40
WSJB-1A+ WSJB-1B	Alt 1 (1a+1b)	Discharge Structure + Seawall/Floodwall + Levee + Elevated living shoreline	\$3,520,179	\$3,961,721	-\$441,542	0.89
	Alt 1	Levee + Seawall/Floodwall	\$10,560,200	\$1,418,998	\$9,141,202	7.44
	Alt 2	Horizontal ("Tiered") levee + Seawall/Floodwall	\$10,560,200	\$1,501,723	\$9,058,477	7.03
W/SIB-2	Alt 3	Discharge Structure + Levee + Seawall/Floodwall	\$12,722,287	\$929,641	\$11,792,646	13.69
	Alt 4	Discharge Structure + Horizontal ("Tiered") Levee + Seawall/Floodwall	\$12,722,287	\$949,714	\$11,772,572	13.40
	Alt 5	Buyout in low lying elevations	\$13,532,392	\$9,053,628	\$4,478,764	1.49
\\/\\CIP_2	Alt 1	Seawall/Floodwall + Higher T-wall floodwall	\$63,239,363	\$6,953,358	\$56,286,005	9.09
VV 010-3	Alt 2	Seawall/Floodwall + Breakwater	\$63,826,013	\$6,033,587	\$57,792,426	10.58

 Table 3-3. Economic Analysis for the focused array of alternatives.²⁶

²⁶ Results are based on 5-iteration model runs in G2CRM, and are a good representation of damages for plan formulation. Fifty-iteration model runs in G2CRM are used for refined benefits in Chapter 4.

San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

	Alt 3	Seawall/Floodwall + Emergent Island	\$63,239,363	\$5,864,812	\$57,374,551	10.78
	Alt 4	Seawall/Floodwall + Living Shoreline + Breakwater	\$63,826,013	\$5,794,279	\$58,031,734	11.02
	Alt 1	Seawall/Floodwall in low elevations	\$2,667,710	\$1,545,697	\$1,122,014	1.73
WSJB-4	Alt 2	Seawall/Floodwall + Levee in low elevations	\$2,667,710	\$1,370,288	\$1,297,423	1.95

3.9 SCREENING OF ALTERNATIVES

After the above analyses were completed, the economic analysis shows that several alternatives are shown to have negative net benefits and a benefit to cost ratio less than 1. These alternatives are: CL Alt 1 and 3; WSJB-1A Alt 1a; WSJB-1A + 1B Alt 1(1a +1b). With consideration given to the planning criteria evaluation and the environmental evaluation, these alternatives were not carried forward for further analysis. Reach WSJB-1A does not have any alternatives which have a benefit to cost ratio equal to or greater than 1. The team consulted with staff at the Palo Seco Power Plants, which are the most significant critical infrastructure in this reach. Verbal communication indicated that the power plants have not had problems from storm surge, given past historical storms. The current analysis using planning criteria and environmental evaluations did not provide sufficient additional benefits or rationale to carry this reach forward in the analysis for inclusion in the Recommended Plan.

3.10 PLAN SELECTION RATIONALE

As discussed in the previous sections, the alternatives were compared and evaluated using planning criteria, environmental minimization, and avoidance factors, and the USACE economic analysis. In reaches WSJB-1B and WSJB-3, life safety considerations carried more weight in the selection.

The following discussion describes which alternatives were selected to be part of the Recommended Plan, and why they were selected.

<u>CL Alt 2- Elevated Living Shoreline</u>: Under planning criteria evaluations, this alternative scored high marks under all categories, including high benefits in the four P&G accounts. Regarding environmental avoidance and mitigation, the living shoreline, while initially expected to impact environmental resources during construction, will create long-term habitat. In the economic analysis, this plan reasonably maximizes net benefits and the benefit to cost ratio was greater than 1.0, at 1.38.

<u>WSJB-1B: Alt 2 - Seawall/Floodwall + Levee:</u> Under planning criteria evaluations, this alternative scored high marks under all categories, including high benefits in the four P&G accounts. In this reach, life safety was paramount in the OSE category, and therefore the seawall/floodwall measure was chosen over the living shoreline in Alternative 1 for its robustness. Regarding environmental avoidance and mitigation, this alternative will have fewer environmental impacts during construction when compared to Alternative 1, but it will not create habitat, and it will likely require mitigation. In the economic analysis, this plan reasonably maximizes net benefits and the benefit to cost ratio was greater than 1.0, at 1.4.

<u>WSJB-2: Alt 3 – Discharge Structure + Levee + Seawall/Floodwall</u>: Under planning criteria evaluations, this alternative scored high marks under all categories, including high benefits in the four P&G accounts. Alternative 5 scored the least favorably, due to potential public opposition to acquisition and buyout in low lying elevations, which would also not be a complete solution as it would not reduce coastal flooding in other areas. Regarding environmental avoidance and mitigation, this alternative will have fewer environmental impacts during construction when compared to Alternatives 1 and 2 due to less construction, but it will not create habitat. It will have some impacts to environmental resources during construction, which would likely require mitigation. It would have the same impacts Alternative 4, where Alternative 4 would create additional habitat. In the economic analysis, this plan reasonably maximizes net benefits and the benefit to cost ratio was greater than 1.0, at 13.69.

<u>WSJB-3: Alt 2 –Seawall/Floodwall + Breakwater:</u> Under planning criteria evaluations, this alternative 1 scored high marks under all categories, including high benefits in the four P&G accounts. Alternative 1 scored the least favorable, since it would not include a breakwater and would therefore include a much taller seawall/floodwall than the seawall/floodwalls presented in Alts 2, 3 and 4. This would likely not be favorable in the OSE category to the communities in the area. In this reach, life safety was paramount in the OSE category, and therefore the seawall/floodwall measure in this alternative was chosen over the living shoreline in Alternative 4 for its robustness. Regarding environmental avoidance and mitigation, this alternative would have the same environmental impacts during construction when compared to Alternative 4, but it will not create habitat with a living shoreline as Alternative 4 would. In the economic analysis, this plan reasonably maximizes net benefits and the benefit to cost ratio was greater than 1.0 at 10.58.

<u>WSJB-4: Alt 2 – Levee + Seawall/Floodwall</u>: Under planning criteria evaluations, this alternative scored high marks under all categories, including high benefits in the four P&G accounts. Regarding environmental avoidance and mitigation, this alternative would have roughly the same environmental impacts during construction when compared to Alternative 1, which would likely require mitigation. In the economic analysis, this plan reasonably maximizes net benefits and the benefit to cost ratio was greater than 1.0 at 1.95.

3.11 OPTIMIZATION OF LENGTH OF ELEVATED LIVING SHORELINE ALONG CONDADO LAGOON

The original configuration included an elevated living shoreline around most of Condado Lagoon. Additional analysis showed that along the south side of the lagoon, the ground surface quickly rises approaching elevations as high as 6 to 8 feet PRVD02. Only the approximate first 200 feet from the south bank of the lagoon would experience flooding, which generally consist of the Expreso Roman Baldorioty de Castro roadway, where an alternate route could be chosen if it was flooded. Additionally, the few structures in this area are multistory, indicating low risk to life loss. When the number of structures in the area on the south were assessed, it became clear that the primary damages are to the north and east, which is consistent with feedback from the non-federal sponsor and local communities. When considering environmental resources during construction, more mangroves would be impacted on the south side of the lagoon, when compared to the north. Finally, when considering other social effects, there is a substantial riverwalk along the southern perimeter of the lagoon (as described in Chapter 2). Although construction of a feature along this area would not negatively impact the riverwalk itself, it would block the viewshed, which could be unpopular. Considering all of the factors, the elevated living

shoreline was optimized to run along the northern and eastern perimeter of the lagoon only, not including the southern perimeter, which strategically reduces the majority of damages in the area, avoids impacts to environmental resources, and maintains public acceptability, while maintaining a low risk of life loss. This alternative with an optimized length is carried forward as CL-Alternative 2a.

3.12 THE RECOMMENDED PLAN

This analysis finds that there is Federal Interest in a cohesive plan to reduce damages to the San Juan Metro Area. The P&G and ER 1105-2-100 state that the NED plan is the plan that reasonably maximizes net economic benefits consistent with protecting the Nation's environment. The NED Plan consists of the plan which reasonable maximizes net benefits from each of the most vulnerable areas within the San Juan Metro Area, which is:

- CL Alt 2a- Elevated Living Shoreline;
- WSBJ-1B: Alt 2 Seawall/Floodwall + Levee;
- WSJB-2: Alt 3 Discharge Structure + Levee + Seawall/Floodwall;
- WSJB-3: Alt 2 –Seawall/Floodwall + Breakwater;
- WSJB-4: Alt 2 Levee + Seawall/Floodwall;

This NED plan uses key structural and natural and nature-based features in strategic locations designed to appropriate elevations which work together to reduce the risk of damages as a result of coastal flooding from storm surge, tide and waves during coastal storms and hurricanes in the San Juan Metro Area.

The NED plan brings benefits to the nation in all of the four P&G accounts (NED, EQ, RED, OSE), in line with guidance in the memorandum from the Assistant Secretary of the Army (Civil Works), dated 3 April 2020, Comprehensive Documentation of Benefits in Feasibility Studies, and meets the planning criteria of being complete, efficient, effective, and acceptable. Under NEPA, the NED plan has been evaluated for effects, which are described in Chapter 4. Consistent with the NEPA, USACE has formalized its commitment to the environment by creating a set of "Environmental Operating Principles" applicable to all its decision making and programs. These principles foster unity of purpose regarding environmental issues and ensure that environmental conservation and preservation, and restoration are considered in all USACE activities. These are identified and addressed specifically in Section 6.6.25 of this report. The NED provides average annual net benefits (AAEQ) of \$57.6M each year of a 50-year period of analysis. The NED plan is economically justified with a benefit to cost ratio of 4.8 to 1.

The Recommended Plan includes levees (1.5 miles), a series of breakwaters (0.7 miles) along the Cataño shoreline, seawalls/floodwalls (6.5 miles), elevated living shoreline (0.7 miles), a discharge structure on the Malaria Canal, and associated inland hydrology features (to allow rainfall runoff with constructed features). Although the NED plan was formulated to avoid and minimize impacts to every extent possible, impacts are expected to occur and would be addressed as mitigation, which is evaluated further in Chapter 5 under NEPA and in the mitigation plan in **Appendix F, Environmental, Attachment 3**, and in Chapter 4.

Typically, the NED plan becomes the Recommended Plan unless the non-federal sponsor chooses to pursue a Locally Preferred Plan (LPP) which differs from the NED plan. An LPP is subject to the requirements described in ER 1105-2-100. The option of selecting an LPP was coordinated with the non-federal sponsor, who does not wish to pursue an LPP at this time. The NED plan therefore is the Recommended Plan.



4 THE RECOMMENDED PLAN

4.1 DESCRIPTION OF THE RECOMMENDED PLAN

The Recommended Plan consists of a collection of key structural and natural and nature-based features in strategic locations designed to appropriate elevations which work together to reduce coastal flood risk from extreme high water events that result from storm surge, waves, tides and sea level change and combinations of these forces

The Recommended Plan includes levees (1.5 miles), a series of breakwaters over 0.7 miles along the Cataño shoreline, seawalls/floodwalls (6.5 miles), elevated living shoreline (0.7 miles), a discharge structure on the Malaria Canal, and associated inland hydrology features (pumps and culverts) to allow continued rainfall runoff drainage with the Recommended Plan constructed features. The Recommended Plan also contributes to creation of habitat. Although the Recommended Plan was formulated to avoid and minimize impacts to the extent practicable, impacts are expected to occur and would be addressed through mitigation, which is evaluated further in Chapter 5 and in the preliminary mitigation plan in **Appendix F, Environmental, Attachment 4**. These features and aspects of the Recommended Plan are discussed in this Chapter.

4.2 BENEFITS OF THE RECOMMENDED PLAN

4.2.1 ECONOMIC SUMMARY

This analysis finds that there is Federal Interest in a comprehensive plan to reduce damages to the San Juan Metro Area.

This Recommended Plan uses key structural and natural and nature-based features in strategic locations designed to appropriate elevations which work together to effectively and efficiently reduce the risk of damages due to coastal flooding by 98% to 100% in the San Juan Metro Area. The Recommended Plan provides average annual net benefits (AAEQ) of \$57.6M each year of a 50-year period of analysis. The Recommended Plan is economically justified with a benefit to cost ratio of 4.8 (Table 4-1). The incremental benefits of each reach are displayed in Table 4-2. Condado Lagoon is one of the most popular recreational sites in San Juan and the living shoreline is expected to provide substantial incidental recreation benefits were calculated for this reach. Recreation benefits were also calculated for Reach WSJB 1B where the proposed levee will contribute to recreation opportunities in the community. More information on the recreation benefit calculation assumptions can be found in Section 6.2 of the Economics Appendix. More information on all proposed reaches in the Recommended Plan with respect to the four P&G accounts is included in the next section.

The selected plan, which includes Condado Lagoon and WSJB-1B, 2, 3, 4 reaches, provides high net benefits, promotes regional economic development, and preserves health and human safety. It is also supported by the sponsor and local community and provides benefits to residents across the income spectrum.

Table 4-1.	Economic Sum	mary in AAEQ	of the Recomm	ended Plan. (FY2	21 Price level a	nd FY21Water
Resources	Discount rate (2	2.5 %).				

Recommended Plan ECONOMIC SUMMARY (FY21 price level, 50-year period of analysis, 2.5% discount rate)					
Total Average Annual Cost ²⁷	\$15.3M				
Average Annual Total Benefits	\$72.9M				
Average Annual Net Benefits	\$57.6M				
Benefit Cost Ratio (BCR) (2.5 % discount rate)	4.8				

Table 4-2. Benefits and Reduction in Damages By Reach (in thousands)²⁸.

	Condado Lagoon	WSJB-1	WSJB-2	WSJB-3	WSJB-4	Total
Total First Cost of Project	\$41,999	\$62,321	\$48,509	\$174,530	\$37,832	\$365,190
Interest During Construction	\$1,902	\$3,176	\$1,837	\$12,141	\$1,821	\$20,877
Total Economic Cost	\$43,901	\$65 <i>,</i> 497	\$50,346	\$186,671	\$39,653	\$386,068
Present Value Cost	\$46,153	\$68,812	\$53,151	\$201,610	\$41,558	\$411,284
AAEQ* Cost	\$1,627	\$2,426	\$1,874	\$7,109	\$1,465	\$14,501
Annual OMRR&R	\$130	\$105	\$197	\$305	\$82	\$819
Total AAEQ Cost	\$1,757	\$2,532	\$2,071	\$7,414	\$1,547	\$15,321
AAEQ Damage Reduction Benefits	\$1,398	\$2,479	\$9 <i>,</i> 963	\$56,201	\$2 <i>,</i> 350	\$72,391
AAEQ Recreation Benefits	\$548	\$85	\$0	\$0	\$0	\$633
AAEQ Total Benefits	\$1,946	\$2,564	\$9 <i>,</i> 963	\$56,201	\$2,350	\$73,024
AAEQ Net Benefits	\$188	\$33	\$7,892	\$48,787	\$803	\$57,703
Benefit-Cost Ratio (BCR)	1.1	1.0	4.8	7.6	1.5	4.8

Figure 4-1 shows the future damages as predicted by G2CRM (inventory of storm data sets plus intermediate sea level change scenario) in both the FWOP and FWP scenarios. Based on 100-iteration runs (50 iterations for WSJB-2 and WSJB3), the project remains extremely effective at preventing storm damages. The graph shows that benefits would be expected to begin in the year 2029. No extreme events

²⁷ Includes Interest During Construction (IDC) and OMRR&R

²⁸ Results are based on 100-iteration model runs in G2CRM. Benefits reflect storm damage reduction benefits, but have additional recreation benefits in Condado Lagoon.

FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

are causing significant damages during the projected period of analysis because the design elevations to address life safety concerns for WSJB-1, WSJB-2, and WSJB-3 are higher than the mean water levels associated with the 33.0% to 0.2% Annual Exceedance Probability (AEP) events within the model. Also, the optimized design elevations within CL and WSJB-4 are still higher than the mean water levels associated with the 33.0% to 0.2% AEP events within G2CRM. The design elevations for WSJB-1 and WSJB-2 protect almost all the damages from occurring, under the intermediate SLR curve. The design elevations for CL, WSJB-3 and WSJB-4 protect from 98%, 99%, and 99% of all of the damages intermediate SLR curve, respectively.

Table 4-3 shows economic benefits for each sea level rise scenario. These results shown that the project is still very effective across all sea level conditions.





Table 4-3. Percent Damage Reduction in FWOP compared to FWP with SLC."	Table 4-3	. Percent	Damage	Reduction	in FWOP	compared	to FWP v	with SLC. ³⁰
--	-----------	-----------	--------	-----------	---------	----------	----------	-------------------------

	LOW	INTERMEDIATE	HIGH
CL	98%	98%	94%
WSJB-1B	100%	100%	97%
WSJB-2	100%	100%	100%
WSJB-3	99%	99%	99%
WSJB-4	99%	99%	92%

²⁹ Based on 100-iteration runs (50 iterations for WSJB-2 and WSJB3).

³⁰ Based on 35-iteration model runs in G2CRM. These are estimated values based on limited model outputs.

4.2.2 BENEFITS WITH REGARD TO THE FOUR P&G ACCOUNTS AND THE P&G CRITERIA

The Recommended Plan brings benefits to the nation in all of the four P&G accounts (NED, EQ, RED, OSE), and meets the planning criteria of being complete, efficient, effective, and acceptable. Under NEPA, the NED plan has been evaluated for effects, which are described in Chapter 5. Consistent with the NEPA, USACE has formalized its commitment to the environment by creating a set of "Environmental Operating Principles" applicable to all its decision making and programs. These principles foster unity of purpose regarding environmental issues and ensure that environmental conservation and preservation, and restoration are considered in all USACE activities. These are identified and addressed specifically in Section 6.6.26 of this report.

