US Army Corps of Engineers

Prepared by:

New York District

North Atlantic Division

Green Brook Segments C1, C2 & H, C3 & C4, C5 & B3 & B4, C & D, Green Brook, Middlesex and Somerset Counties, NJ, Flood Risk Management Project

Review Plan

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11 September 2020

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MSC Approval Date: 11Sep 2020

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Section 1
Introduction

1.1 Purpose

This Review Plan (RP) for Green Brook Segments C1, C2 & H, C3 & C4, C5 & B3 & B4, C & D, Green Brook, Middlesex and Somerset Counties, NJ, Flood Risk Management Project, 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 lays out a value-added process and describes the scope of review for the current phase of work. The EC outlines five general levels of review: District Quality Control/Quality Assurance (DQC), Agency Technical Review (ATR), Biddability, Constructability, Operability, Environmental and Sustainability (BCOES) Review, Independent External Peer Review (IEPR), and Policy and Legal Compliance Review. This RP will be provided to Project Delivery Team (PDT), DQC, ATR, BCOES, and IEPR Teams. The technical review efforts addressed in this RP, DQC and ATR, are to augment and complement the policy review processes. The District Chief of Engineering has assessed that the life safety risk of this project is significant; therefore a Type II IEPR/Safety Assurance Review (SAR) will be required, see Paragraph 6.1.

1.2 References

- EC 1165-2-217, Review Policy for Civil Works, 20 Feb 2018
- ER 1110-1-12, Quality Management, as revised through 31 Mar 2011
- ER 415-1-11, Biddability, Constructability, Operability, Environmental and Sustainability (BCOES) Reviews, 1 Jan 2013
- EM 1110-2-1913, Design, Construction, and Evaluation of Levees, 30 Apr 2000
- ER 1110-2-1150, Engineering and Design for Civil Works Projects, 31 Aug 1999
- ER 1100-2-8162, Incorporating Sea Level Change in Civil Works Programs, 31 Dec 2013

- ER 1110-2-1302, Civil Works Cost Engineering, 30 Jun 2016
- ECB 2019-15, Interim Approach for Risk-Informed Design for Dam and Levee Projects
- Interim Guidance on Streamlining Independent External Peer Review (IEPR) for Improved Civil Works Product Delivery Memorandum, dated 5 Apr 2019
- Section 2035 of the Water Resources Development Act (WRDA) of 2007 (Public Law 110-114, 8 Nov 2007, as amended by the Water Resources Reform and Development Act (WRRDA) of 2014 (P.L. 113-121)

1.3 Review Management Organization

The USACE Risk Management Center (RMC) is the Review Management Organization (RMO) for this project. This RP will be updated for the construction phase.

Section 2
Project Description

2.1 Project Description

The Green Brook Watershed, a sub-basin of the Raritan River Basin, encompasses sixty-five (65) square-miles within the State of New Jersey, specifically within Somerset, Middlesex and Somerset Counties. The Green Brook Flood Risk Management Project has been divided into segments and sub-segments which are being designed and constructed as funding permits. The segments are designated with letters (e.g., B, C, D, H, etc.) and the sub-segments by a number suffix (e.g., C1, C2, C3, C4, etc.).

The authorized plan provides a project alignment that acts as the first line of defense against river severe flooding and reduces the risk of damage to homes and infrastructure by construction of floodwall, earthen levee, road closure structure, and associated interior drainage features. The estimated fully funded cost of the projects is TBD.

The Green Brook Flood Risk Management projects will be constructed under multiple construction Segments:

- **Segment C1 –** Levee, Floodwall, Pump Station, Culverts, Interior Drainage; construction cost $29 million.
- **Segment C2 & H**- Levee, Floodwall, Pump Station, Road Closure Gate, Interior Drainage; estimated construction cost $50 million.
- **Segment C3 & C4** - Levee, Floodwall, Road Closure Gate, Interior Drainage; estimated construction cost $25 million.
- **Segment C5 & B3 & B4** - Levee, Floodwall, Pump Station, Interior Drainage; estimated construction cost TBD.
- **Segment C & D** - Levee, Floodwall, Road Closure Gate, Pump Stations, Interior Drainage; estimated construction cost TBD.

See Figure 1 for projects overview and segments scheduled award and overall construction scheduled completion dates.

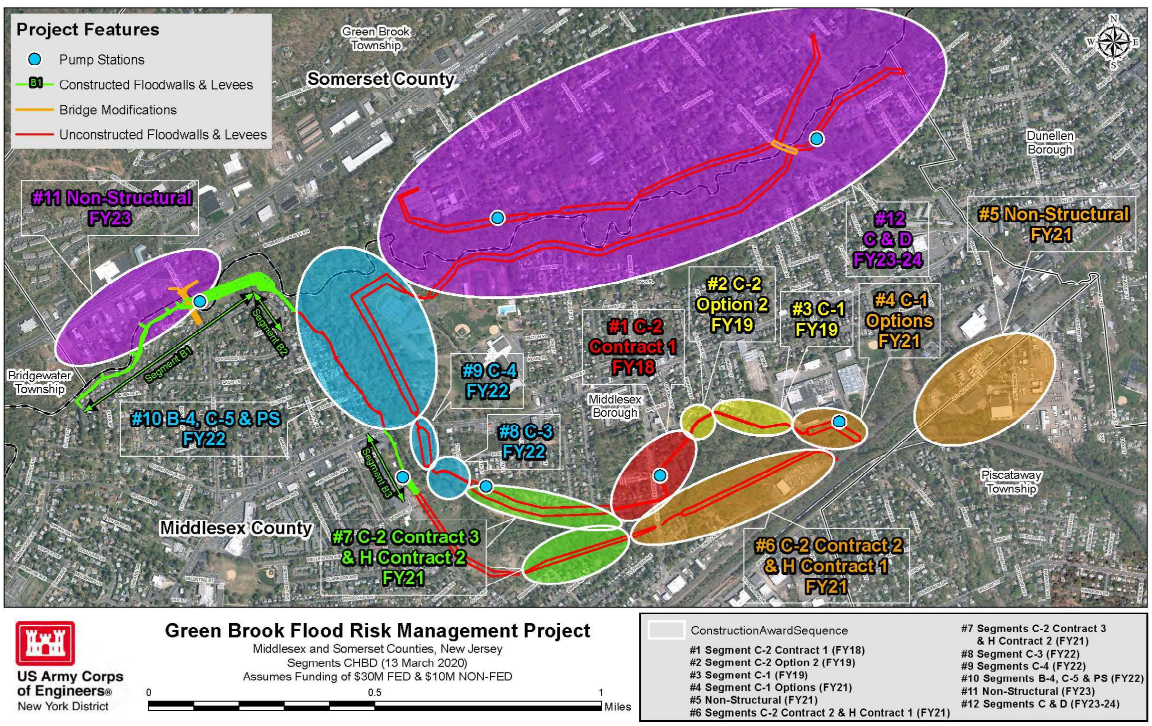

Figure 1 – Green Brook Flood Risk Management Project

Segment C1 – 400 linear feet of earthen levee, 1,100 linear feet of a cantilever composite floodwall with soldier piles socked into rock, three (3) 12.67 cfs pumps for the pump station and two (2) 22 feet x 10 feet concrete bridge culverts thru the NJ Transit railroad embankment. Awarded for construction on 30 September 2020.

Segment C2 & H – Approximately 1,170 linear feet of floodwall. Approximately 1,950 linear feet of earthen embankment levee. Two (2) 135 cfs pumps for the pump station. Roller steel closure gate and interior drainage features for routing stormwater.

