Community Development Block Grant

Disaster Recovery Program

Fifth Substantial Amendment to the Action Plan:

Identification of Final Rebuild by Design Project

CONNECTICUT
Department of Housing

DEPARTMENT OF HOUSING

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A. Background

On Monday, October 29, 2012 Hurricane Sandy made landfall near Atlantic City, New Jersey, as a post-tropical cyclone. The storm created a significant tidal surge from the Mid-Atlantic region to New England. After landfall, Sandy headed north by northwest bringing high winds, rain, and storm surge to coastal areas of Connecticut, causing widespread wind damage, flooding, and power outages. On Saturday, October 27, in advance of Sandy's forecasted impact on Connecticut, Governor Malloy signed a declaration of emergency and the following day the Governor requested, and President Obama approved a declaration of emergency.

The size and scope of the storm has been attributed to a convergence of weather systems. As the hurricane pivoted toward land, it merged with a winter storm from the west and cold air moving south from the Arctic. The hybrid storm - with both tropical and extra-tropical characteristics - brought high winds and coastal flooding to southern New England. High wind warnings and coastal flood warnings were issued by the National Weather Service, with storm surge prediction in the range of 6 to 11 feet above astronomic high tide, with 6 to 10 foot waves on top of the surge.

In response to the extraordinary destruction caused by Hurricane Sandy, Congress passed and the President signed into law The Disaster Relief Appropriations Act; also known as Public Law 113-2 (the "Act"), which, among other things, appropriated approximately $60 billion for recovery efforts related to Hurricane Sandy and other natural disasters specified in the Act. A significant portion of those funds was set aside for the Community Development Block Grant - Disaster Recovery Program (the "CDBG-DR Program") to be administered by the United States Department of Housing and Urban Development ("HUD").

Governor Dannel P. Malloy has designated the Connecticut Department of Housing ("DOH") the principal state agency for the allocation and administration of the CDBG-DR Program and all associated funding.

As explained in more detail below, the State of Connecticut, through DOH, has received three allocations of these federal block grant funds, Tranche 1 - $71,820,000, Tranche 2 - $66,000,000, Tranche 3 – which consists of $11,459,000 in CDBG-DR funds and $10,000,000 in Rebuild by Design ("RBD") funds intended to support the Resilient Bridgeport initiative, totaling $21,459,000.

This Fifth Substantial Amendment to the Action Plan provides details on the Pilot Project (the "Pilot Project") for the Rebuild By Design award.

In accordance with the Federal Register Notice (Vol. 79, No. 200; October 16, 2014 Page 62184) titled: "Third Allocation, Waivers, and Alternative Requirements for Grantees Receiving Community Development Block Grant (CDBG) Disaster Recovery Funds in Response to Hurricane Sandy" (the "Federal Register Notice"), for both the Tranche 3 funds and the RBD funds, the State must submit a Substantial Action Plan Amendment to the Action Plan which defines the Pilot Project. As with the previous Substantial Action Plan Amendments, this Substantial Amendment must also provide a description of the State's public outreach and citizen participation practices, and describe the planned citizen participation throughout the development and implementation of the Pilot Project. The State is obligated to ensure that the processes, procedures, and fiscal and administrative controls it will use in the course of expending CDBG-DR funds are sufficient to safeguard CDBG-DR funds from waste, fraud and abuse.

In addition to specifying the amount of funds allocated to the State, the Federal Register Notice also sets forth, among other requirements, the areas within the State where CDBG-DR funds can be expended, the programs or activities for which CDBG-DR funds can be used, and the national objectives that each program or activity must meet. The Federal Register Notice also imposes strict expenditure and compliance deadlines on the State.

Substantial Amendments to the Action Plan

A Substantial Amendment to the Action Plan shall be defined as:

1. a change in program benefit or eligibility criteria;
2. the addition or deletion of an activity; or
3. the allocation or reallocation of more than $1 million between activities.

Only those amendments that meet the definition of a Substantial Amendment are subject to the public notification and public comment procedures previously identified herein. Specifically, a public notice will be published and comment will be sought when assistance programs are further defined (i.e. change in program benefit or eligibility criteria) or when funding allocations are further refined by type of activity and location, if applicable.

Citizens, units of local government, and our community partners will be provided with advanced notice and the opportunity to comment on proposed Substantial Amendments to the Action Plan. An electronic copy of the proposed Substantial Amendment will be posted on the official Hurricane Sandy page of the DOH website. Hard copies will also be made available upon request. No less than seven days will be provided for review and comment on the Substantial Amendment. Comments will be accepted electronically or in writing. A summary of all comments received and responses will be included in the Substantial Amendment that is submitted to HUD for approval.