This report qualitatively describes the impacts associated with the RED and OSE accounts to include impacts to life safety and local and regional economies and NED benefits are quantified to the fullest extent reasonably possible. This report's evaluations are in line with recent guidance from the Assistant Secretary of the Army, Civil Works (ASA(CW)), from the memorandum dated 5 January 2021, which "updates current procedures, and emphasizes and expands upon policies and guidance to ensure the USACE decision framework considers, in a comprehensive manner, the total benefits of project alternatives, including equal consideration of economic, environmental and social categories." A summary of the four P&G accounts for the Recommended Plan is presented in **Figure 4-2**. The benefits for each reach are discussed below.

Condado Lagoon: Under the NED account, the Recommended Plan, which includes an elevated living shoreline, provides important and extremely effective coastal flooding damage reduction to the dense assets, including critical infrastructure, within the Condado Lagoon area. Under the EQ account, the recommended plan in this reach will have some impacts to SAV and mangroves, but would also construct an elevated living shoreline which will add native vegetation such as mangroves to the area, creating habitat, as well as contributing to potential incidental water quality improvements to the lagoon. Under the OSE account, the recommended plan maintains life safety for residents while reducing damages, and provides a large incidental benefit in that the Recommended Plan will also reduce the frequent tidal flooding problems experienced by the communities. The plan also increases incidental recreational opportunities in the area as the elevated living shoreline can be used by the community for hiking, biking, etc. The elevated living shoreline will be constructed on the north side of the lagoon where there is currently not a sidewalk; therefore it will essentially close the loop to create a complete walking path, connecting the existing Riverwalk on the south side of the lagoon, and the existing bridge pathways on the east side of the lagoon. Under the RED account, the Recommended Plan could create a boost to the local economy through increased access to the lagoon for activities, and it ultimately provides resilience to the entire reach, allowing the communities to return to normal life sooner and with less economic impacts after an event. More specifically, in this reach, the Recommended Plan would reduce risk from an event with an approximate 0.44% annual exceedance probability and would provide approximately 98% risk reduction under the intermediate sea level rise curve, and approximately 94% risk reduction under the high sea level rise curve.

<u>WSJB 1B:</u> Under the NED account, the Recommended Plan which includes seawalls and a levee, provides extremely effective coastal flooding damage reduction to the assets within the area, including critical infrastructure. This reach is recommended for inclusion in the Recommended Plan for its ability to provide additional risk reduction benefits to the other reaches due to its unique position as a first line of defense

against flooding into the Cataño region. Under the EQ account, the plan will have some impacts to mangrove, wetland and SAV and will be mitigated as required; incidental water quality benefits could potentially be realized by the prevention of salt water into natural areas. Under the OSE account, the recommended plan maintains life safety for residents while reducing damages. It provides social cohesion, in terms of a plan to reduce risk for connected communities, for the entire West San Juan Bay area. In addition to several dense areas of residential population, the Casa Bacardi Factory is located in this reach and is an important cultural attraction and economic engine in the area for the community, representing RED. Also, under the RED account, the Recommended Plan ultimately provides resilience to the entire reach, allowing the communities to return to normal life sooner and with less economic impacts after an event. Regionally, the Casa Bacardi Factory provides benefits to tourism and the ability to recover more quickly after a storm event which would boost the economy. More specifically, in this reach, the Recommended Plan would reduce risk from an event with an approximate 0.18% annual exceedance probability and would provide close to 100% risk reduction under the intermediate sea level rise curve, and approximately 97% risk reduction under the high sea level rise curve.

<u>WSJB 2:</u> Under the NED account, the Recommended Plan which includes a discharge structure and levee (connecting to the levee in WSJB 1B), has very minimal features and associated construction compared to the other alternatives which were considered and provides extremely effective coastal flooding damage reduction to the high density of assets, including critical infrastructure, within the area. Under the EQ account, the plan will have some impacts to mangrove and wetlands and will be mitigated as required. It is important to note that due to the minimal features, impacts to a larger degree were avoided and minimized in this reach. The plan could also provide incidental water quality improvements to the freshwater wetlands located in the area. Under the OSE account, the recommended plan maintains life safety for residents while reducing damages and provides social cohesion for the entire West San Jun Bay area. Under the RED account, the Recommended Plan ultimately provides resilience to the entire reach, allowing the communities to return to normal life sooner and with less economic impacts after an event.

More specifically, in this reach, the Recommended Plan would reduce risk from an event with an approximate 0.18% annual exceedance probability and would provide close to 100% risk reduction under the intermediate sea level rise curve, and close to 100% risk reduction under the high sea level rise curve.

<u>WSJB 3</u>: Under the NED account, the Recommended Plan which includes a breakwater and seawalls/floodwalls provides extremely effective coastal flooding damage reduction and wave action reduction to the high density of assets, including critical infrastructure, within the area. Under the EQ account, the plan will have some impacts to mangrove and SAV and will be mitigated as required. The breakwater could potentially support mangroves and provide foraging habitat for fish on the landward side. Under the OSE account, the recommended plan maintains life safety for residents while reducing damages, allows continued access and gathering along the important Cataño shoreline gathering area, and provides social cohesion for the entire West San Jun Bay area. The breakwater also provides the function to allow the seawall to be less tall than it would be without a breakwater, which helps to reduce effects to the viewshed and to increase public acceptability. Under the RED account, the Recommended Plan ultimately provides resilience to the entire reach, allowing the communities to return to normal life sooner and with less economic impacts after an event. More specifically, in this reach, the Recommended Plan would reduce risk from an event with an approximate 0.18% annual exceedance probability and would provide approximately 99% risk reduction under the intermediate sea level rise curve, and approximately 99% risk reduction under the high sea level rise curve.

<u>WSJB 4</u>: Under the NED account, the Recommended Plan which includes floodwalls and a levee provides extremely effective coastal flooding damage reduction and wave action reduction to the assets, including critical infrastructure, within the area. Under the EQ account, the plan will have some impacts to

mangrove and wetlands and will be mitigated as required. Under the OSE account, the recommended plan maintains life safety for residents while reducing damages and provides social cohesion for the entire West San Jun Bay area. Under the RED account, the Recommended Plan ultimately provides resilience to the entire reach, allowing the communities to return to normal life sooner and with less economic impacts after an event. More specifically, in this reach, the Recommended Plan would reduce risk from an event with an approximate 0.24% annual exceedance probability and would provide approximately 99% risk reduction under the intermediate sea level rise curve, and approximately 92% risk reduction under the high sea level rise curve.



Figure 4-2. Summary of Evaluations Under the Four P&G Accounts.

4.3 PROJECT DESIGN - CONCEPTUAL DETAILS OF THE RECOMMENDED PLAN BY PLANNING REACH

Designs and assumptions described below are at a 10% level of design and are at a conceptual level only. The PED phase (which occurs after the feasibility phase is complete) would refine design to get to 100% level for construction. In this phase, floodwalls and seawalls were further delineated in reaches. Appendix A, Engineering, provides a detailed account of the modeling, assumptions, and analysis that led to the design of the Recommended Plan. The following discussions represent summaries of the key aspects of the Recommended Plan in each reach.

4.3.1 CONDADO LAGOON (CL-1)

In this reach, an elevated living shoreline will be constructed on the northern shoreline of the lagoon, shown in the graphic overview and in Figure 4-3. The elevated living shoreline will consist of three berms, with the first berm set to the specified design elevation and a top width of 10 ft and the slopes will range from 1V:2.5H to 1V:3H.The second berm will be set to an elevation of 1 ft-PRVD02 and maintain a berm width of 3 feet to support various vegetative species like marsh grass. The third berm will be set to an elevation of -1 ft-PRVD02 and contain a berm width of 3 feet. The toe protection will consist of two layers of armor stone between the second and third berm, including the third berm top width. The toe protection will consist of a D_{n50} of 1-ft and a unit weight of 160 lb/ft³. A sediment tube (1 ft diameter) surrounded by filter fabric will be placed within the center of the toe protection to support mangrove plantings to help stabilize the toe of the berm.

The elevated living shoreline was optimized to an elevation of 7.5 ft PRVD02, which is based on the risk associated with the mean storm event, in this case approximately a 0.44% annual exceedance probability (AEP) event, with 90% confidence interval (CI). Further optimizations to the design elevation could occur during PED, if necessary. This plan accounts for inland drainage by using both culverts and pumps. A key inland hydrology feature consisting of a pump and culvert will be placed within the eastern side of the area to assist with the outflow of rainfall at the lowest elevation region within the area. Smaller culverts will be placed at various intervals to allow rainfall runoff drainage through the elevated living shoreline. Crushed limestone will be placed on the 10 ft wide berm to facilitate access to operation and maintenance vehicles as well as provide incidental recreation opportunities for the community. Height and width from a community and environmental standpoint can be found in the cross-section depiction shown in **Figure 4-4.** There are no anticipated impacts to recreational facilities in the area. Refer to **Section 5.8 of Appendix A, Engineering,** for construction techniques regarding potential settlement and liquefaction to achieve the design elevation.



Figure 4-3. Living Shoreline in Condado Lagoon.



Figure 4-4. Elevated Living Shoreline Cross-section.

4.3.2 WEST SAN JUAN BAY 1B (WSJB-1B)

In this reach, a seawall and levee will be constructed along the eastern and western shorelines, as shown in the graphic overview and **Figure 4-5**. A levee (**Figure 4-6**) is proposed along the western side of the area. Additionally, the study assumed a top width of 12-ft to maintain vehicle access to the levees. Crushed limestone will be placed on the top of the 12 ft wide levee to facilitate access to operation and maintenance vehicles as well as provide incidental recreation opportunities for the community. There are no anticipated impacts to recreational facilities in the area.

The seawalls have been designed to be a steel cantilever sheetpile and will be driven approximately to -37 feet (PRVD02). The seawalls are designed to 9 ft-PRVD02, to better reduce the risk of overtopping during approximately a 0.18 % AEP event (with 90% assurance), as well as match the design elevation within WSJB-2 and WSJB-3. Additionally, the alignments of some of the seawalls were pushed landward whenever enough real estate existed to do so in order to reduce construction costs. Typical cross-sections of landward and seaward seawalls are shown in Figure 4-5 and Figure 4-6. To maintain the current public accessibility and viewshed, the team has included accessibility over or through the seawalls, at various locations, through a combination of walkovers and or deployable storm surge barriers for the landward seawalls. The seaward seawalls will contain back-fill on the landward side of the structure to provide access to the top of the structure. All landward seawalls will be encased with concrete; all seaward seawalls will contain a 2 ft by 2 ft concrete cap with epoxy coating on the seaward side and backfill on the landward side. There are no anticipated impacts to recreational facilities in the area. Further optimizations to the design elevation could occur during PED, if necessary. Culverts will be placed at various intervals to allow rainfall runoff drainage through the seawalls and levee. Refer to Section 5.8 of Appendix A, Engineering, for construction techniques regarding potential settlement and liquefaction to achieve the desired design elevation.




Figure 4-6. Typical Levee.



San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT









San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

4.3.3 WEST SAN JUAN BAY 2 (WSJB-2)

In this reach, a discharge structure will be constructed as shown in the graphic overview and Figure 4-9 to extend approximately 50-ft across the Malaria Canal. It will consist of a large box culvert with flap gates and pump stations. The existing sluice gate, pump station and weir feature (owned and operated by DNER) will be removed as they are no longer functional. The team designed the capacity to include three 50 cubic feet per second (CFS) pumps and two 100 CFS pump. The western side of the area will be protected by a levee (Figure 4-6, previous section). Additionally, the study assumed a top width of 12-ft to maintain vehicle access to the levees. Crushed limestone will be placed on the top of the 12 ft wide levee to facilitate access to operation and maintenance vehicles as well as provide incidental recreation opportunities for the community. There are no anticipated impacts to recreational facilities in the area. The feature was designed to an elevation of 9 ft-PRVD02, to better reduce the risk of overtopping during approximately a 0.18 % AEP event (with 90% assurance), to match the chosen design elevations within WSJB-1B and WSJB-3, as well as balance the economic justification, public acceptability, and risk associated with life safety. As a result of design refinement during this stage, the small seawall which was originally proposed as a part of this alternative to tie in the box culvert to high ground was not needed. Further optimizations to the design elevation could occur during PED, if necessary. Culverts will be placed at intervals to allow rainfall runoff drainage through the levee. Refer to Section 5.8 of Appendix A, Engineering, for construction techniques regarding potential settlement and liquefaction to achieve the desired design elevation with specific features.



Figure 4-9. Discharge Structure and Levee in West San Juan Bay 2.

4.3.4 WEST SAN JUAN BAY 3 (WJSB-3)

This reach will include a segmented rock breakwater to reduce the risk of wave action along the Cataño shoreline from the incoming wave action, and a floodwall/seawall in various locations to reduce the risk of coastal flooding, as shown in the **graphic overview (Executive Summary)** and **Figure 4-10** and **Figure 4-11**.

The breakwaters **(Figure 4-12)** are approximately 656 ft (200 m) offshore with a crest elevation of +6 ft-PRVD02 and located at an average existing elevation of -11.6 ft-PRVD02. Each breakwater is 328 ft (100 m) long at the crest and between each breakwater there will be a 164-foot (50 m) gap width at the base. The top width of each will be 10 ft with an approximate base width of 80 ft. An approximate slope of 1V:2.5H will be used and a 10- to 12-inch marine mattress will be placed at the base of each breakwater. The armor stone will have an average nominal diameter (Dn50) of approximately 3.0-ft with a unit weight of 160 lb/ft3 (approximately 2 ton armor stone). The breakwater will consist of 2 layers of armor stone on top of underlayer stone.

The recommended plan proposes to construct a seawall along the northern and eastern shoreline. Access to the water along the shoreline for would be maintained through gaps in the floodwall, where deployable floodwalls would be used. Some boat docks in La Puntilla could be impacted; the configuration of the floodwall will be further evaluated in PED to avoid impacts as much as possible. Although relocations of public facilities such as boat docks and boardwalks are not currently anticipated or identified, a more detailed analysis will be conducted during PED.

The design height of the seawalls and floodwalls in this reach was changed to 9 ft-PRVD02 to better reduce the risk of overtopping during an approximate 0.18 % AEP event (with 90% assurance), as well as match the design elevation within WSJB-1B and WSJB-2. Further optimizations to the design elevation could occur during PED, if necessary.

A seawall with king piles³¹, referred to as a king pile seawall in this report, will be constructed along the northern shoreline of WSJB-3 as a more robust seawall, given the geology in the area. Additionally, cantilever sheetpile seawalls will be constructed at locations that have insufficient real estate to cost effectively construct a T-Wall floodwall.

The typical sheetpile seawall will be driven to approximately -50 ft (PRVD02), and could vary slightly based on soil characteristics in different locations. Typical cross-sections of landward and seaward seawalls are shown in **Figure 4-7 and Figure 4-8**. To maintain the current public accessibility and viewshed, the plan includes accessibility over or through the seawalls, at various locations, through a combination of walkovers and or deployable storm surge barriers for the landward seawalls. The seaward seawalls will contain back-fill on the landward side of the structure to provide access to the top of the structure. All landward seawalls will be encased with concrete; all seaward seawalls will contain a 2 ft by 2 ft concrete cap with epoxy coating on the seaward side and backfill on the landward side. The toe protection has a D_{n50}^{32} of approximately 2 feet and a unit weight of 160 lb/ft³.

³¹ A pile which provides added support for a sheet steel pile

 $^{^{32}\}mathsf{D}_{n50}$ represents the average nominal diameter of the stone.

The configuration of the southeastern portion of WSJB-3 was re-aligned after Puma Energy provided feedback on the existing Puma Energy oil line in the area. To avoid negatively impacting the Puma Energy oil line the team altered the alternative to a more landward location and modified the structures to a combination of king pile seawalls and T-Wall floodwalls. The T-Wall floodwall **(Figure 4-13)** will consist of two piles spaced approximately 10 ft along the centerline of the wall with a total pile length of approximately 50 feet.

Overall, these modifications reduce risk to life safety and the potential for soil liquefaction, while remaining cognizant of public concern regarding excessive height along viewsheds.

This design accounts for inland drainage by using both culverts and pumps. Culverts will be placed at various intervals to allow rainfall runoff drainage along the seawalls and floodwalls. Pumps will be placed within the eastern side of the area to assist with the outflow of rainfall at the lowest elevation region within the area.

Refer to **Section 5.8 of Appendix A, Engineering,** for construction techniques regarding potential settlement and liquefaction to achieve the desired design elevation with specific features.



Figure 4-10. Seawall/Floodwall and Breakwater in West San Juan Bay 3.

Figure 4-11. Seawall and Breakwater.



San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT





Figure 4-13. Typical T-wall Floodwall.



4.3.5 WEST SAN JUAN BAY 4 (WSJB-4)

In this reach, a T-wall floodwall will be constructed as shown in earlier in **Figure 4-13**, as well as the **graphic overview (Executive Summary)** and **Figure 4-14** below. At the central location of the area there is an existing king pile seawall that runs along both sides of the Bechara Canal, from the USACE Rio Puerto Nuevo project. Due to limited real estate around the existing seawall there is insufficient room to place a T-Wall, therefore the team designed a concrete cap extension from the existing seawall to the appropriate design elevation. The team refined the alternative within the northeast region of the area to T-Wall with

a combination of micro-piles or standard H-piles. The micro-piles will be used under the Kennedy Bridge location due to the limited head room under the bridge, while the remaining T-Wall will contain previously assumed H-piles.