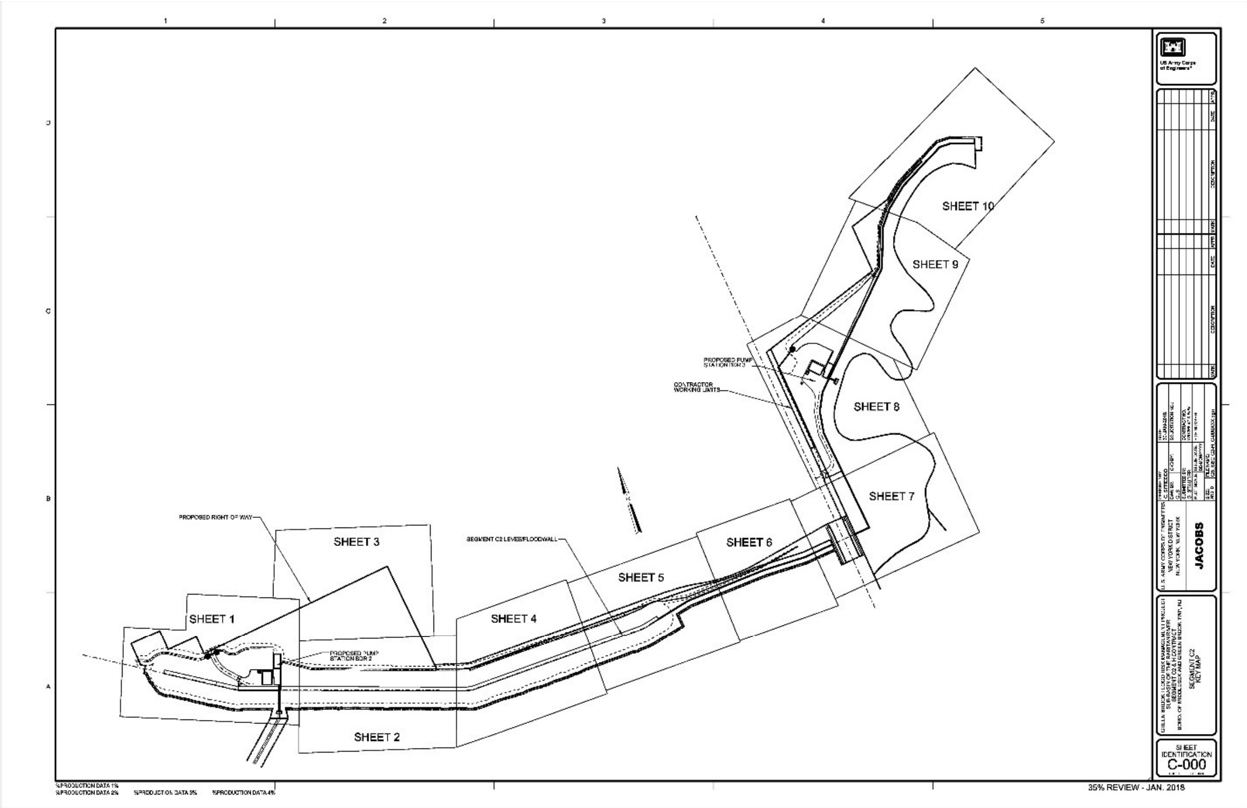

Figure 2 – Green Brook Segment C2 Design Layout

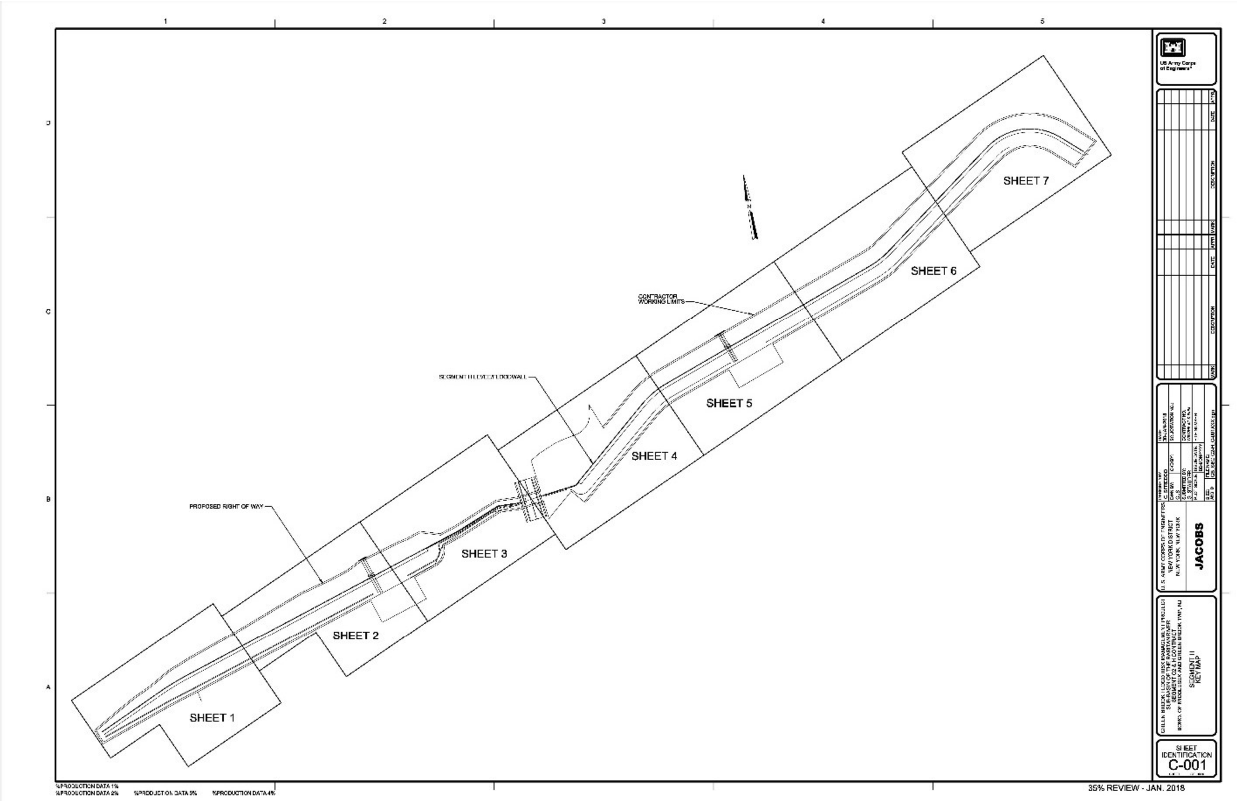

Figure 3 – Green Brook Segment H Design Layout

Segment C3 & C4 – Approximately 785 linear feet of pile supported, reinforced concrete T-Wall type structural floodwall. The structure is approximately 12 feet to 15 feet wide with a height of approximately 16 feet to 20 feet.

Approximately 400 linear feet of earthen embankment levee. The levee crown is set at EL 51.1 feet to match the elevation of the cross-river flood control devices. The crown is 12 feet wide with side slopes graded to 1V:2.5H.

Approximately 60 linear feet of roller steel flood closure gate at Bound Brook Rd (NJ Route 28). The structure is approximately 13 feet high with an opening of approximately 58 feet.

Interior drainage features for routing stormwater.

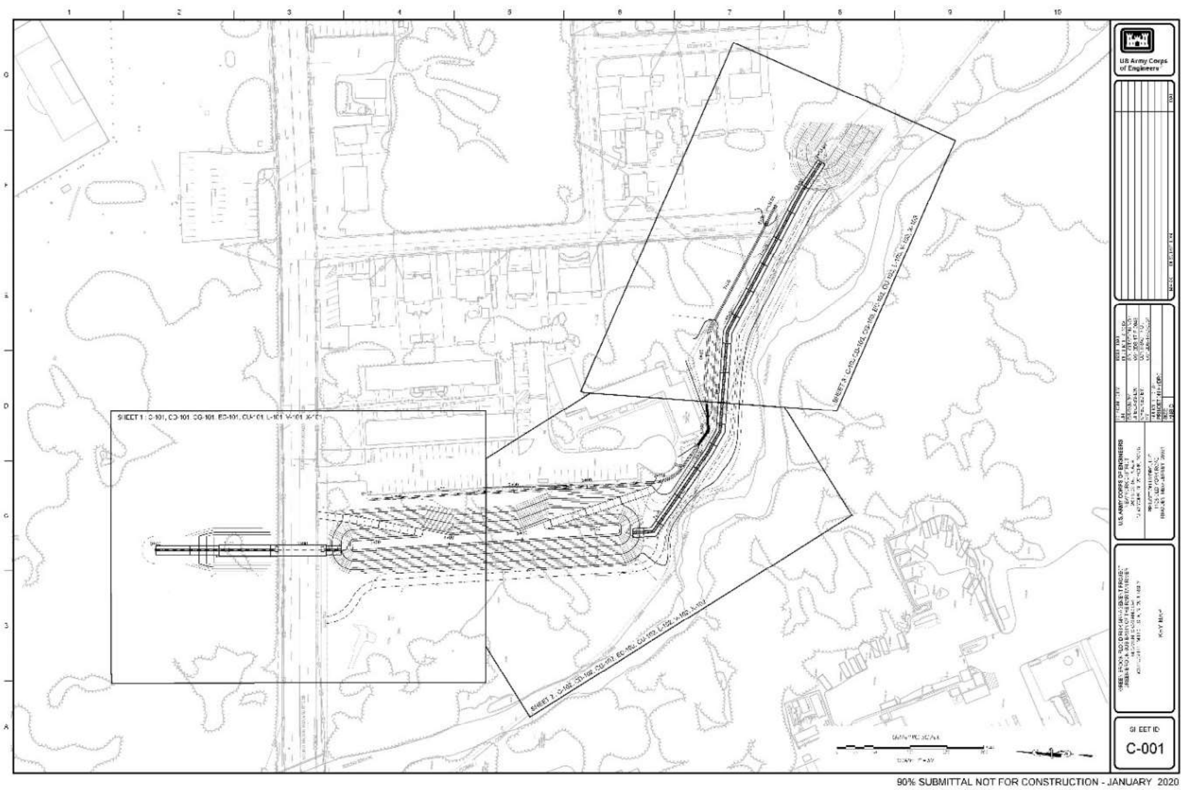

Figure 4 – Green Brook Segment C3 & C4 Design Layout

Segment C5 – Approximately 1 mile of flood risk reduction improvements including levees, floodwalls, closure structures and additions.

Segment B3 – Approximately 313 linear feet of levee and 518 linear feet of floodwall with construction completed on 15 April 2019. Four (4) 50 cfs pumps for the pump station with construction award TBD.

Segment B4 - Approximately 1,930 linear feet of floodwall. Approximately 60 linear feet of roller steel closure gate. Interior drainage features for routing stormwater.

Segment C and D - Approximately 2.4 miles of flood risk reduction improvements including levees, floodwalls, closure structures, two pump stations and culvert upgrades and additions.

More specifically, the flood risk management project consists of a combination of flood protection measures (i.e., earthen levees, reinforced concrete structural floodwalls, pump stations and a flood closure gate) with lengths as indicated above. Associated design and ancillary features consist of the utilization of a deep foundation system to support the structural floodwalls (i.e., micropiles and sheet pile cut-off walls), earthen levee construction, flood closure gate, pump station, interior drainage design, utility coordination/relocation, scour protection along the base of the line of flood protection, and right of way identification including operation and maintenance access along the line of protection. Various hydrology and hydraulic, geotechnical, structural, and civil site analyses, design, and inter-discipline coordination are required to facilitate the design of the flood risk management project.

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 SAR reviews. Sponsor Peer Review of In-Kind Contributions - There will not be in-kind contributions for this effort. The non-Federal sponsors are the Middlesex and Somerset Counties New Jersey and the New Jersey Department of Environmental Protection. The Project Partnership Agreement was executed in June 1999.

Section 3

District Quality Control

3.1 Requirements

All implementation documents (including supporting data, analyses, reports, environmental compliance documents, water control manuals, etc.) and semi-quantitative risk assessment shall undergo DQC in accordance EC 1165-2-217. The District shall perform these minimum required reviews in accordance with District's Quality Management Plan.

See Attachment 1, Table 6 for the DQC Lead, reviewers, and reviewer's disciplines.

