



DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, JACKSONVILLE DISTRICT
701 SAN MARCO BOULEVARD
JACKSONVILLE, FLORIDA 32207-8915

- 9 MAY 2019

CESAJ-EN-Q

MEMORANDUM FOR Commander, South Atlantic Division (CESAD-RBT), 60 Forsyth Street SW, Room 10M15, Atlanta, GA 30303

SUBJECT: Approval of Review Plan for the Rio Grande de Arecibo Supplemental Project Hydrology and Hydraulic Products

1. References.

- a. Engineering Circular (EC) 1165-2-217, Review Policy for Civil Works, 20 Feb 18.
- b. Bipartisan Budget Act of 2018, Public Law 115-123, 9 Feb 2018.

2. I hereby request approval of the enclosed Review Plan for the Rio Grande de Arecibo Supplemental Project Hydrology and Hydraulic Products and concurrence with the conclusion that a Type II Independent External Peer Review (IEPR) of the subject project is not required. The recommendation not to perform a Type II IEPR is based on the EC 1165-2-217 Risk Informed Decision Process as presented in the Review Plan. The Review Plan complies with applicable policy, provides for Agency Technical Review, and has been coordinated with the CESAD. It is my understanding that non-substantive changes to this Review Plan, should they become necessary, are authorized by CESAD.

3. The district will post the CESAD approved Review Plan to its website and provide a link to the CESAD for its use. Names of Corps/Army employees will be withheld from the posted version, in accordance with guidance.

4. If you have any questions regarding the information in this memo, please feel free to contact me or contact [REDACTED].

Encl



COL, EN
Commanding



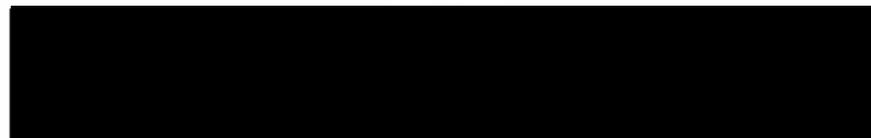
**US Army Corps
of Engineers.**

Prepared by:
**SAJ District
SAD Division**

Rio Grande de Arecibo Supplemental Project Hydrology and Hydraulic Products

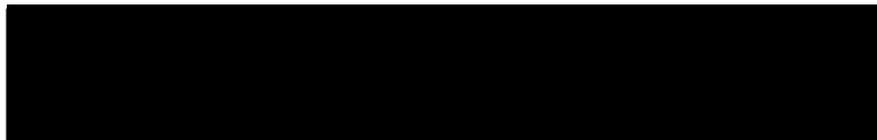
Review Plan

**PREPARED
BY:**



Chief, Hydraulic Design Section
USACE, Jacksonville District

**ENDORSED
BY:**



Chief, Eastern Division
USACE, Risk Management Center

MSC Approval Date:

Last Revision Date:

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Section 1

Introduction

1.1 Purpose

This Review Plan (RP) for the Hydrology and Hydraulic (H&H) products of the Rio Grande de Arecibo Supplemental Project (P2# 113885) will help ensure a quality-engineering project is developed by the Corps of Engineers in accordance with EC 1165-2-217, "Review Policy for Civil Works." As part of the Project Management Plan, this RP establishes an accountable, comprehensive, life-cycle review strategy for Civil Works products and describes the scope of review for the current phase of work. This RP is solely focused on the H&H products of the Rio Grande de Arecibo Supplemental Project. Products include HEC-RAS hydraulic routing model and an HEC-HMS hydrologic routing model. The results of this review will be provided in subsequent project reviews of the design phase implementation documents, including the plans and specifications (P&S) and the Design Documentation Report (DDR), as a reference. The H&H products will not require further review unless significant changes are made to them during the design phase that cause previous reviews to be superseded. A separate review plan will be developed describing the scope of review for the design phase implementation documents associated with the remaining construction contracts of the Rio Grande de Arecibo Supplemental Project.

1.2 References

- EC 1165-2-217, Review Policy For Civil Works, 20 February 2018
- ER 1110-1-12, Quality Management, 31 March 2011
- ER 415-1-11, Biddability, Constructability, Operability, Environmental and Sustainability (BCOES) Reviews, 1 January 2013
- ER 1110-2-1150, Engineering and Design for Civil Works Projects, 31 August 1999
- EM 1110-2-1913 Design, Construction, and Evaluation of Levees, 30 April 2000
- EM 1110-2-1418, Channel Stability Assessment for Flood Control Projects, 31 October 1994
- EM 1110-2-1601, Hydraulic Design of Flood Control Channels, 1 July 1991
- EM 1110-2-1913, Design and Construction of Levees, 30 April 2000
- EM 1110-2-2502, Retaining and Flood Walls, 29 September 1989
- EM 1110-2-2504, Design of Sheet Pile Walls, 31 March 1994
- EM 1110-2-2902, Conduits, Culverts, and Pipes, 31 March 1998
- ETL 1110-2-583, Engineering and Design: Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures, 30 April 2014