A levee will also be constructed in the location as shown. The floodwall and levee are designed to 8.5 ft-PRVD02, to better reduce the risk of overtopping during approximately a 0.24% AEP event (with 90% assurance), as well as tie into existing high ground in the area. Further optimizations to the design elevation could occur during PED, if necessary. Crushed limestone will be placed on the top of the 12 ft wide levee to facilitate access to operation and maintenance vehicles as well as provide incidental recreation opportunities for the community. Additionally, a top width of 12-ft is assumed to maintain vehicle access to the levee and will be available for public use for walking, hiking, etc. There are no anticipated impacts to recreational facilities in the area.



Figure 4-14. Floodwall + Levee in West San Juan Bay 4.



4.3.6 RECREATION

Existing recreational facilities in the area will not be impacted. The elevated living shoreline and levees will incorporate access steps at intervals for operation and maintenance purposes, which the community would be able to also use for incidental recreation opportunities. The crests of the levees and elevated living shorelines will include crushed limestone, which communities will be able to use for hiking, walking, etc. The design has incorporated access through or around floodwalls/seawalls at key intervals with temporary deployable floodwalls in some areas to ensure public access to the water and existing community facilities. As a note, the activities anticipated for incidental recreation are compatible with the feature functions. The features would be built to O&M standards (ie: maintenance vehicle driving on the crest, etc) and therefore the incidental recreational activities as described would not compromise the sustainability of the feature or its storm reduction function.

4.3.7 PROJECT CONSTRUCTION

Project construction is assumed to begin in 2024 and take approximately 5 years, assuming concurrent construction crews in various locations. Current construction timeframe estimates are as follows:

- 1. Condado Lagoon: 2.25 years
- 2. WSJB 1B: 3 years
- 3. WSJB 2: 2.3 years
- 4. WSJB 3: Two separate contracts: Seawall/Floodwall (4.5 years) and Breakwater (3 years)
- 5. WSJB 4: 2 years

4.3.8 PROJECT MITIGATION

Although the NED plan was formulated to avoid and minimize impacts to every extent possible, impacts are expected to occur and will be addressed with mitigation. Effects and impacts, including unavoidable impacts, are evaluated further in **Chapter 5**. Estimated mitigation acreages to be constructed for unavoidable impacts and mitigation siting is addressed in the preliminary mitigation plan in Appendix F, **Environmental, Attachment 4**, It is anticipated that the mitigation can be constructed close by and proposed locations are mapped and discussed in the preliminary mitigation plan. However, the final siting of compensatory mitigation will be conducted during the PED Phase of the project when site-specific survey data is available to assess existing conditions, hydrology, water quality, and presence of protected species. In addition, upon final design, the functional lift provided by the Recommended Plan will be incorporated into the functional assessment and mitigation plan. A bathymetric survey will be conducted prior to in-water work to assess water depths and bottom conditions in the project area. The limits of existing resources will be identified prior to implementation to ensure the estimated acreages and functional analysis are accurate. Wherever feasible, mitigation sites (if needed) will be within approximately five miles of the impact site to offset impacts as close as possible to the site. For instance, there is opportunity to enhance the degraded palustrine wetlands adjacent the MCC as discussed in Section 2.3 of this report.

The project cost includes both mitigation estimates and monitoring costs for 5 years after initial construction. The preliminary mitigation construction cost estimate is \$9,531,000 and is based on the preliminary impact estimates which used best available habitat data overlaid with the recommended plan footprints to develop an estimated acreage of impacts. That acreage was then multiplied by unit costs per acre for each habitat type developed from previously constructed mitigation projects within the Jacksonville District. An additional \$7,986,000 was estimated for Monitoring and Adaptive Management including contingency. These mitigation costs are considered low-risk conservative estimates with project contingency covering any potential differences. The mitigation cost would be reinvestigated during the PED Phase of the project.

4.3.9 OPERATIONS AND MAINTENANCE CONSIDERATIONS

Operation and Maintenance (also known as Operation, Maintenance, Repair, Replacement, Rehabilitation, or OMRR&R) includes all activities which are not related to the initial construction, and are borne 100% by the non-federal sponsor, as the non-federal sponsor will have the primary responsibility for operating and maintaining the project. The monitoring and inspection procedures for the constructed

project will be written in an (OMRR&R) Manual and provided to the non-federal sponsor prior to completion of construction. More information can be found in **Appendix A, Engineering, Section 6.5.**

Operations and maintenance costs for the Recommended Plan were based on costs for similar existing structures for labor and materials to perform yearly inspections/tests of pump stations, floodwall street closures, storm surge barriers, small repairs, and potentially replacing gates or equipment during the 50-year period of analysis. Costs were then adjusted based on the length, type of measure, and additional labor/material costs as deemed necessary for different structural measures. After computation of the total costs, they were annualized using the FY2021 discount rate of 2.50% for a 50-year period of analysis. The annual average costs for OMRR&R are estimated to be \$819,000 per year over a 50-year period of analysis. A summary of OMRR&R activities can be found in **Table 4-4**.

Measure	Frequency	Action
	Yearly	Routine Inspections
	Every 5 Years	Periodic Inspections
Standard Levee and Living Shoreline	Yearly or as needed	Debris and unwanted vegetation growth needs to be removed from the levee and areas protected by riprap Vegetation monitoring and replacement Repair animal burrows Add additional riprap to toe of levee, if displaced due to storm Periodic surveys to monitor for possible settlement
Breakwaters	1 to 5 years	Routine and Periodic Inspections Debris Removal
Inland Hydrology (culverts)	1	Routine and Periodic Inspection Culvert repair or replacement of flap gate controls Clear Culverts of debris accumulation
Inland Hydrology (pumps)	1-5 years	Routine and Periodic Inspection Field Operations Costs, including Operation and maintenance of mechanical and electrical components
Floodwall/Seawall	1-5 years	Routine and Periodic Inspection Reapplication of Epoxy Coating Inspection and repairs to toe protection Repairs to concrete facing Regular maintenance and operation of flood control barriers

Table 4-4. OMRR&R Summary.

4.4 PRE-CONSTRUCTION, ENGINEERING & DESIGN (PED) CONSIDERATIONS

During PED, design refinements will be conducted for all planned structural elements based on new field investigations and analyses. The following sections summarize information and field investigations will be needed to achieve a final design. Additional details can be found in **Appendix A, Engineering, Section 7.**

4.4.1 UPDATED SURVEYS

It is recommended that topographic and/or bathymetric surveys be performed during PED in areas where structural measures are proposed. New surveys may determine an adjustment to the proposed height and/or length of structures is necessary. All elevations within the alternative designs are based off elevations from the digital elevation model (DEM), which is based off data from 2018 or older. A more recent and comprehensive topographic and hydrographic survey will be required in order to develop plans and specifications.

4.4.2 GEOTECHNICAL INFORMATION

Seismic activity is well documented in Puerto Rico and as such, seismic considerations will be incorporated in the final design of the Recommended Plan features. During PED, a site-specific seismic study will be performed. Additionally, robust subsurface exploration should be conducted to include additional borings, lab tests, and geophysical exploration. More information can be found in Engineering Appendix A, Section 4.6 Seismic Considerations and Section 5.4 Geologic Investigations.

4.4.3 FLOODWALL/SEAWALL DESIGN REFINEMENT

During the PED phase, subsurface explorations will be conducted along seawall alignments to supplement the existing information. **Appendix A, Engineering**, can be referenced for additional details. Information from all subsurface explorations will be used to develop site-specific subsurface cross sections and refine the floodwall/seawall designs, if necessary. These data will supplement additional design calculations, including but not limited to axial and lateral load capacity, settlement, footing uplift pressure, and depth driven of piles/sheetpiles. Findings from these analyses could result in changes to the assumed embedment depth of the piles (shorter or longer). Additionally, it is recommended to further analyze the wave conditions adjacent to each model area to potentially refine the rock size within alternatives that include toe protection and/or breakwaters. The apron width and height may be subject to change following this analysis as well. The wave analysis will also be used to determine if additional rock revetment should be designed to reduce potential wave reflection towards other areas within San Juan Harbor. The crest elevation of the system will be reevaluated during PED to consider the latest information on the total water level, waves, and SLC per the ER 1105-2-101 guidance on risk-based design. Additionally, locations along the proposed seawalls may need refinement where existing boat ramps and/or marinas are located to maintain public accessibility to the waterfront.

4.4.4 BREAKWATER DESIGN REFINEMENT

During the PED phase, additional analysis will be performed to optimize final location and design of the breakwaters.

4.4.5 INLAND HYDROLOGY ANALYSIS REFINEMENT

During the PED phase, the team will refine the interior drainage analysis to optimize design measures for interior drainage relief. The analysis will entail the use of the HEC-HMS (Hydrologic Engineering Center – Hydrologic Modelling System) software version 4.3 or the latest model available with the guidance of Engineering Manual 1110-2-1413. Rainfall frequencies ranging from the 2-year to 500-year 24-hour point rainfall from NOAA Atlas 14 will be used as the input.

4.4.6 ALIGNMENT & EASEMENTS

During the PED Phase, more information and data will be collected, including real estate information. Real estate requirements for the study area consist of Fee, Channel Improvement Easement, Flood Protection Levee Easement, Temporary Work Area Easement, and Road Easement. These easements are necessary to provide adequate construction room to build proposed flood risk management features and secure lands needed for Operations and Maintenance (O&M). Additionally, the team created preliminary staging areas, although additional refinement to the exact acreage and location will be refined in PED. More information on easements and real estate requirements can be found in the **Appendix D, Real Estate** of this report.

4.5 SEA LEVEL CHANGE CONSIDERATIONS

The total regional sea level rise predicted by the three scenarios (low, intermediate, and high) will have a significant impact to the San Juan Metro area. Potential impacts of rising sea level include overtopping of waterside structures, and flooding of low-lying areas. Sea level change will further exacerbate the problem of inundation due to storm surge and tidal impacts to the study area for the Future Without-Project condition. The intermediate sea level rise scenario was selected as a basis for the feasibility level of design. The increase in water level due to sea level rise is reflected as an increase in the design elevation of hard structures such as levees, floodwall, and seawalls. Additionally, associated measures such as pump stations and culverts have been incorporated into the design to help facilitate the proper discharge of the hydrologic runoff during elevated sea levels due to storm surge and sea level rise. Under the low or intermediate sea level change scenarios, within the 100-year adaptation horizon, no adaptation measures are anticipated for the recommended plan. Under the high sea level rise scenario, adaptation could be evaluated with adaptation being defined as either adapt, rebuild, and/or retreat, depending on the proposed feature. Adaptation triggers and considerations can be found in **Appendix A, Engineering, Section 6.5.1**.

4.6 LANDS, EASEMENTS, RIGHTS OF WAY, RELOCATION AND DISPOSAL AREAS (LERRDS)

This section is a summary of Appendix D, Real Estate, and describes the lands, easements, rights of way, relocation, and disposal areas (LERRD) anticipated, identified or estimated at this time, that appear to be required for construction, operation and maintenance of the proposed project; including estimated acreage, estates, ownerships, and preliminarily and roughly estimated values and identified assumptions. The non-federal sponsor shall provide LERRD.

The following Real estate requirements are necessary to provide adequate construction room to build the proposed coastal storm risk management features and secure lands needed for Operations and Maintenance (O&M):

- **Floodwall and Seawall:** Approximately 13.80 acres of land will need to be acquired as a Flood Protection Levee Easement by the non-federal sponsor.
- **King Pile Seawall (WSJB-3):** Approximately 1.29 acres will need to be acquired as a Flood Protection Levee Easement by the non-federal sponsor.

- Levee: Approximately 25.66 acres of uplands will need to be acquired as a Flood Protection Levee Easements by the non-federal sponsor.
- Inland Hydrology/Outflow Structures: Location will be determined during PED phase, but these features are expected to be within the channel (culverts) and private lands (pump stations). Therefore, 1.01 acres of land for pump stations will need to be acquired in Fee by the non-federal sponsor.
- **Breakwaters:** Approximately 10.68 acres would be used, and would be located within submerged lands managed by the non-Federal Sponsor. No lands will need to be acquired by the non-federal sponsor.
- Elevated Living Shoreline: This feature would use approximately 7 acres of land, which would be constructed within the Maritime Terrestrial Zone. Elevated Living Shoreline feature will be constructed within the Maritime Terrestrial Zone (MTZ), which is administered by the NFS through PR Law 23, Art.5(h). Therefore, lands would not need to be acquired by the non-Federal sponsor. Therefore, lands would not need to be acquired by the non-federal sponsor.
- Staging Areas: Staging and storage areas have been identified for every reach of the project. Total area consists of 16.90 acres. Lands will need to be acquired as Temporary Work Area Easement by the non-federal sponsor.
- **Disposal:** All actions related to disposal during construction will be accomplished by Contractor. Once the Contractor selects a site, it will be approved by the Contracting Officer prior to disposal. Land acquisition is not required by the non-federal sponsor.
- **Mitigation:** Mitigation areas are anticipated to be used as remediation for projects impacts. Location and area needed will be finalized during the design phase. Lands will be needed to be acquired in Fee by the non-Federal sponsor.
- **Road Access:** Road access would be mainly over public roads and highways. However, in WSJB 4, access to a staging area will be needed over private land. Total area consists of 1.96 acres. Land will be needed to be acquired as a Temporary Road Easement by the non-federal sponsor.
- **Operation and Maintenance:** After construction is completed, operation and maintenance of the project features would be conducted within the public domain lands. No additional real estate is expected to be required for operation and maintenance.

ESTATES REQUIRED

If a property must be acquired for the project, the non-federal sponsor will need to acquire all needed property rights and interest up to and including fee acquisitions. Most of the structural measures for the storm surge wall will require perpetual and temporary construction easements. Some properties would require fee acquisitions due to the amount of land and building remaining after the taking, leaving an uneconomic remnant. The non-federal and Federal administrative costs associated with obtaining all real estate is included in the Administrative Review.

4.7 RECOMMENDED PLAN COST

The project first cost is currently estimated to be \$365.2M (including a risk-based contingency³³). Project construction is assumed to begin in 2024 and take approximately 5 years, assuming concurrent construction crews in various locations. **Appendix B, Cost** provides additional detail.

WBS Code	Item	Total Project First Cost (FY21)
06	Fish & Wildlife Facilities ³⁴	\$9,531,000
09	Channels and Canals	\$613,000
10	Breakwaters & Seawalls	\$88,900,000
11	Levees & Floodwalls	\$103,804,000
13	Pumping Plant	\$40,369,000
15	Floodway Control & Diversion Structures	\$22,950,000
01	Lands and Damages	\$28,881,000
30	Preconstruction, Engineering and Design (PED) ³⁵	\$39,659,000
30	Real Estate Administration Cost (Fed)	\$3,051,000
30	Real Estate Administration Cost (non-fed)	\$4,542,000
31	Construction Management	\$22,890,000
	Project First Cost	\$365,190,000

Table 4-5. Recommended Plan Cost Summary (Project First Cost, FY21 Price Levels).

4.8 RECOMMENDED PLAN COST SHARING

Based on Fiscal Year 2021 (October 1, 2020 price levels), the estimated total project first cost of the Recommended Plan is \$365,190,000. In accordance with the cost sharing provisions of Section 103 of WRDA 1986, as amended, the non-federal sponsor must contribute a minimum of 35 percent of construction costs. The remaining portion of the non-federal share can be provided in lands, easements, rights-of-way, relocations and dredged or excavated material disposal areas; in-kind contributions; cash; or a combination. The estimated share of costs is adjusted based on Section 1156 of WRDA 1986, as amended (33 USC 2310), which provides a waiver for a portion of non-federal cost sharing for Puerto Rico, Territories, and Indian Tribes. As a result, the non-federal share would be reduced by \$511,000 and the federal and non-federal shares of construction costs would be \$237,885,000 and \$127,306,000, respectively. The non-federal costs include the value of lands, easements, rights-of-way, relocations and

³³ The contingency for construction, pre-construction engineering & design, and supervision & administration (S&A) is 37%; real estate contingency is 30%.

³⁴ "Fish and Wildlife Facilities" includes all estimated mitigation costs that may be required as a result of impacts to submerged aquatic vegetation (SAV), mangroves, and freshwater wetlands.

³⁵The 30 account includes an estimate for cultural resource surveys to be conducted during PED. Based on current information, experience, investigations, and methods to avoid mitigation, there is a low likelihood of requiring mitigation for historic properties and therefore costs for mitigation of historic properties have not been assigned to the 18 account.

FINAL INTEGRATED FEASIBIILITY REPORT AND ENVIRONMENTAL ASSESSMENT

disposal areas (LERRD) which are estimated at \$33,400,000.

Item	Federal Share	Federal Cost	Non- federal Share	Non-federal Cost	Project First Cost
Project First Cost	65%	\$237,374,000	35%	\$127,817,000	\$365,190,000
LERRD Credit ³⁶				\$33,400,000	
Section 1032 of WRRDA 14 Waiver		\$511,000		(\$511,000)	
Adjusted Cost Share ³⁷		\$237,885,000		\$127,306,000	
Non-Fed Cash Contribution ³⁸				\$93,906,000	

 Table 4-6. Recommended Plan Cost Allocation (Project First Cost, FY21 Price Levels).

4.9 FINANCIAL ANALYSIS OF NON-FEDERAL SPONSOR'S CAPABILITIES

A financial analysis used to be required for any plan being considered for USACE implementation that involves non-federal cost sharing. By memorandum dated April 24, 2007, the Assistant Secretary of the Army (Civil Works), granted approval of the self-certification of non-federal sponsors for their ability to pay the non-federal share of projects. The self-certification was received by Department of Natural and Environmental Resources (DNER) on October 27, 2020.