The design work will be performed by Architect-Engineer (A/E) firms. Review of all deliverables will be accomplished by the prime A/E prior to submitting to the District. The documents will be reviewed prior to delivery for consistency among disciplines enabling a coordinated and complete design package. The design documents, including calculations and spreadsheet models, and the plans and specifications will receive detail checking and independent quality control review throughout the stages of work. The intent of the Independent Quality Control Review is to ensure technical accuracy, soundness of approach/design, conformance with standards and to ensure overall product quality. Independent Quality Control Reviews will be performed by A/E personnel not directly involved with the preparation of the work product. The reviewer will verify that any comments have been adequately addressed by the designer. Each work product by subcontractors will be reviewed by staff from the prime A/E. Independent Quality Control Review will be performed on all early release decision information (i.e., loading conditions, geotechnical parameters, hydraulic conditions, etc.) and certified complete prior to incorporation into the design. The A/E will perform QC certifications per Chapter 8 of EC 1165-2-217 to the component and subcomponent level. The District will perform Quality Assurance Reviews of all products.

To facilitate a coordinated product, the prime A/E will have weekly coordination calls or meetings among key staff. The A/E's Project Manager will be copied on all correspondence regarding the project and will confirm that review of each deliverable has been performed. The A/E will maintain documentation that their quality control plan has been followed. Documentation will include a Project Quality Assurance Plan Checklist, Calculation Cover Sheets verifying that calculations have been checked, Detailed Checking Reports/Comments, resolution of Independent Quality Control Review comments and certification.

3.2 Documentation

Documentation of DQC activities is required and will be implemented by the process described in paragraph 3.1. DrChecks^{SM} (Design Review and Checking System) will be used to record comments and evaluations. A DQC certification will be signed at the completion of the process.

3.3 DQC Schedule and Estimated Cost

Although DQC is always seamless, the following milestone reviews are schedule in Table 1. The cost for the DQC is approximately $1,000,000. Note, the PDT will QA each submittal.

Table 1 DQC Schedule

Project Phase/Submittal	Review Start Date	Review End Date
Segment C1		
DQC 30% P&S Review	Feb 2018	Mar 2018
DQC 60% P&S Review	May 2018	May 2018

Project Phase/Submittal	Review Start Date	Review End Date
DQC 90% P&S Review	Sep 2018	Mar 2019
DQC 100% P&S	May 2019	May 2019
Segment C2 & H		
DQC 30% P&S Review	Feb 2018	Mar 2018
DQC 60% P&S Review	Nov 2018	Dec 2018
DQC 90% P&S Review	TBD	TBD
DQC 100% P&S	TBD	TBD
Segment C3 & C4		
DQC 30% P&S Review	Jul 2018	Aug 2018
DQC 60% P&S Review	Mar 2018	Apr 2018
DQC 90% P&S Review	Jan 2020	Feb 2020
DQC 100% P&S	Jan 2021	Feb 2021
Segment C5 & B3 & B4		
DQC 30% P&S Review	TBD	TBD
DQC 60% P&S Review	TBD	TBD
DQC 90% P&S Review	TBD	TBD
DQC 100% P&S	TBD	TBD
Segments C & D		
DQC 30% P&S Review	TBD	TBD
DQC 60% P&S Review	TBD	TBD
DQC 90% P&S Review	TBD	TBD
DQC 100% P&S	TBD	TBD

Section 4

Agency Technical Review

4.1 Requirements

All implementation documents (including supporting data, analyses, reports, environmental compliance documents, water control manuals, etc.) and risk assessment reports shall undergo ATR in accordance EC 1165-2-217. The objective of ATR is to ensure consistency with established criteria, guidance, procedures, and policy. The ATR will assess whether the analyses presented are technically correct and comply with published USACE guidance, and that the document explains the analyses and results in a reasonably clear manner. ATR is managed within USACE by the designated RMO and is conducted by a qualified team from outside the home district that is not involved in the day-to-day production of the project/product. ATR teams will be comprised of senior USACE personnel and may be supplemented by outside experts as appropriate. The ATR team lead will be from outside the home MSC.

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 Table 2 in Section 4.6. A single site visit to all contract areas will be scheduled for the ATR Team disciplines dealing with life safety issues and other disciplines as appropriate, early in the design phase and periodically as needed in a risk-informed manner during construction.

4.2 Documentation of ATR

Documentation of ATR will occur using the requirements of EC 1165-2-217. DrChecks[SM] will be used to document all ATR comments, responses and associated resolutions accomplished throughout the review process. Comments should be limited to those that are required to ensure adequacy of the product. The four key parts of a quality review comment will normally include:

(1) The review concern – identify the product's information deficiency or incorrect application of policy, guidance, or procedures;
(2) The basis for the concern – cite the appropriate law, policy, guidance, or procedure that has not be properly followed;
(3) The significance of the concern – indicate the importance of the concern with regard to its potential impact on the plan components, efficiency (cost), effectiveness (function/outputs), implementation responsibilities, safety, Federal interest, or public acceptability; and
(4) The probable specific action needed to resolve the concern – identify the action(s) that the reporting officers must take to resolve the concern.

The ATR documentation in DrChecks[SM] will include the text of each ATR concern, the PDT response, a brief summary of the pertinent points in any discussion, including any vertical team coordination (the vertical team includes the district, RMO/MSC, and HQUSACE), and the agreed upon resolution. If an ATR concern cannot be satisfactorily resolved between the ATR team and the PDT, it will be elevated to the vertical team for further resolution in accordance with the policy issue resolution process described in ER 1110-1-12. Unresolved concerns can be closed in DrChecks[SM] with a notation that the concern has been elevated to the vertical team for resolution.

4.3 Products to Undergo ATR

The products that will undergo ATR include the DDR, 30%, 60% and 90% for Segments C5, C and D and 90% for Segments B3 Pump Station, B4, C2, H, C3 and C4 Design & Final Design Plans and Specifications for this contract and initial Semi-Quantitative Risk Assessment (SQRA) reports and final SQRA reports for the project. Per coordination with the Levee Safety Center, a SQRA will be implemented during design and post-construction. The first risk assessment will be performed during design to verify whether a positive/negative or inconclusive recommendation regarding FEMA NFIP accreditation can be made and to inform any changes during design in accordance with ECB 2019-15. The second risk assessment will be performed at the end of construction for the official recommendation regarding FEMA accreditation and risk characterization of the levee system. The risk assessment reports are covered by a separate review plan.

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 is a senior professional outside the home MSC with extensive experience in preparing Civil Works documents and conducting ATRs. The lead has 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, Civil, Structural, or Geotechnical Engineering, and must have a strong levee safety background.

Hydraulic/Hydrologic Engineer – reviewer shall have expertise in conducting and evaluating hydraulics and hydrologic engineering analysis for flood risk management and levee safety projects. The team member will hold a degree in Civil Engineering or Water Resources Engineering. Reviewer shall have experience with utilizing HEC computer modeling programs, analyzing levee hydraulics, and sizing interior drainage features. The reviewer shall be a registered professional engineer.

Civil Engineer- shall have expertise in civil engineering design and review of site/civil layout, grading, drainage and utilities for projects involving levees, floodwalls, and gated structures and shall be a registered professional engineer.

Geotechnical Engineer - shall have experience in the field of geotechnical engineering, analysis, design, and construction of levees and foundations for floodwalls, pump stations and gate structures. The geotechnical engineer shall have experience in subsurface investigations, soil mechanics, internal erosion (seepage and piping), slope stability evaluations, erosion protection design, and earthwork construction. The geotechnical engineer also shall have knowledge and experience in the seepage, settlement, stability, and deformation problems associated with levees constructed on soil foundations. The geotechnical engineer shall be a registered professional engineer. A minimum of a Master's degree in geotechnical engineering is also required.

Structural Engineer – shall have experience in design and review of floodwalls, pump stations and road closure gates and shall be a registered professional engineer.

Mechanical Engineer –shall have experience in design and review of mechanical components of closure gates, pump stations, controls and sluice gates and shall be a registered professional engineer.

Electrical Engineer- shall have experience in electrical engineering design and review of electrical components and instrumentation for closure gates, pump stations, controls and sluice gates, and shall be a registered professional engineer.

Construction Engineer – Reviewer shall be a senior level, professionally registered engineer with extensive experience in the engineering construction field, with particular emphasis on river flood risk management construction projects. Reviewer shall have experience as an Administrative Contracting Officer for projects involving construction of levees, floodwalls, pump stations and road closure gates. The Construction reviewer should have a minimum of 10 years of experience.

Environmental - The environmental reviewer shall have experience in the review of construction designs and specifications, including review of erosion and sediment control plans and landscaping plans and details independently completed EA/EIS's and be well versed in the NEPA process. The reviewer shall have experience with identifying and resolving environmental issues in within freshwater wetland and riverine ecosystems, and shall have experience with Section 106 actions and documentation.

Risk Reviewer – The team member shall have experience evaluating flood risk management projects and performing consistency reviews of SQRAs on levee safety projects.

Please note, a Cost Engineer ATR member is not required as per Public Law 113-2 – Jan 29 2013. Due to specific language included in the Law regarding Hurricane Sandy Funds, provisions of section 902 of the WRDA of 1986 do not apply to this project.

Additionally, the appropriate Cost Engineering Reviews will be conducted by NAN Cost Engineering Branch to ensure all cost products are in compliance with Corps regulations.

4.5 Statement of Technical Review Report

At the conclusion of each ATR effort, the ATR team will prepare a review report with a template provided by the RMC that includes a completion and certification memo. The report will be prepared in accordance with EC 1165-2-217.

Review Reports will be considered an integral part of the ATR documentation and shall:

(1) Identify the document(s) reviewed and the purpose of the review;
(2) Disclose the names of the reviewers, their organizational affiliations, and include a short paragraph on both the credentials and relevant experiences of each reviewer;
(3) Include the charge to the reviewers;
(4) Describe the nature of their review and their findings and conclusions;
(5) Identify and summarize each unresolved issue (if any); and
(6) Include a copy of each ATR comment, the PDT response, a brief summary of the pertinent points in the follow on discussion, including any vertical coordination, and the agreed upon resolution.