- U.S. Department of Interior Bureau of Reclamation and US Army Corps of Engineers, Best Practices in Dam and Levee Safety Risk Analysis, 1 July 2015
- U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC), Hydrologic Modeling System HEC-HMS User's Manual, CPD-74A, Hydrologic Engineering Center, Davis, CA
- U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC), HEC-RAS River Analysis System User's Manual, CPD-68, Hydrologic Engineering Center, Davis, CA
- U.S. Army Corps of Engineers (USACE), Jacksonville District (1993). *Rio Grande De Arecibo, Puerto Rico, Final Feasibility Report and Environmental Impact Statement*. Jacksonville, FL.
- U.S. Army Corps of Engineers (USACE), Jacksonville District (1998). *Rio Grande De Arecibo, Puerto Rico, Limited Reevaluation Report*. Jacksonville, FL.
- Energy Answers Arecibo (2010). *Hydrologic-Hydraulic Study of Río Grande de Arecibo, Renewable Power Generation and Resource Recovery Facility, Arecibo, Puerto Rico*. Albany, NY.
- U.S. Army Corps of Engineers (USACE), Jacksonville District (2016). Rio Grande De Arecibo Flood Risk Management Project, Arecibo, Puerto Rico, Limited Reevaluation Report.
- Project Management Plan (PMP) for Rio Grande de Arecibo Project (P2# 113885)

1.3 Review Management Organization

The USACE Risk Management Center (RMC) is the Review Management Organization (RMO) for this product. Contents of this RP have been coordinated with the RMC and South Atlantic Division (SAD), the Major Subordinate Command (MSC). As RMO, the RMC is responsible for assembling the ATR Team and completing the ATR in accordance with this review plan and USACE guidance. Jacksonville District will assist the RMC with management of the ATR.

Section 2

Project Description

2.1 Project Description

The Arecibo project was authorized for construction by the Bipartisan Budget Act of 2018 (Public Law 115-123), enacted 9 February 2018, and provided funding in support of recovery efforts following Hurricanes Harvey, Irma, and Maria. The project is located in Arecibo, Puerto Rico. The project addresses flood damages caused by the overflow of the Tanamá, Santiago, and Arecibo rivers into the coastal floodplain of Arecibo, Puerto Rico, reducing the effects of the 100-year flood event. The projects will provide protections to the town of Arecibo and the community of Los Caños with a total population at risk of 90,000. The plan of improvement contains three flood control elements including a 2.8-mile long levee and floodwall along the Arecibo River, 2.2 miles of channelization in the lower reaches of the Santiago River, and the replacement of four existing bridges.

Currently, the project work is divided into three contracts. Contract 1 was completed in January 2012 and included construction of the Arecibo Cloverleaf, the Tanamá Levees, and the Rio Santiago Upper Reaches diversion channel. Contract 2A/2B currently includes construction for the Rio Santiago lower reaches channelization and the replacement of three existing bridges, a culvert, and a weir structure. Contract 3 currently includes channel, floodwall, and levee construction, including a closure structure. See Figure 1.

The area undergoing hydrologic and hydraulic analysis is located in the Rio Grande de Arecibo coastal floodplain in the municipality of Arecibo, Puerto Rico. The drainage area covers approximately 487 square kilometers and is one of the largest drainage basins in Puerto Rico. The Rio Grande de Arecibo flows north from the steep slopes of the central mountainous region through the northern karst region and discharges into the Atlantic Ocean. The Rio Grande de Arecibo drainage basin contains various dams designed for hydroelectric production including Dos Bocas and Caonillas Dams. The hydrologic and hydraulic analyses model the project features that provide flood damage protection to the urban area of the municipality of Arecibo from overflows of the Rio Grande de Arecibo and its lower tributaries, the Rio Santiago and Rio Tanamá.

The hydrologic routing model used to determine the appropriate basin runoff was developed using Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS) Version 4.3 and HEC GeoHMS 10.4. The rainfall/runoff analysis will focus on synthetic storm events to match the previously authorized project analysis with updated rainfall totals based on NOAA Atlas 14 rainfall. The methodology for developing the spatial and temporal distribution of rainfall within the 24-hr duration, synthetic design storms will be based on the NRCS approach to applying NOAA Atlas 14 rainfall – this approach has already been reviewed and approved by a member of the Hydrologic Hazards Team (HHT) and is being officially ATR certified as part of the Rio Puerto Nuevo Supplemental Project. Once ATR certified, the methodology will not require ATR review or certification for other Supplemental Projects in Puerto Rico / U.S. Virgin Islands, including the Arecibo project.