4.10 VIEWS OF THE NON-FEDERAL SPONSOR

The DNER is the non-federal sponsor for this study. They have been an integral part of the study team throughout the feasibility study process. DNER supports the Recommended Plan. A letter of support was received on October 27, 2020 and is located in **Appendix G, Pertinent Correspondence**.

4.10.1RESILIENCY

The second objective of this study speaks to resilience. In EP 1100-1-2 USACE Resilience Initiative Roadmap 16 Oct 17, USACE has identified four key principles of resilience from the many definitions of resilience that exist. These principles – Prepare, Absorb, Recover, and Adapt – exemplify the temporal aspects and actions that are inherent to the process of building community resilience capacity.

Prepare: The report communicates the results of analyses, which will help communities anticipate future coastal flooding elevations with sea level rise.

 ³⁶ This includes Lands, Easements, Relocations, Right-of-Way, Disposal (LERRD) plus non-federal administrative costs.
 ³⁷ Cost share is adjusted in the amount of \$511,000 per Section 1156 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2310).

³⁸ Cost share cash contribution when both adjustments for \$511,000 per Section 1156 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2310), and LERRD credit, are applied.

Absorb: The Recommended Plan offers solutions that will reduce between 98-100% of damages, meaning fewer damages for the communities to absorb.

Recover: The Recommended Plan reduces damages, and also reduces the risk to safety of the communities during coastal flooding events through features that will reduce the risk of flooding in roads and safety problems that can arise from standing water, and allowing quicker recovery before, during and after storms.

Adapt: This report offers recommendations for monitoring to inform when adaptations to features in the Recommended Plan may need to occur and to what extent. The ability of the project to adapt into the future was assessed through the analysis of varying rates of sea level rise as well as an assessment of project performance out to 2129. The USACE Climate Change Adaptation Goal is to minimize impacts from climate change and maximize resiliency in the coastal landscape. The current 10% structural design of the San Juan Metro Area project takes into consideration the effects of sea level rise as part of the design (i.e., heights of walls). The Recommended Plan design takes into consideration how and if the design can adapt to the effects of sea level rise and climate change 100 years after the project is constructed and what adjustments can be made to the design to assure that the project can adapt into the future.

4.11 CONSISTENCY WITH SACS

The South Atlantic Coastal Study (SACS) is underway and provides a risk management framework designed to help local communities in the South Atlantic region of the United States better understand changing flood risks associated with climate change and to provide tools to help those communities better prepare for future flood risks. In particular, it encourages planning for resilient coastal communities that incorporates wherever possible sustainable coastal landscape systems that take into account future sea level and climate change scenarios.

The San Juan Metro Area CSRM study echoes the principles of the SACS, considering the entire area as a system, and focuses on solutions in one of the high risk areas noted under SACS. The San Juan Metro Area CSRM feasibility study team has been able to leverage information from SACS. The study used the SACS Tier 1 Risk Assessment Viewer to verify social vulnerability within high storm surge risk areas; additionally, SACS data (ADCIRC/STWAVE) were used to generate hydrology data to identify storm surge risk. The San Juan Metro Area CSRM developed parametric costs which were shared with SACS for future holistic parametric costs; the San Juan Metro Area CSRM Recommended Plan will be referenced in SACS. SACS, and the feasibility studies which overlap it, including the San Juan Metro Area CSRM study, will continue to share and leverage information from one another.

4.12 FEDERAL IMPLEMENTATION RESPONSIBILITIES

USACE is responsible for budgeting for the Federal share of future Federal construction projects. Federal funding is subject to budgetary constraints inherent in the formation of the national civil works budget in a given fiscal year. USACE would perform the necessary preconstruction engineering and design (PED) needed prior to construction and would follow the items of local cooperation as outlined in Chapter 7. Cost sharing of PED and initial construction will be in accordance with WRDA 1986, as amended, subject to the availability of appropriations.

4.13 NON-FEDERAL IMPLEMENTATION RESPONSIBILITIES

The non-federal sponsor for the CSRM project will be DNER. A list of items of local cooperation are included in **Chapter 7, Recommendations.** The non-federal sponsor shall provide lands, easements, and rights-of-way and bear a portion of the administrative costs associated with land requirements. The non-federal project sponsor will be responsible for all costs of operation, maintenance, repair, rehabilitation, and replacement of project features. Section 402 of the 1986 Water Resources Development Act, as amended (33 USC 701b-12), states that "Before construction of any project for local flood protection, or any project for hurricane or storm damage reduction, that involves Federal assistance from the Secretary, the non-federal interest shall agree to participate in and comply with applicable Federal floodplain management and flood insurance programs." The non-federal sponsor and communities must be enrolled in, and in compliance with, the National Flood Insurance Program (NFIP) to receive Federal funding for a recommended storm damage reduction project.

The PR Planning Board (PRPB) runs the National Flood Insurance Program in PR, and manages all PR riverine and coastal flood plains through PRPB Regulation 13. The non-federal sponsor and communities must be enrolled in, and in compliance with, the National Flood Insurance Program (NFIP) to be eligible for Federal cost-sharing of a recommended coastal storm risk reduction project. Under the PR Planning Board, DNER and communities are enrolled in the NFIP and are in compliance with this regulation.

4.14 RISK AND UNCERTAINTY

Risk and uncertainty is inherent within the feasibility phase during planning, and has been addressed and managed in several ways during the process.

<u>Engineering</u>: A Qualitative Risk Assessment (QRA) was conducted to ensure life safety guidelines were met. The analysis factored heavily into plan formulation and led to selection of the Recommended Plan as presented.

Due to lack of existing information and subsequent risk and uncertainty regarding the geotechnical properties in the study area, geotechnical boring logs were completed in October 2020. The information from those surveys allowed refinement of design and assumptions to account for more accurate soil properties and reduce risk.

Interior drainage calculations were computed using the Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS). The U.S. Army Corps of Engineers HEC-HMS version 4.3 software was developed by the Hydrologic Engineering Center to simulate the hydrologic precipitation-runoff relationship in dendritic watersheds. HEC-HMS was used to simulate the upland watersheds of the San Juan Metro area to estimate runoff volumes and flow hydrographs for use in the feasibility level design of interior drainage structures. This analysis was performed to ensure that for each project alternative, appropriate interior drainage components were identified to handle residual flooding due to the proposed project features. The level of detail provided is commensurate with the study purpose and other technical elements as described in EM 1110-2-1413, Hydrologic Analysis of Interior Areas.

The rate of sea level change under low, intermediate and high curves is calculated in this study using best available data and trend analysis. However, the actual sea level change rate which will occur is uncertain. The design accounts for this uncertainty both in design height, and with adaptation triggers, which should

be monitored and evaluated after the project is constructed. These considerations are discussed in **Appendix A, Engineering, Section 6.4.1.**

Additional surveys and analysis are recommended during PED to continue to reduce risk and uncertainty prior to project construction. These are described further in **Appendix A, Engineering, Section 6.2**.

<u>Economic Modeling:</u> G2CRM incorporates risk and uncertainty to determine an optimized plan under many future scenarios. There is some uncertainty in the population data as the sources used to collect the information were not up to date. The structure inventory was compiled using virtual databases and Google Earth; data used may not be up to date to include new structures, vacant buildings and lots or correct occupancy types. There is some uncertainty when accounting for repetitive damages in the model. Assumptions were used based on observed human behavior within these communities. More information on model assumptions and uncertainties can be found in **Appendix C, Economics**.

<u>Environmental Mitigation</u>: There is some uncertainty in terms of the quantity and siting of onsite compensatory mitigation which would be conducted during the PED Phase of the project when site-specific survey data is available. Upon final design, the functional lift provided from the construction of the Recommended Plan measures would be incorporated into the functional assessments and mitigation plan. It is anticipated that any mitigation sites would be located within approximately five miles to offset impacts as close as possible to the impact site. The mitigation cost has been accounted for in the cost estimate and includes contingency.

<u>Real Estate:</u> Potential impacts to public facilities such as boat docks, boat ramps, and boardwalks are possible but will not be further investigated in detail until during PED. Docks along WSJB 3 were estimated from google earth imagery, but it is unknown how many of them are public vs. private, which ones have a real estate interest, and also if others may be built in the interim between now and closer to project construction. Currently, potential costs associated with real estate relocations are estimated to be under \$1.5M, and this cost is captured in the 30% real estate contingency.

<u>Cost:</u> A Cost and Schedule Risk Analysis (CSRA) has been completed, which addresses risks to project implementation and construction. Based on the results of the analysis, a risk-based contingency value of \$97.2M (37%) has been added. This contingency includes risks related to costs for the effect of schedule delay on overall project cost. Risks associated with this project and remaining risks are typical of civil works projects. In the future, the risks will continue to be assessed and managed in during the remainder of the feasibility phase and into the design and construction phase of the project.

4.14.1 RESIDUAL RISK

The proposed project would greatly reduce, but not completely eliminate, future coastal storm risk and damages which result from coastal flooding. Coastal storm damages, caused primarily by coastal flooding, would be reduced by approximately 98% to 99.9% in the location of the project area over the 50 year period of analysis; therefore, the residual damages would be in the range of 0% to 2%. Periodically revisiting sea level rise trends described earlier will be crucial for adaptive management to manage risk.

The Recommended Plan will reduce damages but does not have a specific design level. In other words, the project is not designed to fully withstand a certain category of hurricane or a certain frequency storm

event. During study scoping, it was determined that the vast majority of damages occur at the 90% assurance for the 1% exceedance probability event + MHHW + Intermediate Sea Level Change.

Reaches West San Juan Bay 1A and East San Juan Bay were screened out from the study after the analysis showed that minimal damages are occurring in these areas. The cost to build a project in these reaches to reduce the damages would be higher than the benefit received. As a result, these areas are not economically feasible to pursue; along with additional considerations under planning criteria, these reaches were screened from further analysis. However, the low damages shown by the analysis indicates there is low risk of coastal flooding damages to the communities. The risk of coastal flooding in theses reaches is not affected by the proposed Recommended Plan.

Preliminary analysis by the team showed that there are flooding problems in reaches 4 through 6, resulting in potential risk of damages to assets and socially vulnerable communities from hydrologically induced flooding (precipitation) in addition to storm surge. These areas are recommended to be evaluated under a separate study in order to adequately address both storm surge and precipitation holistically. The same study authority that is used for this study could be used. The risk of coastal flooding in theses reaches is not affected by the proposed Recommended Plan.



5 EFFECTS OF THE RECOMMENDED PLAN*1

This section is the scientific and analytic evaluation of effects that would result from implementing the Recommended Plan. Chapter 2 of this report provides information on existing conditions as well as effects resulting from the "no-action alternative," or the "Future Without-Project Conditions." The future without-project (FWOP) condition is the consequence, 50 years into the future, of taking no action. For the purposes of simplicity in this report and to serve multiple audiences, term "no-action" will be used in combination with "future without-project condition" and understood as described in the sentence above. **Table 3.4** provides a summary of direct and indirect effects of the Recommended Plan and the No Action Plan. The following section provides a more detailed analysis of anticipated changes to the existing environment including direct, indirect, and cumulative effects as a result of the Recommended Plan, or the "Future With-Project Conditions."

5.1 NATURAL (GENERAL) ENVIRONMENT5.1.1 SURFACE WATER QUALITY

Surface water quality can be affected by the proposed project directly or indirectly and temporarily. Direct, temporary effects on water quality may occur during project construction; increased turbidity is primary among these effects. Long term effects are not anticipated. A Water Quality Certification (WQC) in Accordance with Section 401 of the Clean Water Act, as amended, will be obtained and the conditions of this certification will be adhered to as a commitment of this project.

5.1.2 TURBIDITY AND SUSPENDED SOLIDS

Construction of CSRM measures is likely to have a temporary and minor impact to water quality. The proposed project would have construction in various areas of the bay for roughly 5 years.

The direct impacts to local waters during construction would be minor but adverse. Floodwall, living shoreline and possible breakwater construction in the water may result in direct impacts from construction activities. This would be a minor impact to local water quality. Sedimentation may increase in the local area due to the construction, although BMPs (best management practices) would be used to minimize these impacts.

5.1.3 WETLANDS AND SAV

The USACE has determined that construction of the proposed CSRM measures would directly affect existing mangrove and freshwater wetlands and SAV. In addition, temporary indirect effects from elevated turbidity levels during construction would occur. Best available information was used to generate preliminary impact estimates (See **Appendix F Preliminary Mitigation Plan**). These included the U.S. Fish and Wildlife Service National Wetland Inventory maps, NOAA National Ocean Service benthic atlas dataset for Puerto Rico and the USVI from 2000, and geophysical surveys conducted for the San Juan Harbor Navigation Project by USACE and NMFS HCD staff between 2016 and 2017. Preliminarily estimated acreages of direct impacts are:

San Juan Metro Area Coastal Storm Risk Management Project FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

¹ Note that sections pertinent to the NEPA analysis are denoted with an asterisk.

- Approximately 22.08 acres of mangroves
- Approximately 6.17 acres of freshwater wetlands
- Approximately 13.94 acres of SAV

These are preliminary estimates of direct impact and the actual acreages are expected to change once updated field surveys can be conducted. The preliminary mitigation plan for these unavoidable impacts is included in **Appendix F**.

5.1.4 HARDBOTTOM HABITAT

As discussed in Section 2.2.3.1, hardbottom habitat is present adjacent the entrance to San Juan Bay and along the north coast. The USACE anticipates that CSRM measure construction would not directly affect existing hardbottom habitat. However, it is possible that some of the areas preliminarily delineated as SAV could contain hardbottom especially around the shoreline of Condado Lagoon (CL1-Alt 2a) and the Cataño nearshore where the breakwaters are proposed (WSJB3-Alt 2). Therefore, the impact estimates will be revised as necessary once updated field surveys can be conducted.

Indirect impacts to hardbottom habitats would be due in large part to any turbidity resulting from the construction activities. Best Management Practices (BMPs) would be employed to minimize turbidity during in-water construction activities. Turbidity could result in sub-lethal effects (injury, decreased fecundity, etc.) on the macroinvertebrate community. Recent USACE consultations under Section 7 of the Endangered Species Act were conducted with the National Marine Fisheries Service for San Juan Harbor in 2016 and 2018 (Consultation Number SER-2013-10961 and SER-2017-18763). The 2018 BO concluded any effects to corals and critical habitat associated with transit and disposal of dredged materials within the Condado lagoon would be discountable. It is anticipated that construction of CSRM measures around the shoreline of Condado lagoon (and at WSJB) would likewise have discountable effects to corals and Acroporid coral DCH, with use of BMPs during construction. The USACE will conduct turbidity monitoring in accordance with a monitoring plan that will be developed prior to construction to insure avoidance and minimization of effects to hardbottom habitat. Therefore, indirect impacts to hardbottoms and coral reefs from turbidity and sedimentation as a result of construction are not anticipated. The preliminary mitigation plan for these unavoidable impacts is included in Appendix F.

5.1.5 ESSENTIAL FISH HABITAT

Based on preliminary impact estimates the proposed project would affect EFH including hardbottom habitat (See Section 5.1.4), unconsolidated soft bottom, SAV, estuarine water column, estuarine scrub shrub (mangroves) and palustrine emergent wetlands (See Section 5.1.3). The preliminary impact estimates will be revised as necessary once updated field surveys can be conducted. In addition, the Recommended Plan features could be refined during PED to further avoid and minimize impacts. For example, the final location of the WSJB3-Alt 5 breakwaters could be refined, and final design location for the Condado living shoreline could be refined, to avoid resources should SAV or hardbottom be found there during updated field surveys. Considering this, the relatively small Recommended Plan footprint, and expected habitat enhancement benefits from construction of the nature-based CSRM measures, the USACE has determined at this time and based on the preliminarily estimated impacts, the project is not anticipated to significantly affect EFH or federally managed fisheries in Puerto Rico.

Effects of the proposed action could include death and injury of fishes and forage during construction. Direct removal of unconsolidated soft bottom, SAV, hardbottom, mangrove and FW wetland habitats would occur as well as temporary changes in water quality. The below list summarizes potential effects of the proposed project on EFH and managed species.

- 1. Injury or mortality of individual fishes (adults, sub-adults, juveniles, larvae, and/or eggs, depending on species, time of year, location, etc.) due to construction. No one area would experience an extended duration of temporary effects during construction.
- 2. Indirectly affecting foraging behavior of individuals through production of turbidity at construction site (an effect temporary in duration).
- 3. Indirectly affecting movements of individuals around/away from construction equipment/area and related disturbed benthic habitats (an effect temporary in duration).
- 4. Directly affecting foraging and refuge habitats by conversion of unconsolidated sediment and removal of SAV, hardbottom, mangrove and FW wetland habitats.
- 5. Directly benefitting foraging and refuge habitat through construction of natural and nature-based CSRM measures and additional habitat creation as needed.

Besides the conversion of unconsolidated sediment to breakwaters, these impacts would occur on a temporary scale. As noted, the effects would only be felt in the area of construction activity which would not be taking place at all locations at all times. Individually or in sum, the above are not anticipated to significantly adversely affect managed species or EFH. An EFH Assessment is incorporated into this integrated document in sections 2.2.2-2.2.4 and 5.1.3-5.1.5 and was coordinated with NMFS concurrent with the public review of the Draft IFR/EA.

5.1.6 PROTECTED SPECIES

5.1.6.1 OVERVIEW

A summary of effect determinations for threatened and endangered species as a result of the proposed project is in **Table 5-3**. The USACE determined that the proposed project, will have "no effect" (NE) on scalloped hammerhead shark, Nassau grouper, and giant manta ray, elkhorn, staghorn, pillar, rough cactus, lobed star, mountainous star and boulder star corals; "may affect, but is not likely to adversely affect" (MANLAA), loggerhead, hawksbill, leatherback and green sea turtles, Antillean manatee, and Puerto Rican boa; and will not adversely modify DCH for Acroporid corals. Project designs will be refined to minimize potential effects to the extent feasible. A biological assessment evaluating these determinations has been sent to the National Marine Fisheries Service and U.S. Fish and Wildlife Service initiating consultation under Section 7 of the ESA.