ATR will be certified when all ATR concerns are either resolved or referred to the vertical team for resolution and the ATR documentation is complete. The ATR Lead will prepare a Statement of Technical Review certifying that the issues raised by the ATR team have been resolved (or elevated to the vertical team).

4.6 ATR Schedule and Estimated Cost

Although ATR is always seamless, the preliminary ATR milestone schedule is listed in Table 2. The cost for the ATR is approximately is $1,100,000.

Table 2 ATR Schedule

Project Phase/Submittal	Review Start Date	Review End Date
Design Review Site Visit	TBD	TBD
Segment C1		
ATR 30% Review	Mar 2018	Apr 2018

Project Phase/Submittal	Review Start Date	Review End Date
ATR 60% Review	Jun 2018	Jul 2018
ATR 90% Review	May 2019	Jun 2019
ATR Backcheck & Certification	Aug 2019	Sep 2019
Segment C2 & H		
Initial SQRA Report	TBD	TBD
ATR 30% Review	TBD	TBD
ATR 60% Review	TBD	TBD
ATR 90% Review	TBD	TBD
ATR Backcheck & Certification	TBD	TBD
Construction Site Visit	TBD	TBD
Final SQRA Report	TBD	TBD
Segment C3 & C4		
Initial SQRA Report	TBD	TBD
ATR 90% Review	TBD	TBD
ATR Backcheck & Certification	TBD	TBD
Construction Site Visit	TBD	TBD
Final SQRA Report	TBD	TBD
Segment C5 & B3 & B4		
Initial SQRA Report	TBD	TBD
ATR 30% Review	TBD	TBD
ATR 60% Review	TBD	TBD
ATR 90% Review	TBD	TBD
ATR Backcheck & Certification	TBD	TBD
Construction Site Visit	TBD	TBD
Final SQRA Report	TBD	TBD
Segment C & D		
Initial SQRA Report	TBD	TBD
ATR 30% Review	TBD	TBD
ATR 60% Review	TBD	TBD

Project Phase/Submittal	Review Start Date	Review End Date
ATR 90% Review	TBD	TBD
ATR Backcheck & Certification	TBD	TBD
Construction Site Visit	TBD	TBD
Final SQRA Report	TBD	TBD

Section 5
BCOES Review

5.1 Requirements

All implementation documents (including supporting data, analyses, reports, environmental compliance documents, water control manuals, etc.) shall undergo BCOES review in accordance ER 415-1-11 and ER 1110-1-12. BCOES reviews are done during design for a project using the design-bid-build (D-B-B) method or during development of the request for proposal (RFP) for a design-build (D-B) project. The BCOES review results are to be incorporated into the procurement documents for all construction projects.

5.2 Documentation of BCOES

The BCOES review will be documented using DrChecks℠. The BCOES reviewers will include local sponsors' facility operators and maintenance staff, as well as construction, operations, and environmental staff to improve the BCOES aspects of designs. The BCOES roster is provided in Attachment 1.

Section 6
Safety Assurance Review

6.1 Decision on SAR

The District Chief of Engineering has made a risk-informed-decision that this project poses a significant threat to human life (public safety); this being the Segments associated with the structural measures of the Green Brook Segments C2 & H, C3 & C4, C5 & B3 & B4, C & D, Green Brook, Middlesex and Somerset Counties, NJ, Flood Risk Management Project. It is recommended that a Type II IEPR, Safety Assurance Review (SAR) is warranted for Segments C2 & H, C3 & C4, C5 & B3 & B4, C & D of the flood risk management project.

6.2 Products to Undergo SAR

The products that will undergo SAR include the DDR, Plans and Specifications for each contract.

6.3 Required SAR Panel Expertise

SAR panels will be established in accordance with EC 1165-2-217. One of the reviewers shall also function as the SAR Panel Lead, responsible to perform the administrative contract functions to run the meetings, compile the comments, and reports. The following disciplines will be required for SAR of this project:

Hydraulic/Hydrologic Engineer – Panel member shall be a registered professional engineer from an Architect-Engineer or consulting firm, a public agency, or academia with a minimum of 20 years of experience in hydraulics and hydrologic engineering, including extensive experience in the application of water levels and implications of sea level change over the likely range of storm return periods. Reviewer shall have experience with designing levees, floodwalls, and gated structures, utilizing HEC computer modeling programs, and sizing interior drainage features and be familiar with USACE application of risk and uncertainty analyses.

Geotechnical Engineer - Panel member shall be a registered professional engineer from an Architect-Engineer or consulting firm, a public agency, or academia with a minimum of 20 years of experience in the geotechnical design of levees, and foundations for floodwalls, gated structures within a river environment, experience in subsurface investigations; field & laboratory testing and the determination of in-situ material properties; soil compaction and earthwork construction; soil mechanics; seepage and piping; slope stability evaluations; bearing capacity and settlement; and scour protection design. A minimum of a Master's degree in geotechnical engineering is also required.

Structural Engineer – Panel member shall be a registered professional engineer from an Architect-Engineer or consulting firm, a public agency, or academia with a minimum of 20 years of experience in the structural engineering design and construction of hydraulic structures for civil works projects including T-wall and I-wall floodwalls (including lessons learned from Katrina on gap formation), and road closure gates within a river environment.

6.4 Documentation of SAR

Documentation of SAR will be prepared in accordance with EC 1165-2-217.

6.5 Scope, Schedule, and Estimated Cost of SAR's

The SAR's will be performed in accordance with EC 1165-2-217. SAR reviews will occur at the milestones shown in Table 3. The estimated cost for the SAR's of this project are in the range of $1,000,000 to $1,500,000. This estimate will be refined when the Scope of Work for the SAR task order is completed. Milestones to consider for a SAR are at the midpoint and final design in the Design Documentation Report; at the completion of the plans, specifications, and cost estimate; at the midpoint of construction for a particular contract, prior to final inspection, or at any critical design or construction decision milestones. The estimated cost accounts for the scheduled construction reviews as well as two additional construction reviews if needed.

Table 3 SAR Scheduled Milestone Reviews

Project Phase/Submittal	H&H Engineer	Geotechnical Engineer	Structural Engineer	Site Visit Duration (days)	Review Start Date	Review End Date
Segment C2 & H						
SAR 60% Review	O	X	X	1	TBD	TBD
SAR 90% Review	O	O	O		TBD	TBD
Construction Review #1	O	X	X	1	TBD	
Construction Review #2	O	X	X	1	TBD	
Segment C3 & C4						

Project Phase/Submittal	H&H Engineer	Geotechnical Engineer	Structural Engineer	Site Visit Duration (days)	Review Start Date	Review End Date
SAR 90% Review	O	X	X	1	TBD	TBD
Construction Review # 1	O	X	X	1	TBD	
Construction Review # 2	O	X	X	1	TBD	
Segment C5 & B3 & B4						
SAR 60% Review	O	X	X	1	TBD	TBD
SAR 90% Review	O	O	O		TBD	TBD
Construction Review # 1	O	X	X	1	TBD	
Construction Review # 2	O	X	X	1	TBD	
Segment C & D						
SAR 60% Review	O	X	X	1	TBD	TBD
SAR 90% Review	O	O	O		TBD	TBD
Construction Review # 1	O	X	X	1	TBD	
Construction Review # 2	O	X	X	1	TBD	

(X - indicates attendance at the site visit. O - indicates participation via conference call)

Section 7

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.nan.usace.army.mil/Missions/Civil-Works/Review-Plans-and-Documents/). 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 8

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 3, Table 11. 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 should be provided to the RMO.

Section 9

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, policy and legal review, and SAR (if required). 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:

Table 4 Models and Status

Model Name	Version	Release Date
AdH	4.6	
AGi32	19.1	
Autodesk AutoCAD Civil 3D	2018	
Autodesk Civil 3D 2019	2019	2019
Bluebeam Revu CAD	18.5	
ENERCALC	10.18.1.31	2018
Ensoft Inc - Apile	2018.8.5	May 2018
Ensoft Inc - Group	2016.10.13	May 2018
ESRI ArcCatalog	10.6.1.9270	
ESRI ArcMap	10.6.1.9270	
Geostudio 2016 Seepage/W by GEOSLOPE	8.16.2.14053	2016

Model Name	Version	Release Date
Geostudio 2016 Sigma/W by GEOSLOPE	8.16.2.14053	2016
Geostudio 2016 Slope/W by GEOSLOPE	8.16.2.14053	2016
HEC-HMS	4.3	November 2018
HEC-RAS	5.0.6	November 2018
HEC-FDA	1.4.2	2017
Highway Capacity Manual (HCM)		2000
HOBOWare Pro	3.7.17	
Lifesim	1.0.1	2019
Mathcad	15.0 (M005)	November 2010
Mathcad	15.0 (M045)	
Matlab	R2017b (9.3.0.713579)	
MicroStation V8i (SELECT series 4) - Bentley Systems	08.11.09.867	2016
MIKE Zero (MIKE 21)	2017 Service Pack 2	
Power InRoads V8i (SELECTseries 4)	08.11.09.878	April 2016
ProSheet	2.2	August 2017
R	3.5.3	
R Studio	1.1.463	
RIVERMorph	5.2	
SAFE 2016	16.0.1	March 2017
SAP2000	V19	November, 2017
Shoring Suite CivilTech Shoring	8.16h	2016
SpecsIntact	5.0.0.98	
SpecsIntact	4.6.2.996	
United Facilities Guide Specifications (UFGS) Master		May 2019
USACE Computer-Aided Struct. Engin. (CASE) program, CPGA		3/29/1993
Visual Lighting	2017	
Visual MODFLOW (VMOD) Flex - Waterloo Hydrogeologic, 2018	5.1	2018