The hydraulic routing model used to evaluate project alternatives was developed using Hydrologic Engineering Center – River Analysis System (HEC-RAS) Version 5.0.6 with two-dimensional (2D) flow areas. The HEC-RAS model combined one-dimensional and two-dimensional (1D/2D) unsteady-flow routing simulations of the 100-yr and SPF rainfall runoff events.



Figure 1: Contract Locations

2.2 Project Sponsor

Products and analyses provided by non-Federal sponsors as in-kind services are subject to DQC, ATR, policy and legal compliance, BCOES, and IEPR reviews. However, there will not be in-kind contributions for this effort. The non-Federal sponsor for this project is the Puerto Rico Department of Natural and Environmental Resources (DNER).

Section 3

District Quality Control

3.1 Requirements

All implementation documents (including supporting data, analyses, reports, environmental compliance documents, water control manuals, etc.) shall undergo District Quality Control (DQC) in accordance EC 1165-2-217. A DQC is an internal review process of basic science and engineering work products focused on fulfilling the project quality requirements defined in the PMP. DQC will be performed on the HEC-HMS and HEC-RAS models at the 50% and final stages of development. The District shall perform these reviews in accordance with the Jacksonville District Engineering Division Quality Management System (EN QMS) procedures.

3.2 Documentation

Review comments and responses for the DQC review will be coordinated and documented utilizing an Adobe PDF Shared Review containing the supporting documentation related to the H&H models. The DQC shall be certified by the H&H team member and all applicable Section and Branch Chiefs.

3.3 DQC Schedule and Estimated Cost

Although DQC is always seamless, the following milestone reviews are scheduled in Table 1 for HEC-HMS and Table 2 for HEC-RAS. The cost for the DQC is approximately \$20,000.

Project Phase/Submittal	Review Start Date	Review End Date
DQC 50% Model Review	6 May 2019	17 May 2019
DQC Final Model Review	22 July 2019	2 August 2019

Table 1: DQC Schedule – HEC-HMS Model

Project Phase/Submittal	Review Start Date	Review End Date
DQC 50% Model Review	20 May 2019	31 May 2019
DQC Final Model Review	7 October 2019	25 October 2019

Table 2: DQC Schedule – HEC-RAS Model

Section 4

Agency Technical Review

4.1 Requirements

All implementation documents (including supporting data, analyses, reports, environmental compliance documents, water control manuals, etc.) shall undergo an Agency Technical Review (ATR) in accordance with EC 1165-2-217. ATR reviews will occur seamlessly, including early involvement of the ATR team for validation of key design decisions and at the scheduled milestones as shown in Section 4.6. ATR will be performed on both the HEC-HMS and HEC-RAS models at the 50% and final stages of development. A separate ATR has already been performed by a member of the Hydrologic Hazards Team (HHT) on the Jacksonville District's methodology for developing frequency-based hypothetical design storms in Puerto Rico using NOAA Atlas 14 rainfall (in that particular case, for the Rio Puerto Nuevo project near San Juan, Puerto Rico, January 2019.) The same methodology for developing the spatial and temporal distribution of the 24-hr storm event will be applied to the rainfall for Rio Grande de Arecibo, and therefore an additional review of the rainfall development is not included as part of this ATR. Documentation of the Rio Puerto Nuevo review will be provided as reference. A site visit will not be scheduled for the ATR Team. Additional data required by the ATR team will be gathered by PDT members during plan in hand visits, either by USACE personnel stationed in Puerto Rico or by non-federal team members. The information will be reviewed and disseminated to the ATR team by the PDT.

4.2 Documentation of ATR

Documentation of ATR will occur using the requirements of EC 1165-2-217. This includes the four-part comment structure and the use of DrChecksSM. The ATR for the Plans, Specifications, DDR, and Geotechnical Report will be performed under the guidance of a separate review plan prepared by MVS/MVD.

4.3 Products to Undergo ATR

Products that will undergo ATR include the HEC-HMS hydrologic routing model and associated data, the HEC-RAS hydraulic routing model and associated data, and the supporting documentation for each.

4.4 Required Team Expertise and Requirements

ATR teams will be established in accordance with EC 1165-2-217. The following disciplines will be required for ATR of this project:

ATR Lead: The ATR team lead shall be located outside the home MSC and have experience in preparing Civil Works documents and conducting ATRs. The lead shall have the necessary skills and experience to lead a virtual team through the ATR process. The ATR lead may also serve as a reviewer for a specific discipline, in this case, Hydrologist and/or Hydraulic Engineer.

Hydrologist/Hydraulic Engineer – The Hydrologist/Hydraulic Engineer shall be a registered professional with expertise in hydrologic principles and in the development and application of HEC-HMS hydrologic models. Modeling experience shall include precipitation-runoff analysis, watershed characterization, and hydrologic routing methods.