5.1.6.2 FISH (NASSAU GROUPER, SCALLOPED HAMMERHEAD SHARK, AND GIANT MANTA RAY)

Considering the overlaps of various life stages in distribution within the proposed project area and subsequent risk of take relative to construction operations, this section considers the impacts of the proposed project to scalloped hammerhead shark (SHS), Nassau grouper (NG), and giant manta ray (GMR) together. Potential direct and indirect impacts associated with in-water construction that may adversely

San Juan Metro Area Coastal Storm Risk Management Project

impact these species could include entrainment and/or capture of adults, juveniles, larvae, and eggs, shortterm impacts to foraging and refuge habitat, water quality, and disruption of migratory pathways. However, given the mobility of these species, the anticipated small area of active construction and anticipated lack of occurrence of these species in the action area, the likelihood of proposed construction activities to incidentally take SHS, NG and GMR is discountable. Therefore, the no effect determination for these species is based on the anticipated low abundance within the project area and the mandatory buffer distances between construction activities and coral reef/hardbottom habitat.

2020 SAN JUAN METRO BACKBAY CSRM STUDY ESA TABLE				
Common Name	Scientific Name	Status	Determination	
Marine Mammals				
Antillean manatee	Trichechus manatus	Т	MANLAA	
Sea Turtles				
Loggerhead sea turtle	Caretta caretta	Т	MANLAA	
NW Atlantic DPS				
Hawksbill sea turtle	Eretmochelys imbricata	E	MANLAA	
Leatherback sea turtle	Dermochelys coriacea	E	MANLAA	
Green sea turtle	Chelonia mydas	т	MANLAA	
South Atlantic DPS	chelonia myaas	I		
Fish				
Nassau grouper	Epinephelus striatus	Т	NE	
Scalloped hammerhead shark	Sphyrna lewinii	E	NE	
Giant manta ray	Manta birostris	Т	NE	
Invertebrates				
Elkhorn coral	Acropora palmata	Т	NE	
Staghorn coral	Acropora cervicornis	Т	NE	
Acroporid Coral Designated Critico	al Habitat		Not Likely to	
			Adversely Modify	
Pillar coral	Dendrogyra cylindrus	Т	NE	
Lobed star coral	Orbicella annularis	Т	NE	
Mountainous star coral	Orbicella faveolata	Т	NE	
Boulder star coral	Orbicella franksi	Т	NE	
Rough cactus coral	Mycetophyllia ferox	Т	NE	
Terrestrial Reptiles				
Puerto Rican Boa	Epicrates inornatus	E	MANLAA	

 Table 5-3. Summary of Effect Determination for Threatened and Endangered Species. (Details can be found in Appendix F, Environmental.)

5.1.6.3 SEA TURTLES

Overall impacts to sea turtles from construction activities are not anticipated. Current conservation measures implemented by the USACE to reduce impacts to sea turtles during in-water construction are discussed in Section 6 of this report (Environmental Compliance). The USACE will use the following measures outlined below during the construction of the proposed project (described in detail in **Appendix F, Environmental**):

a. Protected species observers during in-water work.

b. Shut-down of construction activities and monitoring should a turtle come with 50-feet until the animal leaves the area of its own volition.

5.1.6.4 ANTILLEAN MANATEE

The proposed project may affect, but is not likely to adversely affect the manatee. The contractor would adhere to the standard manatee conditions during construction in order to avoid impacts. The Contractor may be held responsible for any manatee harmed, harassed, or killed as a result of vessel collisions or construction activities. Failure of the Contractor to follow these specifications is a violation of the Endangered Species Act and could result in prosecution of the Contractor under the Endangered Species Act or the Marine Mammals Protection Act. The standard manatee conditions apply year-round in Puerto Rico. The Contractor will be instructed to take the necessary precautions to avoid contact with manatees. If manatees are sighted within 100 yards of the dredging activity, all appropriate precautions would be implemented to insure protection of the manatee. The Contractor would stop, alter course, or maneuver as necessary to avoid operating moving equipment (including watercraft) any closer than 100 yards of the manatee. Operation of equipment closer than 50-feet to a manatee shall necessitate immediate shutdown of that equipment.

5.1.6.5 CORALS

As stated in Section 2.2.5.1.4, none of the seven Caribbean listed threatened coral species have been documented within the construction footprint or within the 150m indirect impact zone and Acroporid DCH is also 250m from the closest construction area.

Recent USACE consultations under Section 7 of the Endangered Species Act were conducted with the National Marine Fisheries Service for San Juan Harbor in 2016 and 2018 (Consultation Number SER-2013-10961 and SER-2017-18763). The 2018 BO concluded any effects to corals and critical habitat associated with transit and disposal of dredged materials within the Condado lagoon would be discountable. It is anticipated that construction of CSRM measures around the shoreline of Condado lagoon (and at WSJB) would likewise have discountable effects to corals and DCH, with use of BMPs during construction. The USACE will conduct turbidity monitoring in accordance with a monitoring plan that will be developed prior to construction to insure avoidance and minimization of effects to hardbottom habitat. Therefore, indirect impacts to hardbottoms and listed corals from turbidity and sedimentation as a result of construction are not anticipated.

5.1.6.6 PUERTO RICAN BOA

Although CSRM construction activities in WSJB would occur in an area where the Puerto Rican boa could be present the USACE determined by utilizing the USFWS standard construction conditions (including monitoring and relocation), potential effects to the snake can be minimized. The USACE determined that the Project may affect, but is not likely to adversely affect the Puerto Rican boa.

5.1.7 BIRDS

The USACE does not anticipate that avian species, including shorebirds, seabirds, and migratory birds, would be adversely (directly or indirectly) affected by the proposed project. The proposed project would

cause only temporary impacts to the bird community as individuals avoid active construction areas due to noise and general activity. Construction in WSJB would occur in mangroves and wetlands but impacts to the bird community are expected to be temporary and last for the duration of construction.

Shorelines used by birds within the bay are expected to stabilize in the future-with-project condition (proposed project). Beneficial effects to important nesting, foraging, and loafing/roosting habitats for migratory birds should result from the habitat benefits of the nature-based CSRM features. USACE is committed to monitoring the assumptions of the project to ensure that additional impacts to natural resources in the San Juan Bay area are not incurred including monitoring for nesting birds during construction.

5.1.8 INVASIVE SPECIES

The proposed project would include measures to clean construction equipment before and between use which should reduce the potential for the introduction and spread of invasive species.

5.1.9 AIR QUALITY

Construction equipment is typically powered by diesel engines. Depending on the size, type, age, and condition of the equipment, various emissions can be expected for the duration of the operation. The project area is compliant with Puerto Rico air quality standards. The proposed construction would occur in a bay that experiences nearly constant trade winds and sea breezes.

The proposed project has been analyzed for conformity applicability pursuant to regulations implementing Section 176(c) of the Clean Air Act. It has been determined that the activities proposed under this proposed project would not exceed de minimis (a level of risk too small to be concerned with) levels of direct or indirect emissions of a criteria pollutant or its precursors and are exempted by 40 CFR Part 93.153. For these reasons a conformity determination is not required for this proposed project.

5.1.10 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

Using an EPA web mapper (https://www.epa.gov/superfund/search-superfund-sites-where-you-live), the proposed project is not expected to encounter HTRW. No HTRW would be released in the project area during or after construction. The project should not impact existing sediment conditions. None of the construction areas would be affected by HTRW. The proposed project would not change or affect the ability for Federal regulations, U.S. Customs, and Port Security to continue to address the transportation of any HTRW. It is anticipated additional investigations would be conducted in PED prior to construction to insure no HTRW exists within the project area.

5.1.11 NOISE

5.1.11.1 IMPACTS OF CONSTRUCTION NOISE ON MARINE LIFE

NMFS is currently developing guidelines for determining sound pressure level thresholds for fish and marine mammals. Based on existing studies, the NMFS current thresholds for determining impacts to marine mammals is between 180 and 190 dB re 1 uPa for potential injury to cetaceans and pinnipeds respectively, and 160 dB re 1 uPa for behavioral disturbance/harassment from an impulsive noise source, and 120 dB re 1 uPa from a continuous source. Reine et al (2012) found that the 120 dB re 1uPa proposed

threshold was exceeded by ambient noises in their study area. It is unlikely that underwater sound from conventional construction operations can cause physical injury to marine mammals and fish species. Some temporary loss of hearing could occur if the animal remains in the immediate vicinity of construction for lengthy durations, although the risk of this outcome is low. Fish and marine mammals would likely respond to construction by using avoidance techniques. Avoidance is defined as an effect that causes the animal to not occupy an area that is periodically or infrequently occupied. Construction is likely to cause avoidance due to noise (and increased turbidity and other temporary water quality changes). Therefore, construction activities would likely cause the temporary displacement of fish and marine mammals as a response to the noise.

5.1.11.2 IMPACT OF CONSTRUCTION NOISE ON THE HUMAN ENVIRONMENT

There would be a temporary increase in the ambient noise level during the construction phase of the project. The construction would be within 150m of sensitive receptors. However, since construction should not occur in one position for any extended period of time, there will be no disproportionate adverse impact on any communities. Noise generated by this project would not be substantially different from other ambient noise levels of an active harbor and metropolitan area.

5.1.12 COASTAL BARRIER RESOURCES

The proposed project would not affect the three CBRS Units located in the vicinity of San Juan Bay, PR-87 Punta Vacia Talega and PR-87P Punta Vacia Talega OPA approximately 13-19 km east and PR-86P Punta Salinas OPA approximately 6 km west (Figure 2-5). These resources are geographically distant from the project area and no features are to be constructed within the CBRS Units."

5.1.13 CULTURAL AND HISTORIC RESOURCES

Analysis of potential impacts to historic and cultural resources considered both direct and indirect effects (see Section 2.1.17). Direct effects may result from physically altering, damaging, or destroying all or part of a historic or cultural property, or changing the character of physical features within the property's setting that contribute to its historic significance. An effects analysis focuses on the characteristics of a historic property that qualify it for inclusion in the National Register, and assesses the potential to alter historically significant characteristics and diminish the integrity of a historic property. There may also be cultural resources of value which are not eligible for inclusion in the National Register. The APE for direct affects was defined as being within and adjacent to the proposed alternatives, as well as staging and work areas. Indirect effects are reasonably foreseeable effects caused by an undertaking that may occur later in time, be farther removed in distance or be cumulative. In the case of the proposed plan, these may include increased development associated with the protection afforded by the alternatives and increased pedestrian traffic along the seawalls. The APE to include indirect effects was tentatively assessed by buffering the proposed features, but will be more rigorously defined in PED.

While background research revealed numerous cultural resources and historic properties within the APE, a full inventory has not yet been conducted. Each of the alternatives has the potential to affect cultural resources. The direct footprint of levee construction may disturb archaeological sites, be a visual intrusion in historic districts, or alter the appreciation of historic structures. Two archaeological sites have been documented near this footprint, and others may be associated with the historic hacienda or prehistoric occupation of this area. A field visit conducted by the USACE found this area heavily disturbed by past

construction. The design of the seawalls will need to consider the effects on the Distrito Destilería Bacardí and other resources identified in the future, as well as how the seawalls may alter the accessibility to the water or other characteristics which may be contributing to the significance of historic districts or landscapes. The existing conditions in these areas will guide designed seawalls (consistent with Section 5.1.14, below) may not present an adverse effect. The construction of inland water-control infrastructure, to alter the direction of runoff, may change the hydrology of an area and affect archaeological sites over time. The construction of the elevated living shoreline may directly affect archaeological sites within the footprint, as well as alter the viewshed of historic structures or character of historic districts. However, there are existing seawalls in this area and the lagoon has been extensively disturbed by previous dredging. A review of the recorded historic properties in this area does not include the identification of the lagoon view as a contributing element to the eligibility of these resources for listing in the NRHP, but this will be further addressed in PED. No known shipwrecks or submerged archaeological sites were present in the APE, however, the footprint of the breakwaters may overlap unknown historic shipwrecks or submerged prehistoric archaeological sites. The conceptual nature of the plans and planning timeline prevent a full accounting of effects to cultural resources.

As project designs are refined and optimized, impacts to cultural resources will be minimized and avoided where possible. In consultation with SHPO, pursuant to 54 USC 306108, § 800.4(b)(2), and 36 CFR 800.14(b)(1)(ii), USACE is deferring final identification and evaluation of historic properties until after project approval, when additional funding and design details are available. Because the USACE cannot fully determine how the project may affect historic properties prior to finalization of this feasibility study, a PA was executed to ensure compliance with Section 106 of the National Historic Preservation Act of 1966 (NHPA). The executed PA allows the USACE to complete the necessary archaeological surveys during the follow on PED phase of the project, and it will also allow for the identification of historic properties, assessment of effects, and inclusion of measures to avoid, minimize, and mitigate effects to historic properties to be completed after project features have been clearly defined and sited. An executed PA is included in Appendix H.

5.1.14 AESTHETICS

The proposed project, CSRM measure construction, could alter the aesthetic resources of San Juan Bay and increase recreational opportunities. Although the definition of aesthetics is fluid (see Section 2.2.18), for the purposes of the present evaluation, the principal aesthetic "targets" include the visual perception of San Juan Bay's land- and seascapes, historic features, and certain architecture. The degree to which any adverse feature affects aesthetics is frequently based on scale, position, and proximity relative to the viewer. Temporary impacts to the aesthetic appeal during construction are anticipated. However, the CSRM measures could also enhance local aesthetics in the long-term through incorporation of NNBF including living shorelines.

5.1.15 RECREATION

Temporary impacts to recreational activities during construction are anticipated. As a public safety measure, boating would be prohibited near the operating construction equipment. Recreational access to these areas would return to pre-construction conditions following completion of the project. Although short-term impacts could occur, no long-term adverse effects are anticipated. Commercial shipping would continue in the Federal navigation channel. Information would be provided to the USCG so they could issue a "Notice to Mariners" prior to initiation of construction and for each major change in the construction

activities. This would alert public boaters of areas to avoid and the possibility of limited and restricted access. No significant adverse impacts to recreational boating are expected from the proposed project.

<u>Condado Lagoon</u>: The recommended plan proposes to construct an elevated living shoreline on the northern shoreline of the lagoon. The elevated living shoreline would have a 10-foot width and would be topped with crushed limestone with access intervals for the purposes of operation and maintenance. This feature would be available to the community for incidental recreation opportunities where it could be used for running, biking, fishing, walking, and access to the lagoon, etc. This feature would connect the existing southern and western walkways to create a full walking path around the lagoon. The current configuration of the elevated living shoreline is in front of one of the existing beach areas described in Chapter 2 (which is located just northwest of the lagoon), rather than behind it, as was originally intended. The reason for this current configuration is the existing elevation data suggests there is no high ground available, which is needed to be able to configure the feature behind the beach. More refined data will be obtained during PED, and this configuration area will continue to be designed and refined to avoid the existing beach area. Existing recreational features around the lagoon, as described in Chapter 2, would not be negatively impacted.

<u>West San Juan Bay 1</u>: The recommended plan proposes to construct a levee on the southwestern portion of the reach. The levee would have a 12-foot width and would be topped with crushed limestone with access intervals for the purposes of operation and maintenance. This feature would be available to the community for incidental recreation opportunities where it could be used for running, biking, fishing, walking, etc. Access to La Esperanza park and along the shoreline for access to the water would be maintained through gaps in the floodwall, where deployable floodwalls would be used. Access to parking would be maintained. Existing recreational features in this reach, as described in Chapter 2, would not be negatively impacted.

<u>West San Juan Bay 2</u>: The recommended plan proposes to construct a levee on the western portion of the reach. The levee would have a 12-foot width and would be topped with crushed limestone with access intervals for the purposes of operation and maintenance. This feature would be available to the community for incidental recreation opportunities where it could be used for running, biking, fishing, walking, etc. Existing recreational features in this reach, as described in Chapter 2, would not be negatively impacted.

<u>West San Juan Bay 3</u>: The recommended plan proposes to construct a seawall along the northern and eastern shoreline. Access to the water along the shoreline for would be maintained through gaps in the floodwall, where deployable floodwalls would be used. Some boat docks in La Puntilla could be impacted; the configuration of the floodwall will be further evaluated in PED to avoid impacts as much as possible. Although relocations of public facilities such as boat docks and boardwalks are not currently anticipated or identified, a more detailed analysis will be conducted during PED. More information can be found in Section 4.14. Existing recreational features in this reach, as described in Chapter 2, would not be negatively impacted.

<u>West San Juan Bay 4</u>: The recommended plan proposes to construct a levee on the southeastern portion of the reach. The levee would have a 12-foot width and would be topped with crushed limestone with access intervals for the purposes of operation and maintenance. This feature would be available to the community for incidental recreation opportunities where it could be used for running, biking, fishing, walking, etc. There are no known recreational features in this area, and therefore none would be impacted.

5.1.16 FEDERAL PROJECTS

- <u>Caño Martín Peña Ecosystem Restoration Project</u>: This project will not be affected by the San Juan Metro Area CSRM Recommended Plan.
- <u>Rio Puerto Nuevo Flood Control Project</u>: This project, and associated mitigation areas, will not be affected by the San Juan Metro Area CSRM Recommended Plan. Implementation of this project has been factored into modeling and design for the San Juan Metro Area CSRM Recommended Plan.
- <u>San Juan Harbor, Puerto Rico Project</u>: The San Juan Harbor project, and associated mitigation areas, is not yet constructed but would not be affected by the San Juan Metro Area CSRM Recommended Plan. Implementation of the San Juan Harbor project would not have any impact on existing coastal flooding.
- <u>San Juan Harbor Federal Navigation Project Under Section 1135 for Work at La Esperanza Peninsula:</u> This project will not be affected by the San Juan Metro Area CSRM Recommended Plan.