B. Overview of Substantial Amendment

Federal Requirements –Rebuild by Design (RBD)

As discussed in prior substantial amendments, the State is obligated to ensure that the processes, procedures, and fiscal and administrative controls it will use in the course of expending CDBG-DR funds are sufficient to safeguard CDBG-DR funds from waste, fraud and abuse. In addition, any substantive revisions to the allocation of funds or to the policies associated with the administration of these funds must be vetted through a public substantial amendment process.

Any Substantial Amendment submitted is subject to the following requirements:

- DOH consults with affected citizens, stakeholders, local governments and public housing authorities to update its needs assessment;
- DOH amends its citizen participation plan to reflect the requirement for a public hearing;
- DOH publishes a substantial amendment to its previously approved Substantial Amendment or Action Plan for Disaster Recovery on the DOH Web site for no less than 30 calendar days and holds at least one public hearing to solicit public comment;
- DOH responds to public comment and submits its Substantial Amendment to HUD no later than 120 days after the end of the public comment period;
- HUD reviews the Substantial Amendment within 60 days from date of receipt and approves the Amendment according to all published criteria; and
- HUD sends a Substantial Amendment approval letter, with revised grant conditions (if applicable), and an amended unsigned grant agreement to DOH.
- If the substantial Amendment is not approved, a letter will be sent identifying its deficiencies; DOH must then revise and resubmit the Amendment within 45 days of the notification letter; and
- DOH ensures that the HUD approved Substantial Amendment is posted on its official Web site.

As previously discussed, the State of Connecticut, through DOH, has received three allocations of these federal block grant funds, Tranche 1 - $71,820,000, Tranche 2 - $66,000,000, Tranche 3 – which consists of $11,459,000 in CDBG-DR funds and $10,000,000 in Rebuild by Design ("RBD") funds intended to support the Resilient Bridgeport initiative, totaling $21,459,000.

Use of the Tranche Funds

The Appropriations Act requires that these funds be used only for specific disaster recovery related purposes. Consistent with the Rebuilding Strategy, it is essential to build communities back stronger and more resilient. This substantial amendment clarifies the allocation of funds to Sandy-impacted grantees to support investments in resilient recovery.

C. Rebuild by Design – Resilient Bridgeport

In addition to specifying the amount of funds allocated to Connecticut in the third tranche ($11,459,000), the Federal Register Notice also provides an additional $10,000,000 specifically designed to support the Resilient Bridgeport initiative under the Rebuild by Design ("RBD") competition.

RBD was a planning and design competition to increase resilience in the Sandy-affected region as part of recovery from the storm. HUD conducted the competition under the authority of § 105 of the America COMPETES Reauthorization Act of 2010 (15 U.S.C. 3719). Administered in partnership with philanthropic, academic, and nonprofit organizations, HUD solicited the best talents and ideas from around the world to seek innovative solutions for how communities rebuild and adapt in response to the damage from a disaster and future risks presented by natural hazards and climate change. More regarding the history of the competition can be found in the Federal Register at 78 FR 45551, published July 29, 2013, and 78 FR 52560, published August 23, 2013.

The Resilient Bridgeport proposal was awarded $10,000,000 in CDBG-DR funds to reduce flood risk for the most vulnerable public housing stock in the city and to leverage other funding. HUD recognized that additional planning was required to reassess and re-scope one or more elements of the proposal to identify a pilot project that can be implemented and that the forthcoming project may require greater deviation from the proposal as submitted relative to that of the winning proposals.

This Substantial Amendment to the Action Plan will serve to identify the pilot project, per page 54116 of the Federal Register Vol. 81, No. 157 dated August 15th, 2016, and will be constructed using RBD funds to "reduce flood risk to public housing in the City's South End / Black Rock Harbor area."

Predevelopment work continued after the last substantial amendment to move the project from project identification to the subsequent project description that will be submitted in this substantial amendment. The work included additional feasibility analysis and stakeholder engagement that together clarified the scope and depth of the construction project. This pilot project identification, which is more fully defined than the December 2016 description, represents the selected project elements that have emerged from the public participatory and consultant planning and engineering process to meet the goal identified in the Federal Register. Relative to pilot project components identified in the last Substantial Amendment, this pilot project definition represents a finite infrastructure project that can be delivered within the project budget, will meet the established goals, and has the requisite community support.