Section 10
Review Plan Points of Contact

Table 5 RP POC's

Title	Organization	Phone
Project Manager	CENAN-PP	917-790-8624
Technical Manager	CENAN-EN-MC	917-790-8019
Senior Reviewer	CEIWR-RMC	304-399-5217

ATTACHMENT 1

Team Rosters (FOUO)

Table 6 DQC Reviewers

Discipline/Role	Name	Description of Credentials
DQC Review Lead	Encer Shaffer	Mr. Shaffer is a NY licensed professional engineer with over 18 years of civil and geotechnical design and construction experience. He has a MS in Civil Engineering from Manhattan College and a BS in Civil Engineering from the United States Military Academy at West Point.
Civil Engineering	Kevin Whorton	Mr. Whorton is a NY licensed professional engineer with over 23 years of civil engineering design and construction experience. He has a BS in Civil Engineering from Villanova University.
Hydraulic Engineering	Arun Heer	Mr. Heer is a registered Professional Engineer in the State of Illinois and a Certified Floodplain Manager with 11+ years of experience in hydraulic design and watershed planning. His areas of expertise include hydraulic modeling, floodplain mapping, ecosystem restoration, stream bank stabilization, dam removal, roadway drainage, and water/reservoir management. Additionally, Mr. Heer possesses a coastal engineering certificate from old Dominion University and maintains experience in coastal structure and beach design.
Geotechnical Engineering	Stanley Sedwick III	Mr. Sedwick is a NJ licensed professional engineer with 24 years of geotechnical design and construction experience. He has a MS in Civil Engineering from New Jersey Institute of Technology, BS in Civil Engineering from Rutgers, The State University of New Jersey.
Structural Engineering	X. Michael Chen	Mr. Chen is a Structural Leader & NAD Regional Technical Specialist. He holds a BS/MS/Dr. Eng. Prog. in Structural Engineering and is a licensed PE in NYS with 30+ years of structural & foundation engineering experience in design/construction of flood mitigation facilities, coastal infrastructures, bridges, buildings, and mass transit structures. Prominent projects of Mr. Chen include Coastal Protection Programs for Mississippi (MsCIP) and Louisiana (LaCPR); Coastal Storm Damage Reduction for Elliott Bay in Seattle, Pt Monmouth Hurricane & Storm Damage Reduction, and Downtown Manhattan Seawall & Pier Replacement.

Discipline/Role	Name	Description of Credentials
Mechanical Engineering	Claudio Sang	Mr. Sang has 25 years of experience with the NY District, the last 5 years of which included Civil Works projects. He has experience designing the mechanical components of road closure structures, motor operated sluice gates and gravity operated check flap-valve and "Duck-Bill" check valve structures, as well as pump stations.
Electrical Engineering	Thomas Sessa	Mr. Sessa is a NY licensed professional engineer with over 40 years of electrical engineering design and construction experience. He has a both a MS and BS in Electrical Engineering
Environmental	Kimberly Rightler	Ms. Rightler has a B.S. in Agronomy and Environmental Science and 22 years of professional experience in the environmental field. She has been employed as a Biologist with the New York District, since 1999. Ms. Rightler has served as Lead Biologist on numerous civil works projects ranging in size, complexity and ecosystem types and has prepared various NEPA documents and other regulatortyregulatory compliance documents (e.g. CZM, 404(b)1 Evaluations). Prior to working for the Corps, Ms. Rightler was a Resource Conservationist with the Chester County Conservation District in Pennsylvania. As a Resource Conservationist, her duties included reviewing Erosion and Sediment Control Plans and conducting site inspections to determine compliance of Chapter 102 of the Pennsylvania Clean Streams Law and National Pollution Discharge Elimination System (NPDES) permits.
Cultural Resources	Carissa Scarpa	Ms. Scarpa holds a B.A. and M.A. in Anthropology and has 19 years of professional experience in cultural resource management and Section 106 compliance. She has been with the New York District since 2001 working as the lead Project Archaeologist on many complex projects. Registered Professional Archaeologist since 2018.
Specifications	Luis Rosario-Lluveras	Holds a Bachelor of Architecture and a Master of Science in Urban Design from Pratt Institute. Certifications/Licenses: Licensed architect, CSI - Construction Document Technologist (CDT), by the US Green Building Council (USGBC), LEED Accredited Professional (AP), Building Design and Construction (BD+C). Lead Architect in the Design Control and Specifications Section, U.S. ARMY CORPS OF ENGINEERS, NEW YORK DISTRICT, Engineering Branch. Registered Architect in the State of New Jersey with 23 years of experience as an architectural designer, architect, specifications writer and project manager.

Discipline/Role	Name	Description of Credentials
Dam and Levee Safety Program Manager	Jeffrey Gross	Mr. Gross is a licensed professional engineer with over 17 years of experience in structural engineering, dam, and levee safety. He has extensive experience in the analysis of existing flood control features as well as the design and construction of new features. Jeff was the lead structural engineer for the I-Walls within the district's portfolio.

Table 7 ATR Team

Discipline	Name	Description of Credentials
ATR Lead / Geotechnical Engineering	Michael Robinette	**Michael D. Robinette, P.E., ATR Lead – Geotechnical (CELRH-DSPC-GS).** Mike isa Registered Professional Civil Engineer currently working in the Huntington District. He has nearly 28 years of geotechnical engineering experience with the US Army Corps of Engineers. Mike has a Bachelor's degree in Civil Engineering from the West Virginia Institute of Technology and a Master of Science degree in Civil Engineering with geotechnical emphasis from the Virginia Polytechnic Institute and State University. He was the Chief of the Soils Engineering Section for 9 years from 2003-2012 before the district reorganized and now serves as a Senior Geotechnical Engineer in the regional Dam Safety Production Center and national Dam Safety Mandatory Center of Expertise (MCX). He has been involved in a multitude of LRD navigation, dam and levee safety, and various other flood damage reduction projects. Mike is currently providing technical Oversight and Support for the Dam Safety MCX on various Dam Safety Modification Studies (DSMS) including Herbert Hoover Dike, Cherry Creek Dam, Rough River Dam, and in the past has participated in many Agency Technical Reviews for various navigation and flood damage reduction projects including the Lake Pontchartrain and Vicinity and Mississippi River levee systems and the Bayou Sorrel lock extension for MVN and MVK, respectively, the Hamilton City Flood Damage Reduction and Ecosystem Restoration Project for SPK, the Lake Washington Shipping Canal (Hiram Chittenden Lock and Dam Phase 2 Issue Evaluation Study, and various Kissimmee River ecosystem and Florida Everglades restoration projects for SAJ. He is currently the ATR lead and geotechnical reviewer for Cherry Creek DSMS for NWO, J.H. Kerr Auxiliary and Right Wing Dam repairs for SAW, Caloosahatchee River Reservoirs C-43 and C-44, Herbert Hoover Dike DSMS including the Reach 1 Cutoff Wall Project SAJ, Broward County Water Preserve North Mitigation Area A, Moose Creek Dam DSMS

Discipline	Name	Description of Credentials
		for POH, and the Abiquiu Dam Issue Evaluation Study for SPA. Mike also serves as the geotechnical ATR reviewer for Folsom Dam for SPK, Greers Ferry and Beaver Lake reallocation studies for SWD, and the Rough River Dam Cutoff Wall for LRL. He has been participating in risk assessments since early 2002 when he championed the Huntington District's Demonstration for Portfolio Risk Analysis and was a geotechnical risk assessor and cadre lead for the follow-on Screening for Portfolio Risk Analysis national work efforts. In addition, he has assisted the Risk Management Center since 2007 on many risk assessment teams acting as a cadre facilitator for several Potential Failure Modes Analyses and Issue Evaluation Studies.
Civil Engineer	William Halczak	**William Halczak, P.E., Construction/Civil (CESPK-ED-GS-B)**. Bill is a Registered Professional Civil Engineer currently working in the Sacramento District. He has over 38 years of engineering experience with the US Army Corps of Engineers. Bill has a Bachelor's degree in Civil Engineering from California State University at Long Beach. He started out as a civil engineer in the Los Angeles District working mainly on damrelated construction projects prior to relocating to the Sacramento District in 2005 where he works preparing plans and specifications for civil work construction, including specifications for concrete structural elements. He also has prepared plans and specifications for military pavement construction, both PCC and bituminous pavements, and participated in periodic inspections of existing civil works structures (primarily dams). Bill scheduled and coordinated concrete materials studies for large civil works projects (project costs >$1 billion, lab programs of $2.5 to $3 million dollars). These were multistage studies lasting 2 or more years. He also prepared materials engineering studies for large civil works projects and performed Finite Element Analysis (FEA) for Massive Concrete Structures.