5.1.17 ENVIRONMENTAL JUSTICE

The USACE collected and analyzed information to consider the potential impacts of the proposed action on minority and low-income populations. The information and analyses presented below demonstrates that the proposed action complies with Executive Order 12898 and would not cause disproportionately high and adverse impacts to minority or low-income populations. **Appendix F, Attachment 3** provides a full Environmental Justice Analysis report.

The CSRM area of interest is bordered by numerous EJ communities. Possible factors that could impact EJ communities include those resulting directly from the construction of the project and the secondary effects that could occur as a result of the shoreline improvements. These factors include, but are not limited to the following:

- Construction equipment through neighborhoods
- Noise from construction
- Air emissions from construction
- Affects to subsistence fishermen
- Increasing exposure to contaminants
- Decreasing water quality

5.1.17.1 CONSTRUCTION RELATED IMPACTS

The proposed action consists of a collection of key structural and natural and nature-based features in strategic locations in order to increase storm resiliency and flooding within the San Juan Metropolitan area. As such, the construction and operational activities are within the shallow waters of the San Juan Bay, shorelines, and adjacent creeks. The construction and operational work areas are located near residential communities, schools, and hospitals which are situated near the coastal areas of the bay. Impacts from noise, air, and other inconveniences are not likely to significantly impact identified communities. Compared to most large, entirely land-based projects, there is little potential for direct adverse impacts to

minority populations, low-income populations, the elderly, or children. The result of the project would provide a benefit to the identified communities, as it will reduce flooding and provide benefits to the coastal communities, such as recreational opportunities. Recreational opportunities include improved access to the coastline, increased natural recreational areas, and improved wildlife and natural communities. As indicated in previous sections of this document, during construction there would be temporary and minor impacts resulting from increased turbidity (decreased water quality) from in-water work. These impacts will be temporary and minor and will not disproportionately impact low-income, minority, juvenile, or elderly populations. Additionally, the potential exists for subsistence fishing along the coast; however, these practices will not be significantly impacted by the proposed project due to the impacts being temporary. The project is likely to increase availability of locations for the local population to fish. No significant impacts to fish populations are expected to result from the construction of the project. In summary, there will not be disproportionately high and adverse impact on low-income, minority resulting from the construction of the project.

5.1.17.2 PUBLIC ENGAGEMENT DURING CONSTRUCTION

An important component of any project is informing the public at all stages of the project (i.e., planning, design, construction, and maintenance). USACE engaged in public outreach efforts through the media and public information meetings during the feasibility phase (planning phase). USACE will provide a contact information link on the public website for anyone with concerns about, or related to, the project.

5.2 CUMULATIVE EFFECTS

5.2.1 CUMULATIVE ACTIVITIES SCENARIO

NEPA, as implemented by Council on Environmental Quality (CEQ) regulations (40 CFR §§ 1500 -1508), requires Federal agencies, including the USACE, to consider cumulative impacts in rendering a decision on a Federal action under its jurisdiction. According to 40 CFR § 1508.7, a *cumulative impact* is the impact on the environment that results from the incremental impact of the proposed project when added to other past, present, and reasonably foreseeable future actions regardless of the agency (Federal or non-Federal) or person that undertakes such other actions; cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Resource	Past and Present (Baseline/Existing Condition)	Future Without-Project	Future With-Project
Threatened and Endangered Species: Sea Turtles	Four sea turtle species occur in the area (loggerhead, green, hawksbill, and leatherback). Green, hawksbill, and leatherback turtles nest on beaches along the north coast out of the project area. Juvenile green and hawksbill turtles use SAV and nearshore hardbottom areas for feeding, resting, and shelter from predators. Past and current threats to sea turtle populations include artificial lighting, beach armoring, anthropogenic disturbance, trawling, dredging, vessel strikes, fishing gear entanglement, and ingestion of discarded anthropogenic marine debris.	Sea turtle nesting and nearshore habitat use would continue outside the project area. Ongoing threats to sea turtle populations would continue. In the absence of the project, property owners may use armor to protect their property which may result in impacts on SAV and nearshore hardbottom habitat.	CSRM measure construction is not anticipated to result in loss of habitat. Sea turtles may be disturbed by turbidity and noise during construction. Standard protective measures for in-water work would be followed during construction to avoid effects to swimming sea turtles. Due to the small spatial extent and short duration of project impacts, no significant cumulative impacts are anticipated.
Threatened and Endangered Species: Antillean Manatee	The Antillean manatee is common in San Jun bay. Past and current threats to manatee populations include vessel strikes, fishing gear entanglement, loss of foraging habitat (SAV), ingestion of marine debris, pollution, and underwater noise.	Manatees would continue to occur in the area. Ongoing threats to manatee populations would continue.	In addition to ongoing threats, manatees may be disturbed by turbidity and noise during construction. Standard protection measures for in-water work would be followed during construction. These include in part monitoring and shut-down of construction activities should a manatee come within 50-feet. Shoreline stabilization could encourage SAV colonization potentially improving manatee foraging habitat in the area.
Threatened and Endangered Species: Fish	As discussed in Sections 2.2.5.1.1 and 5.1.6.2 above the species are expected to not be present in San Juan Bay. Nassau grouper have been badly overfished but were known to occur on the fringing reefs along the north coast in the past. Scalloped hammerhead shark and giant manta ray are oceanic species but could have occurred in the past along the north coast. Populations of these three species have declined, mainly due to fisheries overexploitation and incidental by- catch. Other past and current threats are habitat loss and degradation, entanglement in marine debris, pollution, and anthropogenic disturbance.	These species would continue to be rare in the area. Ongoing threats to populations would continue and may result in further decreases in population size and range.	In addition to ongoing threats, these ESA listed species could be disturbed by turbidity and noise during construction. Due to the small spatial extent and short duration of project impacts, and the expected low abundance in the project area, it is not likely these species would be effected by CSRM measure construction. Habitat benefits provided by the project could improve water quality in the region possibly indirectly benefitting these species.
Threatened and Endangered Species: Corals	As discussed in Sections 2.2.5.1.4 and 5.1.6.5 above, all seven (7) listed species are known to occur on the fringing reefs along the north coast. Past and current threats are habitat loss and degradation from entanglement in marine pollution/debris, degraded water quality, SLR and anthropogenic disturbance.	These species would continue to occur outside the project area. Ongoing threats to populations would continue and may result in further decreases in population size and range.	These species are expected to occur outside the project area on the fringing reefs along the north coast. These listed species are not expected to be affected by CSRM measure construction. Turbidity would be monitored during construction and activities would cease if the 10 NTU above background standard were exceeded and until levels return to background. Due to the small spatial extent and short duration of project effects, and the expected distances from the project area, it is not likely these species would be affected by CSRM measure construction. Habitat benefits provided by the project could improve water quality in the region possibly indirectly benefitting these species.
Threatened and	The Puerto Rican boa is most likely to occur in the WSJB area where more natural areas occur as opposed to the heavily developed Condado lagoon area. Historically, its population and range have	Puerto Rican boa would continue to inhabit the area. Ongoing threats to boa populations	In addition to ongoing threats, boas may be disturbed during construction. There is a small risk of a boa being injured by construction activities, which would be

Table 5-4. Summary of Cumulative Effects.

San Juan Metro Area Coastal Storm Risk Management Project FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

Resource	Past and Present (Baseline/Existing Condition)	Future Without-Project	Future With-Project
Endangered Species: Puerto Rican Boa	declined, mainly due to habitat loss. Other past and current threats are habitat degradation, pollution, and anthropogenic disturbance.	would continue and could result in further decreases in population size and range.	minimized through required use of standard construction monitoring measures. Due to the small spatial extent and short duration of project effects, the Puerto Rican boa would not likely incur other than minor impacts.
Nearshore Hardbottom	As discussed in Sections 2.2.3 and 5.1.4 above, hardbottom habitat occurs in San Juan Bay. Past and current threats are habitat loss and degradation from inundation and sedimentation, entanglement with marine pollution/debris, degraded water quality, SLR and anthropogenic disturbance.	Hardbottom habitat would continue to occur in San Juan Bay. Ongoing threats would continue and may result in further decreases in coverage in San Juan Bay.	Hardbottom habitat is not expected to be affected by CSRM measure construction. Turbidity would be monitored during construction and activities would cease if the 10 NTU above background standard were exceeded and until levels return to background. Due to the small spatial extent and short duration of project effects, and the expected lack of direct impacts from the project, it is not likely hardbottom habitat would be affected by CSRM measure construction. The project could provide consolidated hard substrate (rock) which could enhance hardbottom habitat in San Juan Bay.
Birds	As discussed in Sections 2.2.6 and 5.1.7 above, bird and bird habitat for shorebirds, seabirds, and migratory birds occurs in San Juan Bay. Past and current threats include habitat loss and degradation from inundation and sedimentation, and anthropogenic disturbance.	Migratory and resident birds would continue to inhabit the San Juan Bay area. Ongoing threats would continue and may result in further decreases in habitat and bird occurrence in San Juan Bay.	The USACE does not anticipate that avian species, including shorebirds, seabirds, and migratory birds, would be adversely affected by the proposed CSRM measure construction. Individual birds could avoid the active construction areas due to noise and general activity. Beneficial effects to important nesting, foraging, and loafing/roosting habitats for migratory birds should result from the habitat benefits of the nature-based CSRM measures.
Essential Fish Habitat	EFH is the area includes hardbottom habitat (See Section 5.1.4), SAV, estuarine water column, estuarine scrub shrub (mangroves) and palustrine emergent wetlands (See Section 5.1.3). Past and current threats include habitat loss and degradation from inundation and sedimentation, and anthropogenic disturbance.	Local extents of these EFH areas would fluctuate with natural variability. In the absence of the project, property owners may construct armoring to protect their property, which may result in impacts to nearshore EFH.	The preliminary impact estimates will be revised as necessary once updated field surveys can be conducted. In addition, the Recommended Plan features could be modified to further avoid and minimize impacts. Conversion of unconsolidated sediment to stone breakwaters anticipated. Considering the relatively small Recommended Plan footprint, and expected habitat enhancement benefits from construction of the nature-based CSRM measures, the project is not anticipated to significantly affect EFH or federally managed fisheries in Puerto Rico.
Water Quality	The project area consists of Class III waters, which are designated as suitable for recreation, propagation, and maintenance of a healthy, well balanced population of fish and wildlife. The predominant issue that affects water quality in the area is turbidity, which varies significantly under natural conditions (e.g., during storms), sometimes exceeding 29 NTU. Historically, coastal water quality has been affected by unrelated	Turbidity would continue to occur intermittently due to storm activity, rainfall, currents, and other natural phenomena. Water quality may deteriorate due to unrelated anthropogenic sources such as storm water and effluent runoff.	In addition to the ongoing natural and anthropogenic fluctuations in water quality, local, short-term turbidity could occur adjacent to the construction sites. BMPs would be implemented during construction to reduce the magnitude and extent of turbidity, and adverse effects on water quality are expected to be minor. Turbidity would

Resource	Past and Present (Baseline/Existing Condition)	Future Without-Project	Future With-Project
	anthropogenic sources such as storm water and effluent runoff		be monitored during construction to ensure that
	resulting in increased nutrients and freshwater inputs.		Commonwealth water quality standards are met.
	Urbanization and population growth in the region contributes to		Due to the small spatial extent and short duration of
	coastal water quality degradation.		project impacts, no long-term effects are expected.
Cultural	The project area is in a historically significant area, with	Project-specific impacts would be avoided,	The reduced risk may lead to development, but
	archaeological sites, historic structures, and historic districts.	but risk of storm damages to cultural	resources would continue to be protected by local
Resources		resources to may not reduced.	laws and regulations.

5.2.1.1 SEA-LEVEL CHANGE

To incorporate the direct and indirect physical effects of projected future sea level change on design, construction, operation, and maintenance of projects, the U.S. Army Corps of Engineers (USACE) has provided guidance in the form of Engineering Regulation, ER 1100-2-8162 and Engineering Pamphlet (EP) 1100-2-1. Three scenarios are required by Engineering Regulation (ER) 1100-2-8162: a Baseline (or "Low") scenario, which is based on historic sea level rise and represents the minimum expected sea level change; an Intermediate scenario; and a High scenario representing the maximum expected sea level change, as discussed in Chapter 2 and Chapter 4.

Future sea-level change is likely to result in both direct and indirect impacts on mangrove, wetland and seagrass resources in the project area. Direct impacts could include changes in coverage of habitat due to higher water levels. Indirect impacts could result from salt water intrusion into the freshwater wetlands. See Section 4.4 Sea Level Change Considerations. The largest uncertainty is predicting the level and types of human activities that may be conducted to protect the shoreline in response to advancing sea level.

5.2.1.2 CONCLUSIONS

Potential cumulative impacts on many resources were considered as part of this study and the majority of these resources were determined to have little risk of being cumulatively impacted. These included land use, terrestrial natural resources, threatened or endangered species, other fish and wildlife, managed fishes, the estuarine water column, certain water quality parameters (turbidity and hazardous and toxic constituents), sediments (hazardous and toxic constituents), coastal barrier resources, bay shorelines and adjacent properties, air quality, noise, aesthetics, cultural and historic resources, environmental justice, and recreation.

Chapter 6: Environmental Compliance



6 ENVIRONMENTAL COMPLIANCE^{40*}

This chapter discusses the status of coordination and compliance of the Recommended Plan with environmental requirements. Additionally, it shows how the Recommended Plan meets USACE Environmental Operating Principles.

6.1 SCOPING

The NEPA scoping period for the study was initiated by letter dated October 16, 2018. Public and interagency meetings were then held November 8, 2018 in San Juan. Comments and feedback received were primarily concerning sea turtles, manatees, coral reefs/benthic resources, fish habitat, public safety, recreation and tourism. Pertinent correspondence associated with this NEPA scoping process is included in **Appendix G**.

6.2 COOPERATING AGENCIES

This proposed project has been coordinated with the following agencies, among others: USFWS, NMFS, U.S. Environmental Protection Agency (EPA), State Historic Preservation Officer (SHPO), Department of Natural and Environmental Resources, Puerto Rico Environmental Quality Board and OGPe. The EPA by electronic correspondence dated November 13, 2018 indicated they will be a Participating Agency under NEPA and E.O. 13807 ("One Federal Decision"). USFWS by letter dated November 15, 2018 indicated they will not be able to be a cooperating agency for the NEPA process; however, the USFWS will provide technical assistance regarding possible impacts to fish and wildlife resources. The NMFS by letter dated December 21, 2018 accepted USACE's invitation to participate as a cooperating agency. As a cooperating agency, NMFS has provided comments on the draft IFR/EA and participates in teleconferences. Correspondence from all Federal and State agencies in included in **Appendix F, Attachment 5.**

6.3 LIST OF RECIPIENTS

The Notice of Availability (NOA) of the draft IFR/EA and Draft FONSI were mailed to those listed in **Appendix G**, Mailing List on July 28, 2020.

6.4 COMMENTS RECEIVED AND RESPONSE

Comments received during scoping and public meetings are discussed in Section 6.1 above and included in **Appendix G**. Comments received in response to release of the NOA for the draft IFR/EA were compiled into a comment/response matrix also included in **Appendix G**. These comments were primarily focused on consideration of adjacent/ongoing projects, factoring rainfall into the analysis, use of green infrastructure, viewshed impacts and long-term O&M.

6.5 ENVIRONMENTAL COMMITMENTS

USACE shall comply with the terms and conditions resulting from the informal ESA consultations with the USFWS and NMFS, and the Water Quality Certification to be issued by DNER.

⁴⁰ Note that sections pertinent to the NEPA analysis are denoted with an asterisk.
SEA TURTLES IN THE WATER

• The contractor shall instruct all personnel associated with the project of the potential presence of these species and the need to avoid collisions with them. All construction personnel are responsible for observing water-related activities for the presence of sea turtles.

• The contractor shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles, which are protected under the Endangered Species Act of 1973.

• Siltation barriers shall be made of material in which a sea turtle cannot become entangled, be properly secured, and be regularly monitored to avoid protected species entrapment. Barriers may not block sea turtle entry to or exit from the area.

• All vessels associated with the construction project shall operate at " no wake/idle" speeds at all times while in the construction area and while in water depths where the draft of the vessel provides less than a four-foot clearance from the bottom. All vessels will preferentially follow deep-water routes (e.g., marked channels) whenever possible.

• If a sea turtle is seen within 100 yards of the active construction or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet of a sea turtle. Operation of any mechanical construction equipment shall cease immediately if a sea turtle is seen within a 50-ft radius of the equipment. Activities shall not resume until the sea turtle has departed the project area of its own volition.

• Any collision with and/or injury to a sea turtle shall be reported immediately to the National Marine Fisheries Service's Protected Resources Division (727-824-5312) and the local authorized sea turtle stranding/rescue organization.

MANATEES

• All vessels associated with the construction project shall operate at "Idle Speed/No Wake" at all times while in the immediate area and while in water where the draft of the vessel provides less than a 4 foot clearance from the bottom. All vessels will follow routes of deep water whenever possible.

• Siltation or turbidity barriers shall be made of material in which manatees cannot become entangled, shall be properly secured, and shall be regularly monitored to avoid manatee entanglement or entrapment. Barriers must not impede manatee movement.