Hydraulic Engineer – The Hydraulic Engineer shall be a registered professional with expertise in engineering analysis related to flood risk management and levee safety projects. The team member shall have knowledge and experience in the analysis and design of hydraulic structures (e.g., spillways, outlet works, and stilling basins) and application of HEC-RAS 1D/2D hydraulic routing models. The hydraulic engineer shall be knowledgeable and experienced with the routing of inflow hydrographs through multipurpose flood control reservoirs utilizing multiple discharge devices and Corps application of risk and uncertainty analyses in flood damage reduction studies.

If a team member can be located that possesses the required expertise for both the Hydrologist and Hydraulic Engineer, that team member may serve in both positions.

4.5 Statement of Technical Review Report

At the conclusion of each ATR effort, the ATR team will prepare a Statement of Technical Review Report with a completion and certification memo. The report will be prepared in accordance with EC 1165-2-217 and will follow the most recent template developed by the RMC.

4.6 ATR Schedule and Estimated Cost

Although ATR is always seamless, the preliminary ATR milestone schedule is listed in Table 3 for the HEC-HMS and Table 4 for the HEC-RAS2. The total cost for both ATRs is approximately \$38,000.

Project Phase/Submittal	Review Start Date	Review End Date	Site Visit
ATR 50% Model Review	27 May 2019	7 June 2019	NA
ATR Final Model Review	12 August 2019	23 August 2019	NA

Table 3: ATR Schedule – HEC-HMS

Project Phase/Submittal	Review Start Date	Review End Date	Site Visit
ATR 50% Model Review	3 June 2019	14 June 2019	NA
ATR Final Model Review	4 November 2019	15 November 2019	NA

Table 4: ATR Schedule - HEC-RAS

Section 5

Safety Assurance Review

5.1 Decision on SAR

A Safety Assurance Review (SAR), also known as a Type II Independent External Peer Review (IEPR), is not recommended for the H&H products associated with the Rio Grande de Arecibo Supplemental Project. The determination as to whether or not a SAR is required for the design phase implementation documents of remaining construction contracts will be completed under the guidance of a separate Review Plan. This Review Plan will be prepared by the Corps of Engineers St. Louis District (MVS) and approved by Mississippi Valley Division (MVD) during the design phase since MVS will be responsible for preparation of the plans, specifications, and DDR. Because the DDR will include the results of the H&H analyses covered under this

Review Plan, these results can be reviewed during a SAR if required. Therefore, a SAR will not be completed for this H&H analysis independently.

Section 6

Public Posting of Review Plan

As required by EC 1165-2-217, the approved RP will be posted on the District public website (<https://www.saj.usace.army.mil/Missions/Civil-Works/Review-Plans/>). This is not a formal comment period and there is no set timeframe for the opportunity for public comment. If and when comments are received, the PDT will consider them and decide if revisions to the RP are necessary.

Section 7

Review Plan Approval and Updates

The MSC Commander, or delegated official, is responsible for approving this RP. The Commander's approval reflects vertical team input (involving the District, MSC, and RMC) as to the appropriate scope, level of review, and endorsement by the RMC. The RP is a living document and should be updated in accordance with 1165-2-217. All changes made to the approved RP will be documented in Attachment 1, Table 7, RP Revisions. The latest version of the RP, along with the Commanders' approval memorandum, will be posted on the District's webpage and linked to the HQUSACE webpage. The approved RP shall be provided to the RMO.

Section 8

Engineering Models

The use of certified, validated, or agency approved engineering models is required for all activities to ensure the models are technically and theoretically sound, compliant with USACE policy, computationally accurate, and based on reasonable assumptions. The responsible use of well-known and proven USACE developed and commercial engineering software will continue and the professional practice of documenting the application of the software and modeling results will be followed. The selection and application of the model and the input and output data is still the responsibility of the users and is subject to DQC, ATR, BCOES, and policy and legal review. Where such approvals have not been completed, appropriate independent checks of critical calculations will be performed and documented. The following engineering models, software, and tools are anticipated to be used:

Model Name	Version	Validation Date
HEC-RAS	5.0.6	HH&C CoP Approved
HEC-HMS	4.3	HH&C CoP Approved

Table 5: Models and Status

Section 9

Review Plan Points of Contact

Title	Organization	Phone
Review Manager	CESAJ-EN-Q	[REDACTED]
Senior Reviewer	CEIWR-RMC	[REDACTED]
Quality Manager	CESAD-RBT	[REDACTED]

Table 6: RP POC's

ATTACHMENT 1

Review Plan Revisions

Revision Date	Description of Change	Page/Paragraph Number

Table 7: RP Revisions

ATTACHMENT 2