Discipline	Name	Description of Credentials
		Some of the projects that Bill worked on were Seven Oaks Dam, Prado Dam, and Folsom Dam. He has also participated in several ATRs including the Tres Rios Flood Control Structure, Matilija Dam removal project, Gatun Lock design on the Panama Canal, Santa Maria levees, and the Charleroi Lock and Dam rehabilitation project.
Hydraulics & Hydrologic Engineering	Edward Stowasser	**Edward "Ed" Stowasser, P.E., ATR Team Member – Hydraulics and Hydrology (CELRH-DSPC-TS).** Mr. Stowasser is a 2005 graduate of West Virginia University Institute of Technology in Montgomery, WV with a Bachelor's Degree in Civil Engineering. In 2001 he obtained an Associate Degree in Computer Programming from Marshall University Community & Technical College. Currently he is a registered professional engineer in the state of West Virginia. He has worked for the Huntington District, US Army Corps of Engineers, since 2001. From 2005 through 2007 he was a participant in the Department of the Army Intern Program as a civil engineer working for the Water Resources Engineering Branch of the Huntington District. He accepted a position as a hydraulic engineer in the Hydrology and Hydraulics Section of Water Resources Engineering Branch in 2007, where he has worked until 2012. He is currently working in the Dam Safety Production Center as a technical lead for the H&H and Technical Support section. While working in the Hydrology and Hydraulics Section and the H&H and Technical Support Section, he has been involved with several Dam Safety and Major Rehabilitations Studies, Periodic Inspections, Periodic Assessments, Issue Evaluation Studies, and Screening for Portfolio Risk Assessments. Ed has performed as a technical team lead with the national Modeling, Mapping, and Consequence Center (MMC), where he creates HEC-RAS dam failure models, inundation flood mapping, and HEC-FIA models to determine risk and consequences associated with dam or levee failures, and

Discipline	Name	Description of Credentials
		recently has worked on the CWMS national implementation team with HEC. Ed currently performs and reviews Inflow Design Floods, Stage Frequency Curves, hydraulic designs for current dam and levee safety projects.
Structural Engineering	Scott Wheeler	Mr. Wheeler has 24+ years of experience as a Structural Engineer with USACE and received a Bachelor of Science degree in Civil Engineering from West Virginia Institute of Technology and a Master of Science degree in Structural Engineering from the University of Illinois at Urbana-Champaign. Mr. Wheeler oversaw the development of the Existing and Future without Federal Action Condition Risk Assessments and served as the lead for the development of a Dam Safety Modification Report for Bluestone Dam to address spillway scour and overtopping scour risks. Mr. Wheeler served on a team developing structural tools and methodology for the Dam Portfolio Risk Analysis, in particular a tool to estimate the probability of seismic failure of reinforced concrete intake towers. He also served on a team developing methodology for performing Levee Baseline Risk Condition Studies which was to be implemented for high risk levee systems identified with the Levee Screening Tool. He also served on a team that developed a Pilot Program for Periodic Assessments which has become standard practice for USACE based on the new Dam Safety Engineering Regulation and has facilitated multiple Periodic Assessments. He has served on Risk Assessment, PFMA, and PA teams for a number of Flood Risk Management Dams including Facilitating or Co-Facilitating several. These projects include both Flood Risk Management and Navigation dams with their primary risk concerns including internal erosion, structural stability, hydraulic steel structures, overtopping and seismic failure modes. He assisted in the development of a new I-Wall Design and Analysis Engineering Circular (EC) including working on the development of an example problem. He has also performed ATR of multiple Dam Safety Modification Reports and Major Rehabilitation Reports. These projects

Discipline	Name	Description of Credentials
		include, along with their primary risk concerns or proposed fixes: J. Edward Roush Dam (LRL) – foundation grouting and concrete cutoff wall to reduce S&P risk, Salamonie Lake Dam (LRL) – foundation grouting, JT Myers Lock and Dam (LRL) – repair of spillway stilling basin scour, rock anchors for seismic stability of dam piers, dam tainter gate machinery and component rehab, Lake Washington Shipping Canal (NWS) – foundation scour below dam, lock and dam operating equipment, dam tainter gates. Mr. Wheeler has served as the Lead Project and/or Structural Engineer on a number of Flood Risk Management Projects. As Lead Project Engineer for the Dover DSA Evaluation Report he was responsible for the preliminary structural investigation and design of remedial measures, which included prestressed rock anchors, precast concrete parapet wall and a gate closure, for the concrete gravity dam. He also was responsible for compiling and producing the Evaluation Report and coordinating with Planning on the EIS for approval and concurrence by LRD and HQ. As part of the IRRMP for Dover Dam, he led the design, plans and specifications for temporary rock anchors. As the Lead Structural Engineer for the Grundy Local Protection Project oversaw the production of P&S for a gate closure and abutment monoliths. He also worked closely with a nationally recognized expert in Risk and Reliability to produce and conduct a 40+ hour training course which has been made available USACE-wide. Other relevant experience includes: Participated in Periodic Inspections of numerous flood risk management projects; Structural design of various O&M related items.
Mechanical Engineering	Brenden McKinley	**Mr. Brenden McKinley, P.E., ATR Team Member – Mechanical (CELRH-EC-DE).** Mr. McKinley is a Registered Professional Engineer currently working in the Huntington District. Brenden has over 28 years of experience and has been Chief of the Electrical/Mechanical Section in Huntington District for approximately four years. Prior to that, he was a senior mechanical engineer in the section and the Mechanical

Discipline	Name	Description of Credentials
		Regional Technical Specialist for the Great Lakes and Ohio River Division. He has been responsible for the design of mechanical components for new navigation locks at several locations. These components have included direct connected miter gate machinery, filling and emptying valves and machinery, hydraulic and utility piping systems, vertical lift gates, and plumbing and HVAC systems. He has also been responsible for the design of components as requested by Operations Division necessary for the continued safe and reliable operation of projects. He has also been the lead mechanical engineer on several new storm water pump stations. He has an undergraduate degree in Mechanical Engineering from West Virginia University.
Electrical Engineering	Jeff Timbas	**Jeff Timbas, P.E., ATR Team Member – Electrical (CELRL-ED-D-E).** Jeff currently serves as a Regional Technical Specialist to LRD with over 11 years of experience working in the design branch of the USACE Louisville District. He graduated from Clarkson University with a bachelor's degree in Electrical Engineering in 2006 and is a registered professional engineer in the state of Kentucky. Prior to joining USACE, Jeff worked for an environmental engineering firm out of Bowie, MD focusing on upgrading water and wastewater treatment plants. Jeff's accomplishments include design and support efforts for the Olmsted Lock and Dam construction, support of LRL's Levee Safety Section with respect to 408 and LNO reviews, lead electrical designer for the Paducah, KY Levee Reconstruction efforts, and is involved in arc flash hazard analysis and motor winding insulation (megger) efforts for the district. Jeff is also a lead electrical inspector for LRL's periodic inspection team and a member of LRD's Operational Condition Assessment group. Jeff is currently providing support to infrastructure upgrades at multiple navigation projects along the Ohio River, and is involved with the Louisville Metro Levee

Discipline	Name	Description of Credentials
		reconstruction. Additionally, Jeff is the lead for LRD's Electrical Engineering Community of Practice.
Construction Engineering	Matthew Folk	**Matthew W. Folk, P.E., Construction Liaison (CELRH-DSPC-TS).** Matt is a Registered Professional Civil Engineer currently working in the Dam Safety Modification MCX. He has over 28 years of construction, civil and geotechnical engineering experience with the US Army Corps of Engineers and private industry. Matt has a Bachelor's degree in Civil Engineering from the West Virginia Institute of Technology and a Master of Civil Engineering degree with construction management emphasis from North Carolina State University. He has broad work experience that includes construction management and design of complex dam safety, navigation, flood damage reduction, hydropower, environmental, utility installation, vertical construction, and disaster recovery projects in four USACE districts. As Resident Engineer, Matt has worked with domestic and international contractors using complex fixed price and cost reimbursement contract vehicles. He now serves as a Construction Liaison in the regional Dam Safety Production Center and national Dam Safety Mandatory Center of Expertise (MCX). Matt is currently providing technical construction support to on-going dam safety construction projects to include Bolivar Dam, East Branch Dam, Center Hill Dam, C-44 Reservoir and Herbert Hoover Dike. He also participates in Constructability Evaluations for dam safety designs, Dam Safety Modification Studies (DSMS) and Agency Technical Reviews.
Environmental Reviewer	Rebecca Rutherford	Ms. Rutherford is a Supervisory Biologist and serves as the District's NEPA Compliance Officer for the Huntington District Corps of Engineers within the Environmental Analysis Section, Planning Branch. She has over 25 years of NEPA and environmental compliance experience. Ms. Rutherford is ATR certified for environmental. Ms. Rutherford's current duties include managing and overseeing NEPA compliance for numerous

Discipline	Name	Description of Credentials
		projects under dam and levee safety, Operations and Maintenance actions, historic properties, Continuing Authority Program (CAP), Real Estate actions, water management actions, Environmental Infrastructure, mitigation requirements, etc. As part of NEPA compliance, Ms. Rutherford has completed and/or supervised the coordination/compliance of numerous projects under multiple federal statutes including the Endangered Species Act, National Historic Preservation Act, Clean Water Act, etc. She has completed numerous District Quality Checks and BCOES reviews. Past ATR reviews have included Isabella Dam Safety Modification DDR and Plans and Specifications, Isabella Dam Safety Supplemental Environmental Assessments, Whittier Narrows Dam Environmental Impact Statement, Independence Section 205, Lock and Dam 25, Albeni Falls Dam, Savannah River Comprehensive Study / Drought Contingency Plan, Lebanon Section 205, Cumberland Section 205 and others.
Risk Reviewer (DDR and P&S only)	TBD	TBD – Risk Reviewer will be member of SQRA cadre team and will review DDR/P&S for consistency between design and risk assessment.

Table 8 SAR Panel

Discipline	Name	Description of Credentials
SAR Lead	TBD	TBD
Hydraulics & Hydrologic Engineering	TBD	TBD
Geotechnical Engineering	TBD	TBD
Civil/Structural Engineering	TBD	TBD
Mechanical Engineering	TBD	TBD

Table 9 BCOES Panel

Discipline	Name	Description of Credentials
Biddability	TBD	TBD
Constructability	TBD	TBD
Operability	TBD	TBD
Environmental	TBD	TBD
Sustainability	TBD	TBD

ATTACHMENT 2
Project Risk Information (FOUO)

CENAN-EN

16 June 2020

MEMORANDUM FOR RECORD

SUBJECT: Green Brook Flood Risk Management Project, Segments C2 & H, C3 & C4, C5 & B3 & B4, C & D (Safety Assurance Review) Risk Informed Assessment of Significant Threat to Human Life

1. **Project Information:** The Green Brook Sub Basin is located within the Raritan River Basin in north- central New Jersey in the counties of Middlesex and Somerset. It encompasses 13 municipalities and drains approximately 65 square miles of primarily urban and industrialized area. For the majority of the project area, the most damaging floods of record resulted from the August 2, 1973 storm, Tropical Storm Floyd on September 16, 1999 and April 15-17 2007 Nor'easter. Eight deaths were attributed to these floods. The Final General Reevaluation Report (GRR) and Supplemental Environmental Impact Statement (SEIS), dated May 1997 recommended flood protection for the Lower Basin and Stony Brook Basin, and is supported by the project sponsor, the New Jersey Department of Environmental Protection. This project is authorized for construction in Section 401a of the Water Resources Development Act of 1986.