• All on-site project personnel are responsible for observing water-related activities for the presence of manatee (s). All in-water operations, including vessels, must be shut down if a manatee(s) comes within 50 feet of the operation. Activities will not resume until the manatee(s) has moved beyond the 50-foot radius of the project operation, or until 30 minutes elapses if the manatee(s) has not reappeared within 50 feet of the operation. Animals must not be herded away or harassed into leaving.

• Any collision with or injury to a manatee shall be reported to Department of Natural and Environmental Resources Law Enforcement (787-724-5700) and the USFWS Caribbean Ecological Services Field Office (787-851-7297).

• Temporary signs concerning manatees shall be posted prior to and during all in-water project activities. All signs are to be removed by the contractor upon completion of the project.

PUERTO RICAN BOA

The U.S. Fish and Wildlife Service has developed recommendations to avoid or minimize impacts on the boa during a project development in an area where the boa may occur. The recommendations are the following:

- Prior to any earth movements or vegetation clearing, the boundaries of the project area, the buffer areas and areas to be protected should be clearly marked in the project plan and in the field.
- A pre-construction meeting should be conducted to inform supervisors and employees about the conservation of protected species, as well as penalties for harassing or harming such species.
- Prior to any use of machinery on areas where the boa may occur, the vegetation should be cleared by hand to provide time to the boa, if present, to be detected or move away from the area. All personnel involved in site clearing must be informed of the potential presence of the snake, and the importance of protecting the snakes.
- Site personnel should be conscious of the possibility of boas sunning in open areas.
- Before activities commence each workday during the vegetation clearing phase, the experienced personnel in identifying and searching for boas should survey the areas to be cleared that day, to ensure that boas are not present or affected within the work area. If boas are found within the working area, activities should stop at the area where the boas are found until the boas move out of the area on their own. Activities at other work sites, where no boas have been found after surveying the area, may continue. If relocation of the species is necessary, any relocated boas should be transferred by authorized personnel of the Department of Natural and Environmental Resources (DNER) to appropriate habitat close to the project site. Any findings should be reported to the Service and to the DNER Ranger office so they can further assist you in developing sound conservation measures and specific recommendations to avoid, minimize and/or compensate for any impacts to this species.
- Strict measures should be established to minimize boa casualties by motor vehicles or other equipment. Before operating or moving equipment and vehicles in staging areas near potential boa habitats (within 25 meters of potential boa habitat), these should be thoroughly inspected to ensure that no boas are lodged in the standing equipment or vehicles. If boas are found within vehicles or equipment, authorized personnel of DNER must be notified immediately for proper handling and relocation. Any relocated boas should be transferred to appropriate habitat close to the project site.

WATER QUALITY

• The Contractor shall monitor water quality (turbidity) at the construction sites, as required by the

401 Water Quality Certification.

• If turbidity values at the construction site exceed permitted values, the Contractor shall suspend all construction activities. Construction shall not continue until water quality meets state standards.

<u>OTHER</u>

- Migratory birds (adult birds, eggs and chicks) shall be protected during construction activities.
- In the event that cultural resources are discovered, then protective measures shall be utilized.
- The environmental resources within the project boundaries and those affected outside the limits of permanent work would be protected during the entire period of work.
- An oil spill prevention plan shall be required.

6.6 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

6.6.1 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) OF 1969

Environmental information on the project has been compiled and the draft IFR/EA was coordinated with interested stakeholders for review and comment. The project is in compliance with the National Environmental Policy Act.

6.6.2 ENDANGERED SPECIES ACT OF 1973

USACE determined construction of the Recommended Plan may affect but would be not likely to adversely affect ESA listed species. The USACE initiated consultation with both the USFWS and NMFS on August 5, 2020. USFWS concurred that the proposed action may affect but is not likely to adversely affect the Antillean manatee and Puerto Rican boa by letter dated August 31, 2020. NMFS concurred that the proposed action may affect the green, leatherback, loggerhead and hawksbill sea turtles, scalloped hammerhead shark, Nassau grouper, and giant manta ray by letter dated January 14, 2021. All correspondence can be found within **Appendix F, Attachment 5.** This project is in full compliance with the Endangered Species Act.

6.6.3 FISH & WILDLIFE COORDINATION ACT OF 1958

The Corps and USFWS agreed to utilize the San Juan Metro Area, Puerto Rico Coastal Storm Risk Management Feasibility Report NEPA review and ESA consultation processes to complete coordination responsibilities under the FWCA. This agreement avoids duplicate analysis and documentation as authorized under 40 CFR section 1500.4 (k), 1502.25, 1506.4, and is consistent with Presidential Executive Order for Improving Regulation and Regulatory Review, released January 18, 2011. The signed Memorandum for the Record is included in **Appendix G**. The project is in full compliance with the Act.

6.6.4 NATIONAL HISTORIC PRESERVATION ACT OF 1966 (INTER ALIA)

The Proposed Action will be in compliance with Section 106 of the National Historic Preservation Act. USACE has initiated consultation, consulted on a tentative APE prior to determination of a TSP, and received concurrence on the development of a programmatic agreement. Pursuant to 54 U.S.C. 306108, 36 CFR 800.4(b)(2), and 36 CFR 800.14(b)(1)(ii), USACE will defer final identification and evaluation of historic properties until after project approval, additional funding becomes available, and prior to construction by executing the programmatic agreement. A programmatic agreement has been executed, and is included as **Appendix H** to this report.

6.6.5 CLEAN WATER ACT OF 1972

A Section 401 water quality certification (State permit) application will be submitted to DNER, and USACE will obtain this certification prior to construction. All Commonwealth water quality requirements would be met. A Section 404(b) evaluation is included in this report as **Appendix F, Attachment 1.** The DNER issued a letter to USACE dated November 23, 2020 which stated: "Based on the information contained in the Draft IFR-EA, the Government of Puerto Rico has determined that, at this stage, the proposed federal activities are conditionally consistent with and are not likely to exceed. our water quality standards. The DNER is likely to issue a Water Quality Certification (WQC) in accordance with Section 401 of the Clean Water Act." The project shall be in full compliance with this Act.

6.6.6 CLEAN AIR ACT OF 1972

The short-term impacts from construction equipment associated with the project would not significantly impact air quality. No air quality permits would be required for this project. San Juan Bay is designated as an attainment area for Federal air quality standards under the Clean Air Act. Because the project is located within an attainment area, USEPA's General Conformity Rule to implement Section 176(c) of the Clean Air Act does not apply and a conformity determination is not required.

6.6.7 COASTAL ZONE MANAGEMENT ACT OF 1972

A Federal consistency determination (CD) in accordance with 15 CFR 930 Subpart C was included in the draft report as Appendix G attachment 2. The USACE CD determined the proposed activity is consistent to the maximum extent practicable with the enforceable policies of the Puerto Rico Coastal Management Program. The CD was submitted to the PRPB and Commonwealth concurrence was issued by letter dated October 28, 2020, which can be found in **Appendix F, Attachment 2**. This project is in compliance with this Act.

6.6.8 FARMLAND PROTECTION POLICY ACT OF 1981

No prime or unique farmland would be impacted by implementation of this project. This Act is not applicable to the project.

6.6.9 WILD AND SCENIC RIVER ACT OF 1968

No designated Wild and Scenic river reaches would be affected by project related activities. This project is in compliance with this Act.

6.6.10 MARINE MAMMAL PROTECTION ACT OF 1972

USACE does not anticipate the take of any marine mammal during any activities associated with the project. Trained observers will monitor construction activities to ensure appropriate actions are taken to avoid adverse effects to listed and protected marine mammal species during project construction. Therefore, this project is in compliance with this Act.

6.6.11 ESTUARY PROTECTION ACT OF 1968

In the Estuary Protection Act Congress declared that many estuaries in the United States are rich in a variety of natural, commercial, and other resources, including environmental natural beauty, and are of immediate and potential value to the present and future generations of Americans. This Act is intended to protect, conserve, and restore estuaries in balance with developing them to further the growth and development of the Nation. The SJBE is of national significance; the proposed nature-based features will be designed to provide habitat while minimizing storm damage, therefore, this project is consistent with the purposes of this Act.

6.6.12 FEDERAL WATER PROJECT RECREATION ACT

The principles of the Federal Water Project Recreation Act, (Public Law 89-72) as amended, have been fulfilled by complying with the recreation cost-sharing criteria as outlined in Section 2 (a), paragraph (2).

6.6.13 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT OF 1976

Pursuant to the 2019 EFH Finding between USACE and NMFS, USACE's Notice of Availability of the draft IFR/EA initiated consultation under the Magnuson-Stevens Fishery Conservation and Management Act. The EFH assessment can be found in sections 2.2.1-2.2.4 and 5.1-5.5. The USACE determined, based on the preliminarily estimated impacts, the project is not anticipated to significantly affect EFH or federally managed fisheries in Puerto Rico. The NMFS provided three EFH conservation recommendations (CRs) by letter dated September 14, 2020. These included: 1) avoiding to the maximum extent practicable existing habitat based on site-specific surveys less than two years old and the USACE agreed, 2) using a functional assessment tailored to Puerto Rico and the USACE agreed to use UMAM which was recently approved for use in Puerto Rico, and 3) convene an interagency team to develop final plans for the NNBF and mitigation and the USACE agreed to continue informal interagency communication with regards to final designs and mitigation. The USACE responded by letter dated October 5, 2020 completing EFH consultation, located in **Appendix F, Attachment 5**. The project is in compliance with the Act.

6.6.14COASTAL BARRIER RESOURCES ACT AND COASTAL BARRIER IMPROVEMENT ACT OF 1990

The Coastal Barrier Resources Act (CBRA) and the Coastal Barrier Improvement Act of 1990 (CBIA) limit federally subsidized development within the CBRA Units to limit the loss of human life by discouraging development in high risk areas, to reduce wasteful expenditures of Federal resources, and to protect the natural resources associated with coastal barriers. CBIA provides development goals for undeveloped coastal property held in public ownership, including wildlife refuges, parks, and other lands set aside for conservation ("otherwise protected areas," or OPAs). These public lands are excluded from most of the CBRA restrictions, although they are prohibited from receiving Federal Flood Insurance for new structures.

There are limits to Federal expenditures related to actions that could affect a unit. The proposed project would not affect the three CBRS Units located near San Juan Bay, PR-87 Punta Vacia Talega and PR-87P Punta Vacia Talega OPA approximately 13-19 km east and PR-86P Punta Salinas OPA approximately 6 km west (Figure 2-5). This project is in compliance with the Act.

6.6.15 RIVERS AND HARBORS ACT OF 1899

The proposed work in not anticipated to obstruct navigable waters of the United States. The proposed action will be subject to public notice and other evaluations normally conducted for activities subject to the Act. The project will be in compliance with this Act

6.6.16 ANADROMOUS FISH CONSERVATION ACT

This Act authorizes the Secretaries of the Interior and Commerce to enter into cooperative agreements with the States and other non-federal interests for conservation, development, and enhancement of anadromous fish and to contribute up to 50 percent as the Federal share of the cost of carrying out such agreements. As this project is not receiving funding for these purposes, this Act does not apply.

6.6.17 MIGRATORY BIRD TREATY ACT AND MIGRATORY BIRD CONSERVATION ACT

Migratory birds would be minimally affected by construction. USACE will include our standard migratory bird protection requirements in the project plans and specifications and will require the Contractor to abide by those requirements. Construction activities will be monitored at dawn or dusk daily during the nesting season to protect nesting migratory birds. If nesting activities occur within the construction area, appropriate buffers will be placed around nests to ensure their protection. The project is in compliance with these Acts.

6.6.18 UNIFORM RELOCATION ASSISTANCE AND REAL PROPERTY ACQUISITION POLICIES ACT OF 1970.

The purpose of PL 91-646 is to ensure that owners of real property to be acquired for Federal and federally assisted projects are treated fairly and consistently and that persons displaced as a direct result of such acquisition will not suffer disproportionate injuries as a result of projects designed for the benefit of the

public as a whole.

While one of the alternatives considered during plan formulation included the acquisition of real property, this is not part of the Recommended Plan. Therefore, this project does not involve any real property acquisition or displacement of property owners or tenants. Therefore, this Act is not relevant to this project.

6.6.19 EXECUTIVE ORDER (EO) 11990, PROTECTION OF WETLANDS

Approximately 14.8 acres of wetlands are preliminarily estimated to be affected by project activities. The nature-based CSRM measures will provide some wetland functions. Please see **Appendix F** preliminary mitigation plan for more information. This project will result in no net loss of wetland functions and will be in compliance with the goals of this Executive Order.

6.6.20 E.O 11988, FLOOD PLAIN MANAGEMENT

To comply with EO 11988, the policy of USACE is to formulate projects that, to the extent possible, avoid or minimize adverse effects associated with the use of the floodplain and avoid inducing development in the floodplain unless there is no practicable alternative. No activities associated with this project are located within a floodplain, which is defined by EO 11988 as an "area which has a one percent or greater chance of flooding in any given year." The project is located within the Coastal High Hazard Area (CHHA), as defined by EO 11988 as an "area subject to inundation by one-percent-annual chance of flood, extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high velocity wave action from storms." The project shoreline is significantly developed, and further development is anticipated to be minimal.

CSRM projects are inherently located in coastal areas, and are often located in CHHAs based on the problems the project is seeking to alleviate. The primary objective of this study is to reduce the risk of damages to assets while not increasing risk to life safety There is no practicable alternative that could be located outside of the CHHA that would achieve this objective.

For the reasons stated above, the project shall be in compliance with EO 11988, Floodplain Management.

Executive Order 11988 requires Federal agencies avoid, to the extent possible, the long and short term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities."

The Water Resources Council Floodplain Management Guidelines for implementation of EO 11988, as referenced in USACE ER 1165-2-26, requires an eight step process that agencies should carry out as part of their decision making on projects that have potential impacts to, or are within the floodplain. The eight steps and project-specific responses to them are summarized below.

1. Determine if a proposed action is in the base floodplain (that area which has a one percent or greater chance of flooding in any given year). The proposed action is within the base floodplain.

However, the project is designed to reduce the risk of damages to existing assets located landward of the proposed project.

- 2. If the action is in the base flood plain, identify and evaluate practicable alternatives to the action or to location of the action in the base flood plain. Chapters 3 discusses the process of screening and analyzing both measures and alternatives. Nonstructural, structural, and NNBF measures were all considered in the process.
- 3. If the action must be in the floodplain, advise the general public in the affected area and obtain their views and comments. An Environmental Assessment (EA) has been developed concurrently with the report during the study. During this process the local stakeholders and the general public have been afforded the opportunity to review and comment on the study recommendations.
- 4. Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial flood plain values. Where actions proposed to be located outside the base flood plain will affect the base flood plain, impacts resulting from these actions should also be identified. The anticipated impacts and environmental compliance associated with the Recommended Plan are summarized in Chapters 5 and 6. The project is not expected to alter or impact the natural or beneficial flood plain values.
- 5. If the action is likely to induce development in the base flood plain, determine if a practicable non-flood plain alternative for the development exists. The project provides benefits primarily for existing and previously approved development, and is not likely to induce significant development.
- 6. As part of the planning process under the Principles and Guidelines, determine viable methods to minimize any adverse impacts of the action including any likely induced development for which there is no practicable alternative and methods to restore and preserve the natural and beneficial flood plain values. This should include reevaluation of the "no action" alternative. The project is not expected to induce development in the flood plain. In areas where the project will impact the natural or beneficial flood plain values, environmental mitigation is planned. Due to the built-out level of the city the impact to natural floodplains is considered minimal. Chapter 3 of this report summarizes the alternative identification, screening and selection process. The "no action" alternative was included in the plan formulation phase.
- 7. If the final determination is made that no practicable alternative exists to locating the action in the flood plain, advise the general public in the affected area of the findings. The Draft Integrated Feasibility Report and EA was provided for public review. Public meetings were scheduled during the public review period. Comments received have been addressed and are included in the Final Report.
- 8. Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order. The Recommended Plan is the most responsive to all of the study objectives and the most consistent with the executive order.

6.6.21 E.O. 12898, ENVIRONMENTAL JUSTICE

On February 11, 1994, the President of the United States issued Executive Order 12898, Federal Actions to Address Environmental Justice Populations and Low-Income Populations. The Executive Order mandates that each Federal agency make environmental justice part of the agency mission and to address, as appropriate, disproportionately high and adverse human health or environmental effects of the programs and policies on minority and low-income populations.

Any potential adverse effects of the proposed action would be more likely to affect those of higher socioeconomic status, such as large watercraft owners or those living in the coastal area surrounding the project. The storm damage reduction benefits are primarily benefitting the landowners in this area. There are no disproportionate adverse impacts to minority or low income populations from implementation of the project. **See Appendix F** for the Environmental Justice analysis.

6.6.22 E.O. 13045, DISPARATE RISKS INVOLVING CHILDREN

On April 21, 1997, the President of the United States issued Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks*. The Executive Order mandates that each F ederal agency make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children and ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

As the proposed action does not affect children disproportionately from other members of the population, the proposed action would not increase any environmental health or safety risks to children.

6.6.23 E.O. 13089, CORAL REEF PROTECTION

The EO refers to "those species, habitats, and other natural resources associated with coral reefs." Coral reefs are not anticipated to be affected by construction activities due to distances from the project area. The project is in compliance with this EO.

6.6.24 E.O. 13112, INVASIVE SPECIES

The proposed action will require the mobilization of construction equipment from other geographical regions. Construction equipment has the potential to transport species from one region to another, introducing them to new habitats where they are able to out-compete native species. The proposed project would include measures to clean construction equipment before and between uses which should reduce the potential for the introduction and spread of invasive species.