To arrive at this pilot project definition, following the award of funds in 2014 and the identification of the pilot project in 2016, significant public outreach and stakeholder engagement has taken place. Described in further detail in the Citizen Outreach Plan component of this Substantial Amendment as the basis for future outreach, the public has been meaningfully engaged in the decision-making process throughout. The team has organized nine workshops and has presented more than ten meetings hosted by other relevant organizations, in addition to dozens of meetings with individual citizens, civic groups, property owners, local businesses, and other key stakeholders. This pilot project identification is the product of the feedback the State and its consultants received and ideas generated in those workshops and discussions.

This Substantial Amendment further describes the pilot project and "incorporates (it) in order for project-related funds to be obligated." This Substantial Amendment will provide a "detailed description" of the pilot project to be constructed. The focus area of the pilot project is the cluster of sub-watersheds bounded roughly by Alsace Street on the West, Interstate 95 on the North, Park Avenue on the East, and Long Island Sound on the South.

The primary objective of this project is to reduce the risk from chronic storm water flooding in the most vulnerable public housing stock in the city, Marina Village, and the surrounding neighborhood rather than from the acute flooding from coastal storm surge that occurs during extreme events.

D. Project Description and National Objective

The Resilient Bridgeport pilot project, also referred to as the demonstration scale project, is a combination of natural/green and fortified/grey infrastructure solutions integrated within a new, multifunctional public realm to facilitate more resilient forms of inhabitation in the neighborhoods of the City of Bridgeport most at risk from severe storms. The proposed project is located in the South End of the city which experienced the most significant impacts during Superstorm Sandy and has also faced acute challenges in other storms (e.g. Hurricane Irene) and chronic flooding challenges as a result of an aged and combined stormwater sewer system, Sea Level Rise, and an aged housing stock including Marina Village, the most flood-prone public housing in the City's South End / Black Rock Harbor area.

Following Superstorm Sandy, a decision was made by the Housing Authority of the City of Bridgeport (a/k/a Park City Communities) to replace the nearly 75-year old Marina Village public housing complex with more modern and resilient housing. Park City Communities selected a private development partner to lead the first several phases of redevelopment which will ultimately result in the 405 units of Marina Village being replaced as components of privately owned and managed mixed-income (and in some instances mixed-use) on multiple parcels throughout the city. Land owned by Park City Communities in the South End and other neighborhoods was rezoned and prepared for revitalization including the demolition of the first approximately 15 buildings of Marina Village, some of which have been vacant since 2012. The first two phases of mixed-income redevelopment (including replacement units for Marina Village) occurred in the city's East Side neighborhood with support from the State of Connecticut including CDBG-DR, Low-Income Housing Tax Credits, and state discretionary affordable housing grants and loans. Given the Marina Village parcels' proximity to downtown and employment opportunities, transit accessibility, higher educational institutions, and park amenities coupled with some residents' desire to remain in the South End neighborhood, the next phases of mixed-income redevelopment are slated for the parcels which formerly held the

Marina Village public housing complex. To that end, the Resilient Bridgeport pilot project specifically aims to facilitate the redevelopment of the Marina Village parcels with mixed-income housing including public housing replacement units by reducing the flood risk to those parcels in both acute and chronic flooding events.

The project area is roughly coterminous with the historic footprint of Marina Village, bounded by Park Avenue on the east, Iranistan Avenue on the west, Ridge Avenue on the south and South Avenue along its northern edge. Outside of this rectangular boundary but included in the project site is a corridor extending five hundred (500) feet west of Iranistan Avenue to Cedar Creek. Though the project activities are limited to this project site, the project is designed to provide benefits to **low- and moderate-income** home ownership and rental housing adjacent to the east and south as well as in the historic post-WWI, community known as Seaside Village to the west.

Designed to be both infrastructure and urban amenity, the project is composed of the following natural and fortified solutions to facilitate a more resilient neighborhood:

- A green and grey infrastructure MS4 micro-grid will reduce chronic flooding in and around the Marina Village mixed-income redevelopment:
    - An approximately 2.5 acre stormwater park to accept water from upland streets and adjacent parcels and to retain, delay and improve the quality of the stormwater runoff via a series of surface features, including terraced basins, intermittent streams, and underground storage features. As the most visible portion of project, the park will function as a "zipper" connecting the future mixed-income housing on the Marina Village site and the existing neighborhood fabric. It will provide an attractive amenity for new and existing residents, incorporating community program elements, opportunities for environmental education, and spaces for passive and active recreation. The park component will also provide expanded habitat for flora and fauna, extend the urban tree canopy, and reduce the heat island effect, all within an innovative landscape design intended to become a regional landmark and identity marker within the South End.