2. **Project Description**: The components of this Flood Risk Management project include the following:

    - **Segment C2 & H** – Approximately 1170 linear feet of floodwall. Approximately 1950 linear feet of earthen embankment levee. Two (2) 135 cfs pumps for the pump station. Roller steel closure gate and interior drainage features for routing stormwater.

    - **Segment C3 & C4** – Approximately 785 linear feet of pile supported, reinforced concrete T-Wall type structural floodwall. The structure is approximately 12 feet to 15 feet wide with a height of approximately 16 feet to 20 feet. Approximately 400 linear feet of earthen embankment levee. The levee crown is set at EL 51.1 feet to match the elevation of the cross-river flood control devices. The crown is 12 feet wide with side slopes graded to 1V:2.5H. Approximately 60 linear feet of roller steel flood closure gate at Bound Brook Rd (NJ Route 28). The structure is approximately 13 feet high with an opening of approximately 58 feet. Interior drainage features for routing stormwater.

- **Segment C5** – Approximately 1 mile of flood risk reduction improvements including levees, floodwalls, closure structures and additions.

- **Segment B3** – Four (4) 50 cfs pumps for the pump station.

- **Segment B4** - Approximately 1930 linear feet of floodwall. Approximately 60 linear feet of roller steel closure gate. Interior drainage features for routing stormwater.

- **Segment C and D** - Approximately 2.4 miles of flood risk reduction improvements including levees, floodwalls, closure structures, two pump stations and culvert upgrades and additions.

3. **Project Risk Information:** The project risk information and life safety assessment is based on, among other things, statistical information of the hazard conditions in the project area. Based on the Census Bureau’s 2018 American Community Survey 5-year estimates of Green Brook Township and Middlesex Township, approximately 3,360 of the population behind the system made up of Segments CHBD is at risk. As indicated in the table below, the primary mode of failure of concern is overtopping, secondary is overtopping with breach. Due to the presence of closure gates and pump stations among Segments CHBD, malfunction or improper operation of levee system components is an additional failure mode of consideration. The primary mode of failure has been assessed in regards to economic damages and project performance, and it is assumed for the purpose of the current analysis that the water level outside the levee is equal to the water level inside the levee the moment the levee is overtopped. This equilibrium of the interior and exterior water surface elevations represents the most

extreme case of inundation of the community receiving flood risk management with Segments CHBD. In the event of overtopping without breach, the incremental risk as it relates to life safety all else equal is therefore null; with-project conditions are equivalent to without-project conditions; transformed and transferred risks aside. Considering the potential for transferred risk resulting from increased development encouraged by levee/floodwall Segments CHBD, the incremental risk is nontrivial. In the event of breach with failure, the incremental risk is also nontrivial as the velocity of the inundation would be much greater in the event of breach.

Table 10 contains a summary of Segments CHBD residual risk and Table 11 contains a summary of CHBD project performance. Given the interior/exterior water level assumption, equivalent annual residual damages for Segments CHBD are estimated to be $1,395,000 which is a 72% reduction from the $5,030,000 in equivalent annual without-project damages. Pursuant to Engineering Regulation 1105-2-101, Paragraph 8(e), the system performance will reflect that of the weakest component, which are Segments B1 and B2 according to the project performance statistics. The expected annual chance of exceedance for Segments B1 and B2 is .0062. The 50-year long-term exceedance probability for these segments is .2659. Segments B1 and B2 pass the .01 ACE flood event with 80.27% assurance.

Table 30: CHBD Project Risk Reduction Summary

Structural Segment	Brook	Modeled Elevation (NAVD88)	FWOPC EAD	FWOP EAD Residual Risk	Risk Reduction
C1	Bonygutt	51.87	$361,000	$240,000	-34%
C1	Bound	53.72	$1,839,000	$92,000	-95%
B3	Bound	48.82	$244,000	$168,000	-31%
B4	Bound	48.82	$1,000	$3,000	+200%
C2, C3, C4, C5	Bound	48.82	$2,061,000	$520,000	-75%
H	Bound	53.37	$32,000	$24,000	-25%
B1, B2	Green	46.22	$199,000	$149,000	-25%
C	Green	50.22	$109,000	$88,000	-19%
D	Green	50.22	$184,000	$111,000	-40%
TOTAL			$5,030,000	$1,395,000	-72%

Future with- and without-project condition equivalent annual damages presented at FY 2019 price level and have been calculated using the FY 2019 plan formulation and evaluation rate (discount rate) pursuant to EGM 2019-01.

Table 11: CHBD Project Performance Summary

Structural Segment	Brook	Modeled Elevation (NAVD88)	AEP		LTEP (years)			Assurance by Event			
			Median	Expected	10	30	50	10%	2%	1%	.2%
C1	Bonygutt	51.87	.0018	.0025	.0248	.0725	.1179	.9997	.9991	.9773	.5576
C1	Bound	53.72	.0008	.0012	.0117	.0348	.0574	.9997	.9997	.9982	.8578
B3	Bound	48.82	.0025	.0035	.0343	.0995	.1602	.9997	.9990	.9590	.4034
B4	Bound	48.82	.0029	.0039	.0381	.1100	.1766	.9997	.9974	.9475	.3338
C2, C3, C4, C5	Bound	48.82	.0031	.0042	.0409	.1178	.1886	.9996	.9962	.9376	.2929
H	Bound	53.37	.0008	.0011	.0112	.0331	.0545	.9997	.9997	.9989	.8739
B1, B2	Green	46.22	.0044	.0062	.0599	.1693	.2659	.9997	.9744	.8027	.254
C	Green	50.22	.0020	.0029	.0281	.082	.1329	.9997	.9995	.9722	.4967
D	Green	50.22	.0022	.0030	.0299	.0871	.1409	.9997	.9995	.9711	.4413

Table 12 contains a summary of the maximum stage and depths in each of the reaches for the future without-project/mode 1 levee failure condition as compared to the modeled levee elevation. The water surface elevation is expected to be below the modeled elevation for all levees in the CHBD system at the .01 ACE event. The CHBD system passes the .01 event with assurance between .8027 and .9989. The water surface elevation for the .002 ACE event is higher than the modeled elevation of the levee for structural segments B1 and B2 on Green Brook, B3 on Bound Brook, B4 on Bound Brook, C2, C3, C4, and C5 on Bound Brook, C on Green Brook, and D on Green Brook. The depth of inundation may be as high as 13 feet when the C2, C3, C4, and C5 levee segments are overtopped conditional on a .002 ACE event. The maximum inundation level simulated for the .002 ACE event is higher than 10 feet or more in four reaches where the water surface elevation exceeds the modeled elevation of the levee. Generally speaking, we can therefore conclude a nonzero probability of life loss given the potential for flooding above the main floor when the levee is overtopped. This risk can be quantitatively assessed using LifeSim.

Table 12: Maximum Stage and Depths Summary

Structural Segment	Brook	Modeled Elevation (NAVD88)	Max of Stage (NAVD88) at 0.01 Probability	Max of Stage (NAVD88) at 0.002 Probability	Max of Depth (ft) at 0.01 Probability	Max of Depth (ft) at 0.002 Probability
C1	Bonygutt	51.87	47.83	51.57	5.83	9.57
B1, B2	Green	46.22	43.585	48.672	9.79	15.07
B3	Bound	48.82	44.32	49.465	7.64	12.87
B4	Bound	48.82	44.455	49.575	-4.845	0.275
C1	Bound	53.72	48.04	51.825	7.765	11.53
C2, C3, C4, C5	Bound	48.82	47.51	51.28	8.09	13.072
C	Green	50.22	48.17	51.372	5.11	10.29
D	Green	50.22	49.405	52.815	4.69	9.56
H	Bound	53.37	47.555	51.31	7.3	12.072

Table 13: Structures Damaged - Mode 1 Levee Failure

Structural Segment	Brook	Sum of Number of Structures	Structures exposed to Mode 1 Failure at Conditional Exceedance Probability of .01 Event	Structures Exposed to Mode 1 Failure at Conditional Exceedance Probability of .002 Event
C1	Bonygutt	446	87	370
B1, B2	Green	177	65	141
B3	Bound	181	32	165
B4	Bound	2	0	2
C1	Bound	15	6	14
C2, C3, C4, C5	Bound	413	387	411
C	Green	223	45	188
D	Green	110	27	88
H	Bound	107	41	105
Total		1674	690	1484

The risk posed to structures of a mode 1 levee failure – overtopping without breach – can be described by the future without-project condition damages at the various flood events. In the case of mode 1 levee failure, it has been assumed that the water surface elevation inside the levee equalizes to the water surface elevation outside the levee, meaning that inundation returns to future without-project conditions. The chance that this happens is given by the complement to the conditional non-exceedance probability.

That is, segments B1 and B2 have a 19.73% chance of being exceeded conditional on a .01 ACE event and a 74.6% chance of being exceeded conditional on a .002 ACE event. Accordingly, all else equal, 65 structures behind levee segments B1 and B2 have a 19.73% chance of being damaged conditional on a .01 ACE event and 141 structures have a 74.6% chance of being damaged conditional on a .002 ACE event. The risk posed to life loss follows from these results.