6.6.25 ENVIRONMENTAL OPERATING PRINCIPLES

1. Foster sustainability as a way of life throughout the organization.

The proposed project formulated measures and alternatives by considering sustainable measures that would mimic the existing site conditions to every extent possible, both when considering structural and natural and nature-based features. Measures were formulated and combined into alternatives with long term adaptability and resilience in mind, to reduce the risk of damages from coastal flooding combined with sea level change.

2. Proactively consider environmental consequences of all USACE activities and act accordingly.

Each measure and subsequently each alternative considered both positive and negative effects in the environmental quality account. Effects were avoided and minimized by considering width footprints of measures, and choosing measures that would have minimal impacts to resources. Additionally, living shorelines consider the native vegetation within the area, and were chosen to create habitat in those environments while serving the function to reduce damages from storm surge.

3. Create mutually supporting economic and environmentally sustainable solutions.

The above description in number 2 demonstrates how environmental effects were considered during the formulation process and in some areas will create additional habitat. The entire Recommended Plan will support the San Juan Metro Area by providing a comprehensive plan to allow communities to experience fewer damages from storms and hurricanes, and recover faster after storms. Additionally, several of the features (living shorelines, breakwaters) bring in recreational elements which can bring communities together, as well as potentially support tourism, therefore strengthening the economy, community, and environment together.

4. Continue to meet our corporate responsibility and accountability under the law for activities undertaken by USACE, which may impact human and natural environments.

This report includes all information necessary to document how the project meets USACE's corporate responsibility and accountability requirements for actions that may impact human and natural environments.

5. Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs.

The team is involved throughout the study process to ensure that environmental considerations are taken into account for the life of the project.

6. Leverage scientific, economic and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner.

The entire Project Delivery Team understands the need to consider the environment during its decision-making process, and worked collaboratively with agencies to foster education and sharing of policies and best management practices.

7. Employ an open, transparent process that respects views of individuals and groups interested in USACE activites.

The actions taken to involve the public, resource agencies, and NGOs who may be interested in the project are outlined in Section 6.1 through 6.4 of this report.



7 **RECOMMENDATIONS**

The Recommended Plan includes levees (1.5 miles), a series of breakwaters over 0.7 miles along the Cataño shoreline, seawalls/floodwalls (6.5 miles), elevated living shoreline (0.7 miles), a discharge structure on the Malaria Canal, and associated inland hydrology features (to allow rainfall runoff drainage with constructed features). The Recommended Plan also contributes to creation of habitat and integrates into the community to allow continued public access to existing facilities and opportunities for outdoor activities. Although the Recommended Plan was formulated to avoid and minimize impacts to every extent possible, impacts are expected to occur and as such the Recommended Plan includes mitigation. It is also recommended that the non-federal sponsor and local communities pursue non-structural measures, such as improved public outreach about coastal flooding, improved evacuation plans and notification systems, and evaluations of re-zoning over time as needed.

Additionally, this report recommends that Reaches 4-6 should be evaluated under a separate study in order to adequately address both storm surge and precipitation (compound flooding) holistically, using the same study authority that is used for this study.

I have given consideration to all significant aspects in the overall public interest including engineering feasibility, economic, social, cost and risk analysis, and environmental effects. The Recommended Plan described in this draft report provides the optimum solution for coastal storm risk management benefits within the study area that can be developed with the framework of the formulation concepts.

7.1 ITEMS OF LOCAL COOPERATION

Federal implementation of the project for coastal risk management is subject to the non-Federal sponsor agreeing to perform, in accordance with applicable Federal laws, regulations, and policies, the required items of local cooperation for the project, including but not limited to the following:

- a. Provide 35 percent of construction costs, as further specified below:
 - (1) Provide, during design, 35 percent of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;
 - (2) Provide all real property interests, including placement area improvements, and perform all relocations determined by the Government to be required for the project;
 - (3) Provide, during construction, any additional contribution necessary to make its total contribution equal to at least 35 percent of construction costs;
- b. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) that might reduce the level of coastal storm risk reduction the project affords, hinder operation and maintenance of the project, or interfere with the project's proper function;
- c. Inform affected interests, at least yearly, of the extent of risk reduction afforded by the project; participate in and comply with applicable Federal floodplain management and flood insurance programs; prepare a floodplain management plan for the project to be implemented not later than one year after completion of

construction of the project; and publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with the project;

- d. Operate, maintain, repair, rehabilitate, and replace the project or functional portion thereof at no cost to the Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal laws and regulations and any specific directions prescribed by the Government;
- e. Give the Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project to inspect the project, and, if necessary, to undertake work necessary to the proper functioning of the project for its authorized purpose;
- f. Hold and save the Government free from all damages arising from design, construction, operation, maintenance, repair, rehabilitation, and replacement of the project, except for damages due to the fault or negligence of the Government or its contractors;
- g. Perform, or ensure performance of, any investigations for hazardous, toxic, and radioactive wastes (HTRW) that are determined necessary to identify the existence and extent of any HTRW regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601-9675, and any other applicable law, that may exist in, on, or under real property interests that the Federal government determines to be necessary for construction, operation and maintenance of the project;
- h. Assume, as between the Government and the non-Federal sponsor, complete performance and financial responsibility for all necessary cleanup and response actions and costs of any HTRW regulated under applicable law that are located in, on, or under real property interests required for construction, operation, maintenance, repair, rehabilitation, or replacement of the project;
- i. Agree, as between the Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the owner and operator of the project for the purpose of CERCLA liability or other applicable law, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause HTRW liability to arise under applicable law; and
- j. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. 4630 and 4655) and the Uniform Regulations contained in 49 C.F.R Part 24, in acquiring real property interests necessary for construction, operation, and maintenance of the project including those necessary for relocations, and placement area improvements; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

KELLY ANDREW.D Digitally signed by ONALD.JR.1025510 MELLY ANDREW DONALD JR.1 025510075 875 Date: 2021.04.06 06:43:35-04:07

ANDREW D. KELLY, JR. COL, EN Commanding



8 LIST OF PREPARERS

8.1 PREPARERS

This Feasibility Report with Integrated Environmental Assessment was prepared by the following U.S. Army Corps of Engineers:

Stacey Roth, P.E. (USACE) Paul DeMarco (USACE) Chris Altes (USACE) Environmental Engineer Biologist Archeologist

8.2 **REVIEWERS**

This report was reviewed by the following personnel:

Angela Dunn Sheila Hint Biologist Project Manager

San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT



9 **REFERENCES AND INDEX**

9.1 REFERENCES

Anamar Environmental Consulting, Inc. 2013. Draft Report. San Juan Harbor Navigation Improvement Project (Post 45) Dredging MPRSA Section 103 Sediment Testing and Analysis, San Juan, Puerto Rico. Prepared for the USACE.

Burgess, D. E., George H.M. Riekerk, and Derk C. Bergquist. 2011. The 2007-2009 Grand Strand nourishment project: Impact of sand migration on invertebrate communities associated with nearshore and hardbottom habitats. Submitted to U.S. Army Corps of Engineers, Charleston District, Prepared by SC Department of Natural Resources, Marine Resources Division.

Clarke, D., Dickerson, C., and K. Reine 2002. "Characterization of underwater sounds produced by dredges. Dredging 2002, ASCE, Orlando, Florida, USA, p 64-81.

Coll Rivera Environmental. 2005. Biological Monitoring Report – Installation of the SMPR-1 Submarine Fiber Optic Cable, Isla Verde, Puerto Rico. Prepared for: Saint Marten International Telecommunications Services, Inc. 30 pp.

Environmental Quality Board, 2020. Puerto Rico Water Quality Standards Regulation. www.jca.pr.gov.

Ernst, C.H., and R. W. Barbour. 1972. Turtles of the United States, Univ. Press Kentucky, Lexington, 342

Haberer, Yvonne L. 2005. An Environmental Review of the Condado Lagoon Ecosystem Restoration Project. A Capstone Review Paper. Nova Southeastern University Oceanographic Center.

Hirth, H.F. 1997. Synopsis of the biological data on the green turtle *Chelonia mydas* (Linnaeus 1758). Biological Report 97(1), U.S. Fish and Wildlife Service, U.S. Dept. of the Interior. 120 pp.

MRI. 2005. Marine Benthic Resource Survey and Biological Assessment for Condado Lagoon and San Geronimo Fort, San Juan, Puerto Rico. Marine Resources Inc.

National Marine Fisheries Service (NMFS). 2016. San Juan Harbor Project, Puerto Rico. Quick Look Video Survey Report of the Benthic Communities of San Juan Bay Adjacent to Navigation Channels. Jose Rivera. NOAA, National Marine Fisheries Service. San Juan, Puerto Rico.

NMFS and USFWS. 1991. Recovery Plan for U.S. Population of Loggerhead Turtle. National Marine Fisheries Service, Washington, D.C.

National Oceanic and Atmospheric Administration (NOAA). 2013. Draft guidance for assessing the effects of anthropogenic sound on marine mammals. Acoustic threshold levels for onset of permanent and temporary threshold shifts. URL:

http://www.nmfs.noaa.gov/pr/acoustics/draft acoustic guidance 2013.pdf.

Ojeda-Serrano, E., R. Appeldoorn, I. Ruiz-Valentin. 2007. Reef fish Spawning Aggregations of the Puerto Rican Shelf. Caribbean Coral Reef Institute. University of Puerto Rico, Mayagüez, PR.

Reine, Kevin J., Douglas Clarke and Charles Dickerson. 2012b. Characterization of underwater sounds produced by a backhoe dredge excavating rock and gravel. ERDC-TN-DOER-E36. December 2012.

South Atlantic Fishery Management Council (SAFMC).1998. Final Habitat Plan for the South Atlantic Region: Essential Fish Habitat Requirements for Fishery Management Plans of the South Atlantic Fishery Management Council. SAFMC. Charleston, SC. 457 pp.

U.S. Fish and Wildlife Service (USFWS). 2017. Final Fish and Wildlife Coordination Act Report for San Juan Harbor Improvements Study. San Juan, Puerto Rico.

USFWS. 2011. Puerto Rican Boa 5-Year Status Review. San Juan, Puerto Rico.

Zug, G.R. and Parham, J.F. 1996. Age and growth in leatherback sea turtles *Dermochelys coriacea*. Chelonian Conservation and Biology 2(2):244-249.

Acosta, Ivonne, 2014. Breve Historia de Puerto Rico. In *Enciclopedia de Puerto Rico*, electronic document, <u>www.enciclopediapr.org</u>.

Krivor, Michael, 2017. San Juan Harbor Improvement Study, San Juan, Puerto Rico Submerged Cultural Resources Survey. USACE Contract No. W912EP-17-F-0004, document on file at office of Puerto Rico State Historic Preservation Officer, San Juan, Puerto Rico.

Jiméz de Wagenheim, Olga, 1998. Puerto Rico: An Interpretive History, from Pre-Colombian Times to 1900. Markus Wiener: Princeton, NJ

Giusti, Juan A., 2014. The English Invasion of 1797. In *Enciclopedia de Puerto Rico*, electronic document, <u>www.enciclopediapr.org</u>.

Oficina Estatal de Conservación Histórica (OECH), 2016. Información Arqueológica del Municipio de San Juan, document on file at office of Puerto Rico State Historic Preservation Officer, San Juan, Puerto Rico.

9.2 INDEX

Α

Air Quality · 2-21 Alternatives · 3-7

С

Clean Air Act of 1972 · 6-5 Climate · 5-14 Coastal Barrier Improvement Act of 1990 · 6-6 Coastal Barrier Resources Act · 6-6 Construction · 3-14

Ε

Economics · 5-14, 6-11 Economy · 3-1 Endangered Species Act of 1973 · 6-4 Environmental Assessment · 6-4 Environmental Justice · 6-9, 6-10 Essential Fish Habitat · 5-12 Estuary Protection Act of 1968 · 6-6 Executive Orders E.O. 12898, Environmental Justice · 6-9

F

Federal · 2-1, 3-6, 3-7 FWS · 2-14

G

Geology · 2-40

Η

Habitat \cdot 2-14

1

Impact · 3-7 Income · 6-9, 6-10 Introduction · 3

L

Listed Species West Indian Manatee · 6-2 Location · 2-14

Μ

Mitigate · 3-7

Ν

National Environmental Policy Act · 3-1, 3-7, 6-4 National Historic Preservation Act of 1966 · 6-5 No Action Alternative · 2-31, 2-33, 2-34, 2-35, 2-36, 2-37, 2-39, 2-40, 2-41, 2-43, 2-44, 2-47

Ρ

Plan Formulation \cdot 3

R

Recommendations · 3, 7-1 Recommended Plan · 7-1 References · 3 Resources · 3-7 risk · 6-11

S

Scoping · 3 Screening Alternatives · 3-1

San Juan Metro Area Coastal Storm Risk Management Study FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

San Juan Metro Area Coastal Storm Risk Management (CSRM) Study, Puerto Rico

INTRODUCTION

BACKGROUND

Puerto Rico is significant to the nation with its rich cultural heritage, unique environmental resources, and tourism. Storms and hurricanes put Puerto Rico's metropolitan areas, with their dense populations, at risk of coastal flooding. The study area within the San Juan Metro Area has approximately 20,000 assets, with a combined estimated value of approximately \$3.4 billion. Coastal flooding from storm surge, tide and wave contributions cause major damages to these assets and will continue to do so with increased risk from sea level change.

PROBLEMS



- Communities experience coastal flooding damages, which results from storm surge, tide, and wave contributions.
- 2. Community resilience is impacted before, during and after storms and hurricanes.
- 3. Future sea level rise conditions will exacerbate these problems.

STUDY AUTHORIZATION AND PROCESS

Authority for the San Juan Metro (back bay) Coastal Storm Risk Management (CSRM) study is granted under Section 204 of the Flood Control Act of 1970, Public Law 91-611. Study funds were appropriated under Bipartisan Budget Act of 2018 Public Law 115-123.



Final Integrated Feasibility Report & Environmental Assessment



ECONOMICS – The National Economic Development Plan (NED)

Recommended Plan ECONOMIC SUMMARY (FY21 price level, 50-year period of analysis, 2.5% discount rate)		70 <u> </u>
Total Average Annual Cost	\$15.3M	50 40
Average Annual Total Benefits	\$72.9M	30 20
Average Annual Net Benefits	\$57.6M	
Benefit Cost Ratio (BCR) (2.5 % discount rate)	4.8	202

ENVIRONMENTAL & CULTURAL RESOURCES

The National Environmental Policy Act (NEPA) is a federal law enacted in 1969. As required by NEPA, the Corps has assessed potential environmental effects, including cultural resources, of alternatives and the Recommended Plan. The findings are explained in the NEPA document, which is integrated into this Final Report and Environmental Assessment. Although the NED plan was formulated to avoid and minimize impacts to every extent possible, impacts are expected to occur to submerged aquatic vegetation (SAV), mangroves, and wetlands, and would be addressed with mitigation close to the project site. Environmental compliance for this feasibility report is complete.

ENGINEERING & MODELING



RECOMMENDED PLAN & BENEFITS

The Recommended Plan reasonably maximizes net benefits to contribute to national economic development (NED) and is consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.



EQ

flooding with approximately 98-100% reduction in damages to assets Risk reduction to Hurricane and Tsunami Emergency evacuation route

TOTAL =20,000 assets, estimated value of \$3.48 Population: ~2 Million

Elevated living shoreline will create habitat Potential Incidental water quality improvements

Although the NED plan was formulated to avoid and minimize impacts to every extent possible, impacts are expected to occur and would be addressed with mitigation Anticipated that mitigation can be constructed close by





The graph shows that benefits would be expected to begin in the year 2029. Recommended Plan is 98% to 100% effective at reducina damages.



Economic damages The engineering analysis for this study has considered the natural coastal processes, geological setting, existing protective features in the study area, as well as sea level rise scenarios. The team has leveraged data and local expertise from the sponsor (PR DNER) and other aroups (PR Academia, stakeholders, Federal agencies, etc.) along with modeling to order to fully understand the problems and develop alternatives to reduce storm damages within the study area. The Corps certified model Generation II Coastal Storm Risk Model (G2CRM) was used for this study.



Maintains life safety

Reduces flooding frequency and duration for both major storm events and nuisance tidal flooding (Condado Lagoon) Increases community resilience associated with sea level rise for entire San Juan Metro Area Existing recreational facilities are not impacted Some features contribute to incidental opportunities for outdoor activities Public access to water is maintained Features work together to strengthen economy of the metro area

U.S. ARMY CORPS OF ENGINEERS



San Juan Metro Area Coastal Storm Risk Management (CSRM) Study, Puerto Rico THE RECOMMENDED PLAN A Cohesive Plan to Reduce the Risk of Damages from Coastal Flooding in the San Juan Metro Area



Final Integrated Feasibility Report & Environmental Assessment

JUCI



KEY FEATURES Structural

- Levees = 1.5 miles
- Seawall/floodwall = 6.5 miles
- 1 Discharge Structure (Malaria Canal)
- Natural & Nature Based Features (NNBF)
- Elevated living shoreline = 0.7 miles
- Breakwater = 0.7 miles
- Habitat creation (Elevated Living shoreline)
- Mitigation for SAV, mangroves, wetland

Incidental recreation opportunities *It is also recommended that the nonfederal sponsor pursues non-structural measures such as local outreach & evacuation plan/notification

improvements PROJECT FIRST COST*: \$365.2M (*includes 37% risk-based contingency) Federal Cost (65%): \$237.9M** Non-Federal Cost (35%): \$127.3M** (**Section 1032 of WRRDA 14 was applied)

AVG OPERATION & MAINTENANCE: Estimated \$819,000/year over 50-year period of analysis

AAEQ NET BENEFITS: \$57.6M AAEQ Benefits: \$72.9M AAEQ Costs: \$15.3M

BCR: 4.8 at 2.5%



U.S. ARMY CORPS OF ENGINEERS