- At the low ponding point of the park, water will collect into a gravity fed pipe and be relayed to a pump at Iranistan and South Avenue. At this point, a new underground force main will transfer water to an existing outfall at Cedar Creek, the result of close collaboration between the design team and Bridgeport Water Pollution Control Authority (WPCA). This water, which formerly would have contributed to flooding in the neighborhood and combined sewer overflows into Cedar Creek and Long Island Sound, will now discharge into the reach of Cedar Creek, improving flushing and overall ecological function.
- The project team has been working in close collaboration with Park City Communities' private redevelopment partner, JHM Group, to ensure that the on-site stormwater management systems designed and implemented as part of the housing development will connect to the pilot project green and grey infrastructure, managing the development's stormwater through the MS4 micro-grid.

- A raised egress corridor linking the Marina Village mixed-income redevelopment with adjacent high ground will provide an evacuation route and facilitate emergency access during an acute flooding event (designed for the current 100-year base flood elevation plus three (3) feet of Sea Level Rise):
    - Running along the northern edge of the stormwater park, between the park and the Marina Village redevelopment site, a new raised green street, an extension of Johnson Street (between Columbia Street and Iranistan Avenue), will improve east-west neighborhood connectivity and provide dry egress above the 100-year storm event elevation plus projected 2075 Sea Level Rise to upland areas, enhancing the resilience of the new mixed-income housing and adjacent parcels during acute storm events and meeting the state Floodplain Management Certification regulatory requirements.
    - The project team has been working in close collaboration with JHM Group to ensure that the building elevations, automobile and pedestrian circulation systems, and public spaces designed and implemented as part of the housing

development will connect to the pilot project raised corridor and park, utilizing the pilot project public realm to establish a new datum for development in this area of the South End, facilitating more resilient forms of inhabitation in this area at risk from severe storms.

The above components are proposed to meet the project's goals to mitigate the impacts of chronic storm events, including flooding, which routinely impact low- and moderate-income residents of Bridgeport's South End, and to provide dry egress during acute storm events from sensitive residential areas currently within the 500-year flood plain (including the future Marina Village redevelopment site) accommodating an additional 3 feet of Sea Level Rise projected for the useful life of the project (see Flood Risk Reduction section below).

The success of this project will be measured against of a range of project outcomes. While flood risk reduction is the primary objective of the project, it is being designed to achieve a variety of co-benefits that will, along with the redevelopment of the Marina Village site into a privately managed mixed-income community, reposition the South End for resilience by targeting ecological, economic, and social improvements to the neighborhood achieved through both the physical project and the inclusive participatory process that spawned it. The complete list of project outcomes is described in detail in Section 1.1.3 of the Benefit Cost Analysis Summary that can be found in Attachment B.

The robust inter-governmental partnerships and stakeholder support enjoyed by the project coupled with significant public sector property ownership ensure that the project can adapt to unforeseen challenges and continue to meet its intent even as it may evolve through the environmental review process.

E. Flood Risk Reduction

The RBD project, specifically focused around the future mixed-income development on the Marina Village site, aims to address both chronic and acute flooding in an area of the Sound End. A positive impact on acute and chronic rainfall-induced flooding is realized by decreasing the frequency of combined sewer overflow events in Cedar Creek, as well as by decreasing the frequency of flooding within low areas of the neighborhood. A positive impact, by lessening impacts of acute flooding from coastal storms, is realized by providing safe passage for the community into and out of the area during a major storm event through the extension and elevation of Johnson Street. The entire Marina Village redevelopment site will have access to dry egress as a result of this project.

Chronic Flooding:

To address chronic flooding, the majority of stormwater runoff from the first phases of the Marina Village redevelopment (located between Park Avenue and Columbia Street) and partial runoff from the subsequent phases of the Marina Village redevelopment (located between Columbia Street and Iranistan Avenue) will be captured and routed to a new 2.5 acre terraced stormwater park (see figure 1.1). Additional stormwater runoff will be routed to the new park from adjacent streets and the neighboring Bridgeport Neighborhood Trust properties near the intersection of Columbia Street and Johnson Street and along Columbia Court. The park will be designed to detain and retain, at a minimum, forty-one thousand cubic feet (41,000 CF) of stormwater runoff, reducing peak flows from the 25-year NRCS storm event, before routing the water to a pump station at the corner of South Avenue and Iranistan Avenue via a gravity pipe. In addition, the extension of Johnson Street will be a "green" street; it will incorporate green infrastructure such as bioswales and rain gardens to enhance the detention capacity of the project site. By enhancing the detention capacity, the MS4 micro-grid system will be able to capture more stormwater runoff while minimizing project costs (e.g., the cost of the stormwater pump).