A map of the critical infrastructure has been provided in Figure 5. The various critical infrastructure and key resources are identified in the legend, and the .004 ACE floodplain is given by the purple shaded area. There are 6 schools, 2 law enforcement stations, 2 fire stations, and 4 EMS stations within the Green Brook floodplain that corresponds with the .004 ACE event. Table 14 contains a summary of the inventoried infrastructure that reside behind the CHBD system. There are 15 municipal buildings and 5 utility structures. The maximum inundation depth projected among these inventoried structures is at a municipal building behind Segments C2, C3, C4, and C5 at 8.731 feet conditional on the .002 ACE event. Evacuation plans have been established by the Borough of Middlesex, whereby evacuation orders are issued ahead of potential flood events.

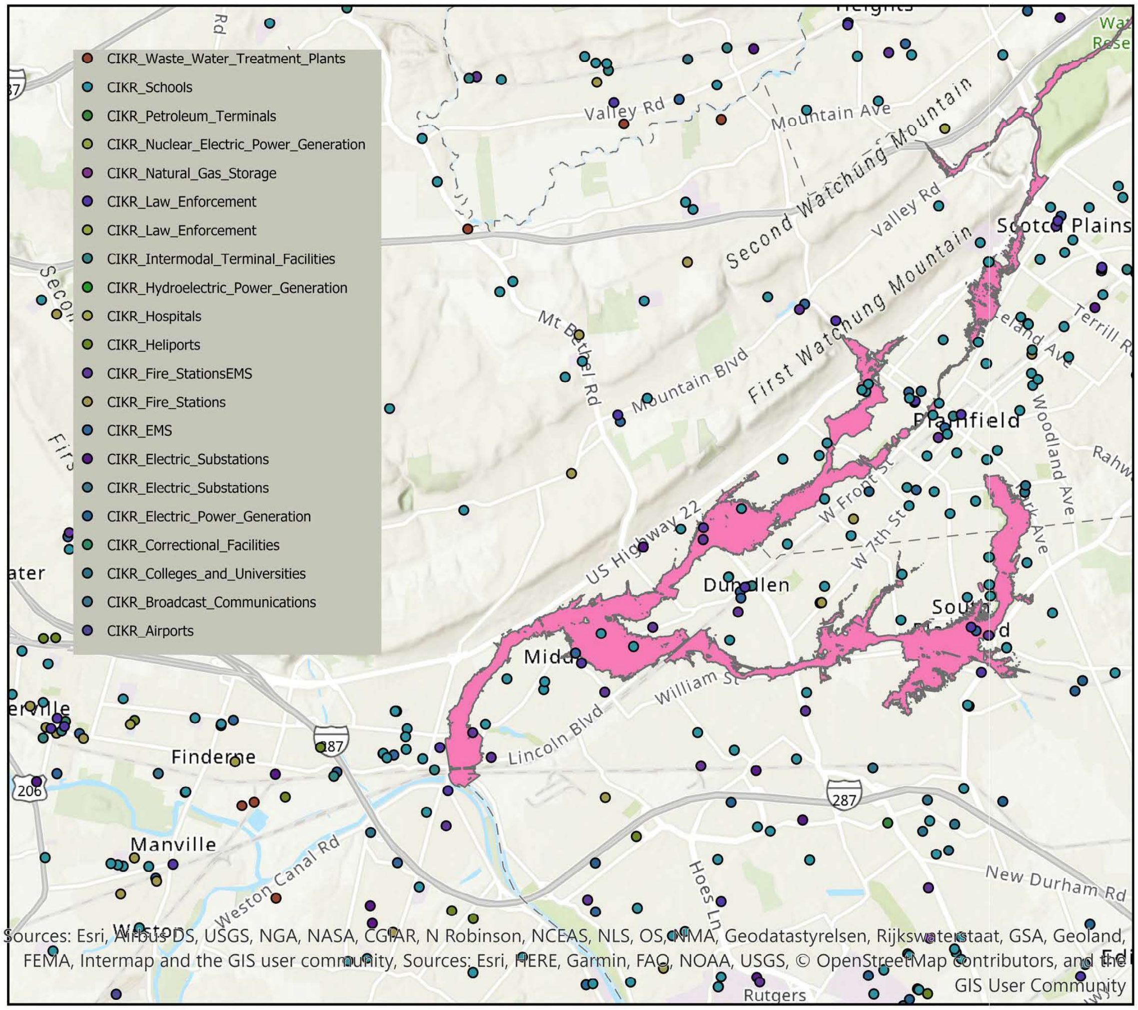

Figure 5: Green Brook Critical Infrastructure

Table 14: Inventoried Infrastructure Behind CHBD Project

Structural Segment	Brook	Structure Count		Max of Depth (ft) at 0.002 Probability	
		Municipal	Utility	Municipal	Utility
C1	Bonygutt	3	1	3.27	4.27
B3	Bound	3	1	3.935	6.372
C2, C3, C4, C5	Bound	7	-	8.731	-
D	Green	1	1	4.825	2.695
H	Bound	1	1	0.772	1.072
Grand Total		15	4	8.731	6.372

4. **Risk Informed Assessment**: In accordance with EC 1165-2-217 (20 February 2018), Review Policy For Civil Works, a risk informed assessment was made as to whether there is a significant threat to human life from the CSRM components (see attached table). In accordance with ECB 2019-15 Interim Approach for Risk-Informed Designs for Dam and Levee Projects, the risk assessment will include an evaluation of the life and economic consequences, hazard curves, potential failure mode analysis, and determination of the annual probability of inundation. The results will be used to further refine the design of the constructed project as well as provide initial recommendations for NFIP accreditation.

5. **Determination:** The Interim Guidance on Streamlining Independent External Peer Review (IEPR) for Improved Civil Works Product Delivery Memorandum, dated 4 April 2019, states that a project may require a Type II Safety Assurance Review (SAR) if there is a significant threat to human life. Based on a risk informed assessment of significant threat which considered life safety factors, there is a significant threat to human life associated with the Green Brook Segments C1, C2 & H, C3 & C4, C5 & B3 & B4, C & D Flood Risk Management Project. Accordingly, a Type II IEPR, Safety Assurance Review, is warranted and it will be performed.

MICHAEL ROVI, PE
Chief, Engineering Division

Risk Informed Assessment of Significant Threat to Human Life for South Green Brook Segments C1, C2 & H, C3 & C4, C5, B3, B4, C & D, Green Brook, Middlesex and Somerset Counties, NJ, Flood Risk Management Project

No.	Risk Factor (Possible Threat to Life Safety)	Risk Magnitude (H/M/L)	Basis of Concern	Risk Assessment
1	Land use adjacent to the project	Moderate	The land use adjacent to the project is generally residential and comprised of single family homes with some commercial and municipal structures.	See 1a-1c below.
1a	Population Density	Moderate	The density behind the floodwall may increase after the project is completed	Due to population density, many people could be affected by flooding or project failure.
1b	Critical Facilities Affected (e.g. schools, hospitals, assisted living/nursing homes, evacuation routes)	Low	New or changes usage would introduce critical facilities to the protected area.	The Borough of Middlesex and Somerset issues evacuation orders to those in flood prone areas prior to storm events to minimize, to the extent possible, the chances that individuals will be trapped during storm events.
1c	Numbers/types of structures in project area	Moderate	There are generally two story, single family homes, with some commercial and municipal structures.	Project structures within the floodplain could be adversely affected by flooding or project failure. Residential areas are exposed to inundation of the Bound Brook River.
2	Structural failure of project components	Moderate	Weather event that creates discharge on Green Brook that could cause significant damage to floodwall system thereby leading to loss of functional integrity.	For the completed project, structural failure of a project component up to the design event is unlikely due to the use of proven design and construction techniques. However, larger events which can lead to failure would result in significant

No.	Risk Factor (Possible Threat to Life Safety)	Risk Magnitude (H/M/L)	Basis of Concern	Risk Assessment
				flood damages and impact a large number of people. Risk would be inherent with all culverts and floodwall project.
3	Overtopping of Hydraulic Structure	High	Weather event that creates discharge on Green Brook that would exceed the design elevation or cause debris jam that restricts flow resulting in overtopping of culverts and floodwall.	Overtopping could lead to structural failure or a breach, which is high risk situation.
4	Use of unique or non-traditional design methods	Low	Unique or non-traditional design methods may be poorly understood or inadequately designed and may be more subject to failure than proven design methods.	The design of this project will be performed by accepted methods in accordance with COE guidance. No innovative or precedent setting methods or models are anticipated.
5	Use of unique or non-traditional design features	Low	Unique or non-traditional design features may be poorly understood or inadequately designed and may be more subject to failure than proven design features.	The design of this project will fall within prevailing practice and include only time tested design features.
6	Use of unique non-traditional construction materials or methodologies	Low	Unique or non-traditional materials or methods may be poorly understood or executed inadequately resulting in a project feature that may be more subject to failure than those built with proven materials and methods.	All materials used will be within common practice.
7	Does this project have unique construction sequencing or a reduced or overlapping design/	Low	Accelerated construction may lead to poor quality work, leading to unexpected maintenance and repairs. Construction sequencing will result in	Due to the construction sequencing, the authorized level of performance will not be achieved until all portions of Segment C are constructed. Sufficient time

No.	Risk Factor (Possible Threat to Life Safety)	Risk Magnitude (H/M/L)	Basis of Concern	Risk Assessment
	construction schedule?		only partial protection.	should be available for completion of construction.
8	Does the project require:			
8a	Redundancy	Low	Failure of one critical project element would result in sudden, catastrophic damage.	The levee, floodwall and closure gate greatly reduce the risk to human life and property relative to the without project conditions.
8b	Resiliency	Moderate	Level of performance maybe reduced over time.	Adherence to OMRR&R requirements will ensure that the features remains at full operating efficiency. However, over time the hydrology may change thereby reducing the level of performance. A performance monitoring should be employed in the Operation and Maintenance of Protection System. The floodwall design allows to change the level of performance to account to future increase in flow, without impacts to real estate.
8c	Robustness	Moderate	Floodwall and levee systems.	Natural events can occur that are greater than the design level and may lead to project failure.

ATTACHMENT 3
Review Plan Revisions

Table 45 RP Revisions

Revision Date	Description of Change	Page/Paragraph Number