At the pump station, stormwater flows routed through the park will be joined by the remaining stormwater runoff from the subsequent phases of the Marina Village redevelopment, overflows from which will be routed directly to the pump station. From the pump station, flows will be conveyed through a shallow force main to the existing Little Regulator Outfall along Cedar Creek, which will be repurposed from an abandoned combined sewer overflow (CSO) outfall to a new stormwater outfall.

Through the intervention described above, the City of Bridgeport is equipped with the first phase of an MS4 for the South End. By reducing stormwater runoff ffrom entering the combined sewer system, the project reduces on-streeet flooding in the project area by roughly 60 percent.

Acute Flooding:

During less frequent coastal storm events, community members may become stranded and be unable to evacuate to higher ground without dry egress. The project addresses acute flooding by providing a new means of egress, (see figure 1.2). The raised roadway gives residents a safe exit out of the 500-year floodplain, as well as entry access into the floodplain for emergency services during storm events. By designing to an elevation of 15 feet NAVD88, the project targets an elevation above the FEMA 500-year stillwater elevation (11.3 feet NAVD88) plus 3 feet of sea level rise. The sea level rise increment of 3 feet used for this phase of design was selected is in accordance with guidance from the Connecticut Institute for Resilience and Climate Adaptation and the Connecticut Department of Energy and Environmental Protection, which references NOAA CPO-1, “Global Sea Level Rise Scenarios for the United States National Climate Assessment,” and discussions with key stakeholders that determined the project’s useful life and the critical assets along Johnson Street.

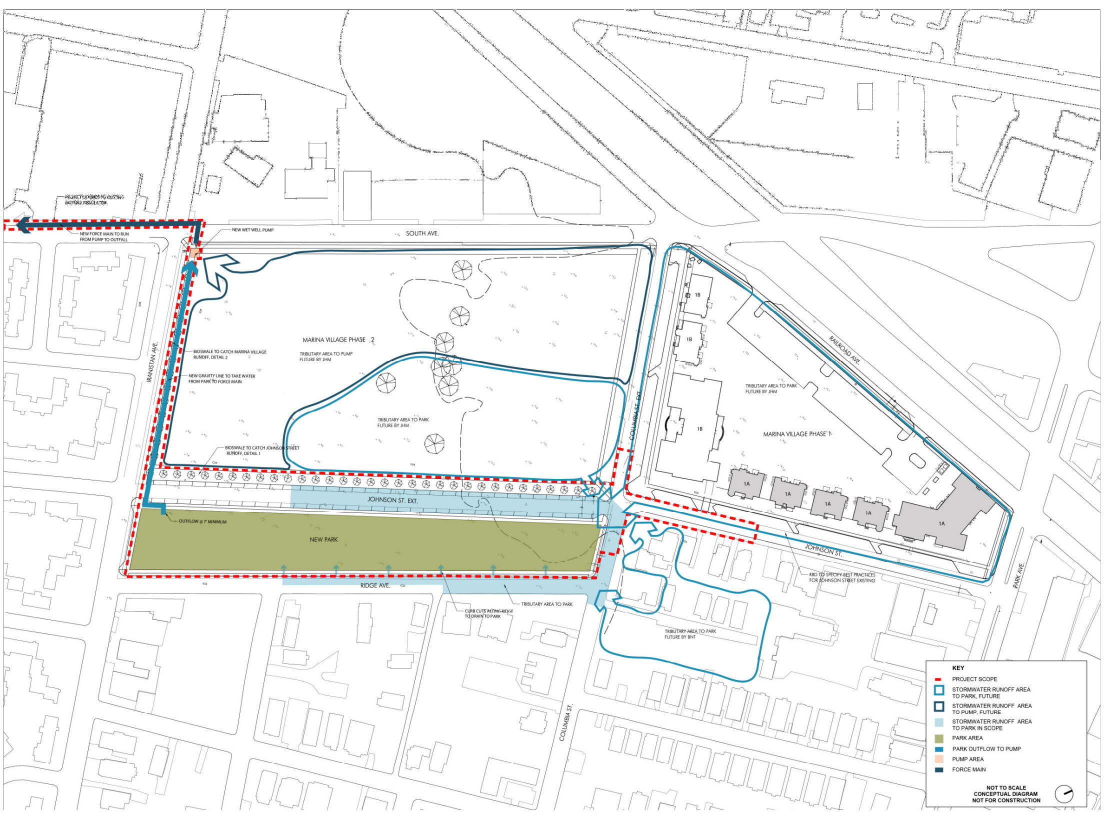


Figure 1.1 Stormwater Micro-Grid Diagram

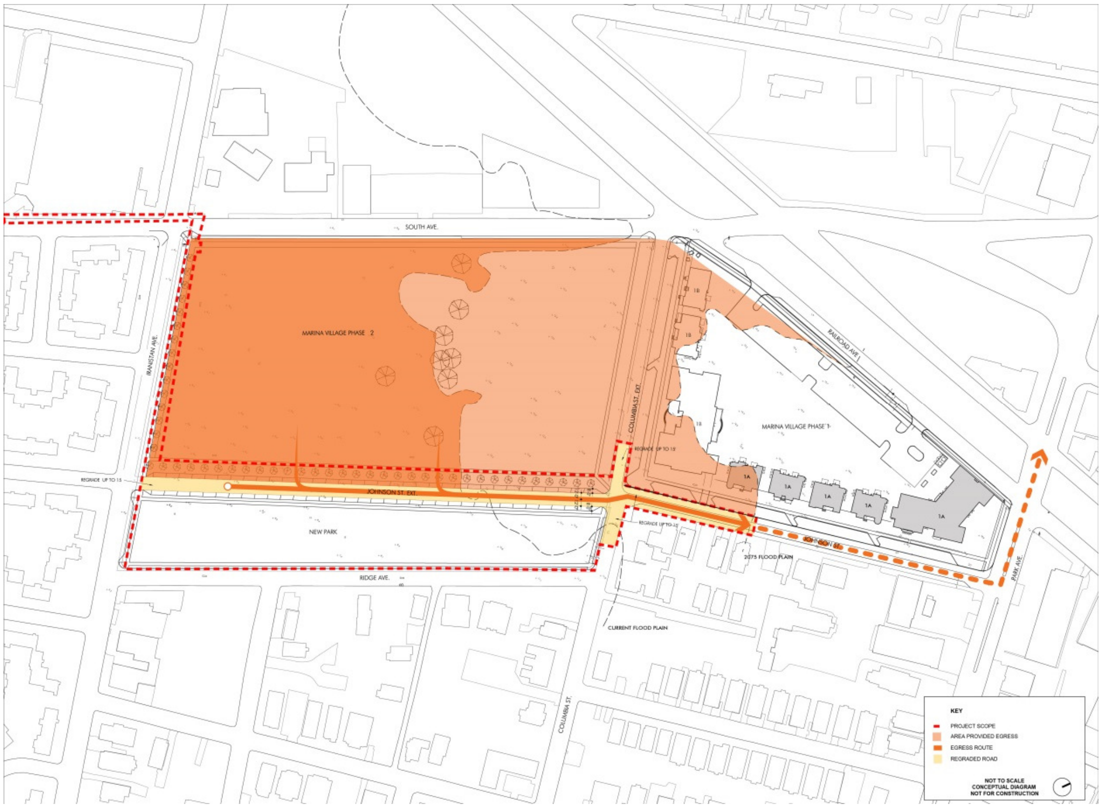


Figure 1.2 Dry Egress Diagram

F. Design Certification and Resilience Performance Standards

In accordance with HUD Guidance and Requirements for the Substantial Action Plan Amendment Reference VI.6.b; 62189, the conceptual design considers the appropriate codes and industry design standards. As design of the pilot project or demonstration project advances through final design, appropriate construction standards will also be adhered to. It is anticipated that final design will adhere to all relevant codes when the design is complete. Further documentation from a registered Professional Engineer (P.E.) in the State of Connecticut can be found in Attachment A.

The State is committed to developing and implementing a set of resilience performance standards for the infrastructure project being funded through RBD. The State will coordinate the standards developed for the project with those that are being developed for the National Disaster Resilience (NDR) -funded infrastructure of similar nature being implemented in the South End of the City of Bridgeport. As with NDR, the State will look to the best available science and practices in resilience to inform the development of these standards. One such resource for developing these will be the State Agencies Fostering Resilience (SAFR) Council that was established through Executive Order during the NDR application process. It consists of nine state agencies, the University of Connecticut (UConn), Yale University, and the Connecticut Conference of Municipalities. The SAFR Council is committed to developing a Resilience Roadmap for the State of Connecticut and, in doing so, will be developing metrics that can be applied to the RBD project. One of the members of the SAFR Council, the Connecticut Institute for Resilience and Climate Adaptation at UConn, is particularly well suited to aid in this effort and researchers from both university members of the SAFR Council as well as those from other colleges and universities local to the infrastructure projects (e.g. the University of Bridgeport, Sacred Heart University, Fairfield University, and Housatonic Community College among others) will be consulted in the standards development to ensure that a long-term and sustainable strategy for measurement and tracking is established utilizing all available local and statewide resources. In consultation with these institutions, it is anticipated that an ongoing assessment program is developed to monitor the effectiveness of the infrastructure measures implemented as part of the project and, given constantly updating understanding of climate change impacts, altered or augmented to meet changing conditions as warranted.

G. Benefit Cost Analysis

Per HUD Notice: CPD-16-06, the Benefit Cost Analysis (BCA) conducted for the Resilient Bridgeport pilot project incorporates methodologies from the Federal Emergency Management Administration (FEMA), the United States Army Corps of Engineers (USACE), the Federal Aviation Administration (FAA), the Environmental Protection Agency (EPA), and other published sources. The summary report can be found in Attachment B and provides sufficient detail to help the reader understand the research and processes used to arrive at the benefit cost ratio (BCR) and to duplicate results following the same procedures (additional methodology detail can be found in the methodology report located in Appendix 1). Benefits fall into two broad categories: resiliency benefits and value added benefits. Resiliency benefits consist of estimated flood impacts to structures, roads, and the population that the pilot project will reduce. Value added benefits consist of additional benefits beyond flood protection, such as environmental, aesthetic, and recreational benefits. Costs incorporated into the BCA include all project life-cycle costs, or costs incurred over the life of the project. Such costs include capital costs and operations and maintenance costs.

The project seeks to serve as a catalyst and example of how the City and the State of Connecticut can begin to adapt their urban environment to become more resilient to an unpredictable future. The project proposes to implement a series of components designed to improve the City's flood resiliency, foster community cohesion, increase economic opportunities, and promote redevelopment through growth, prosperity, awareness, and beauty. The Resilient Bridgeport Team developed this project to meet the project objectives and produce a project that is both practical and implementable given the available funding and site conditions.

The BCA findings indicate that the project would not only reduce the impacts of chronic and acute flooding, but would also enhance the quality of the surrounding communities by providing increased recreational amenities and aesthetic enhancements; resulting in greater physical, social, ecological, and environmental resilience for the South End.

BCA analysts compared the present value of project costs and benefits, and found the project to be cost beneficial based on the current level of design. The project is expected to provide a range of resilience, social, environmental, and economic benefits totaling to **$14,469,860** in today's dollars, compared to an overall investment of **$9,235,060**, both at a 7% discount rate. The NPV of the RBD project is **$5,234,800**, and the BCR using a 7% discount rate is **1.57**. Table 1 provides the total present value of costs and benefits, as well as the benefit cost ratio of the medium scenario at both the 3% and 7% discount rate scenario.

Table 1. Resilient Bridgeport Results, Medium Scenario

Scenario	Total Present Value of Costs	Total Present Value of Benefits	Benefit Cost Ratio
Calculation	*A*	*B*	*C = B/A*
7% Discount Rate			
RBD Project	$ 9,235,060	$ 14,469,860	1.57
3% Discount Rate			
RBD Project	$ 10,112,620	$ 26,561,970	2.63

Use of Funds

The Resilient Bridgeport proposal was awarded $10,000,000 in CDBG-DR funds to reduce flood risk for the most vulnerable public housing stock in the city's South End / Black Rock Harbor area. Particular to the Resilient Bridgeport award, HUD recognized that additional planning would be required in order to reassess and re-scope elements of the proposal to identify a pilot project that can be implemented with the grant award.

$1,655,000 of the $10,000,000 of the award funded the resilience strategies for the study area within Bridgeport and the broader planning context used to identify the pilot project, $8,200,000 is allocated to the design and construction of the pilot project, and the remaining $145,000 is reserved for administration of the grant. Table 2 details a breakdown of pilot project delivery costs for construction and design/engineering that support the $8,200,000 estimate.

Table 2. Construction Soft and Hard Cost Breakdown

Construction Cost	
Description	**Cost**
Johnson Street Extension*	$ 1,040,000
24" RCP*	$ 287,000
30" Force Main*	$ 588,000
Mobilization	$ 85,000.00
*Pump (HOLD)***	*$ 2,100,000.00*
*Green Streets (HOLD)***	*$ 300,000.00*
*Stormwater Park (HOLD)***	*$ 2,700,000.00*
Construction Total	**$ 7,100,000.00**
Engineering / Design (2016)	$ 95,000.00
Engineering / Design (2017)	$ 480,000.00
Final Design and Environmental Review (2018)	$ 525,000.00
E & D Total	**$ 1,100,000.00**
Project Total	**$ 8,200,000.00**

** Costs include 35% design contingency, 20% general requirements, 15% overhead and profit, 3% escalation*
*** Costs are based off of comparable size projects in the area with 3% / year adjustment for inflation*

H. Permitting and Timeline

The project has not yet been permitted. Preliminary permitting requirements have been identified and additional permit requirements may be identified during the development of an Environmental Impact Statement (EIS) when project alternatives are analyzed and a preferred alternative is selected. An aggregated EIS to include both the Resilient Bridgeport RBD and the Bridgeport resilience projects being funded through the State of Connecticut's National Disaster Resilience Grant award will be performed to satisfy HUD's project aggregation requirement at 24 CFR Part 58.32(a) that directs that "A responsible entity must group together and evaluate as a single project all individual activities which are related on a geographical or functional basis, or are logical parts of a composite of contemplated actions." Concurrent to the completion of this Substantial Action Plan Amendment, the State is concluding a public procurement process that will result in a consultant team being engaged under contract to complete the Environmental Impact Statement and other tasks designed to move forward the projects funded by both Rebuild by Design and National Disaster Resilience. Concurrent to this, the State's existing consultant team is also advancing the project to 30% design. It is expected that environmental review, preliminary design, and permitting will continue into the last quarter of 2018 and construction will commence in early 2019 and continue into the middle of 2021. A Notice of Intent to Prepare an EIS as required at 24 CFR Part 58.55 is anticipated to be published in the Federal Register in September 2017 thereby launching the public scoping process. A permitting chart listing all the Federal, State, and local permits that will be necessary for project implementation along with a likely timeline of approval for each can be found in Attachment C. Table 3 below delineates the overall timeline for project completion including remaining design and engineering work, permitting, bidding, and construction and additional details expanding on the below timeline in the form of a Gantt chart can be found in Attachment D. A more detailed anticipated timeline for completing the Environmental Impact Statement is as follows:

September 2017 (NOI Federal Register Publication) (30 -day comment period)
Public scoping hearing no earlier than 15 days after publication (would include EO11990 - Floodplain Management compliance)
January 2018 - DEIS FR publication (45-day comment period)
Public hearing after 15 days
June 2018 - FEIS FR Publication (30-day comment period)
Public hearing after 15 days
September 2018 ROD - no comment period and no FR publication

Table 3. Resilient Bridgeport Project Milestone Timeline

Activity	Start Date	End Date
CDBG-DR Action Plan Substantial Amendment	**November-2016**	**December-2016**
Public Notice	November-2016	November-2016
Open House	November-2016	November-2016
Open House	December-2016	December-2016
Public Comment Period	November-2016	December-2016
Public Hearing	December-2016	December-2016
Submission to HUD	December-2016	December-2016
CDBG-DR Action Plan Substantial Amendment 2	**February-2017**	**June-2017**
Draft Submission	February-2017	April-2017
Public Workshop	April-2017	April-2017
Public Comment Period	April-2017	May-2017
Released to Public	April-2017	April-2017
Public Hearing	April-2017	May-2017
Public Hearing 2	April-2017	May-2017
Finalize SAPA	May-2017	May-2017
Submission to HUD	June-2017	June-2017
30% Design	**February-2017**	**June-2017**
30% Design Set	February-2017	June-2017
Resilience Strategies	**December-2016**	**June-2017**
Draft Resilience Strategies	December-2016	June-2017
Public Workshop	May-2017	June-2017
Strategy Published	June-2017	June-2017
Environmental Impact Statement	**June-2017**	**July-2018**
Final Design	**July-2017**	**November-2018**
Permitting	**October-2017**	**November-2018**
FEMA Letter of Map Revision	August-2018	November-2018
New England District of the U.S. Army Corps of Engineers, Pre-Construction Notification for General Permit		
DEEP IWRD Flood Management Certification	September-2018	November-2018
Modifcation of City of Bridgeport MS4 Permit		
DEEP IWRD General Permit Registration Form for the Discharge of Stormwater and Dewatering Wasterwaters from		
DEEP Office of Long Island Sound Program Structures , Dredging and Fill & Tidal Wetlands Permit	August-2018	November-2018
DEEP IWRD, Office of Long Island Sound Program	May-2018	November-2018
DEEP CT Coastal Management Act Consistency Review	August-2018	November-2018
DEEP Air Emissions Permit	May-2018	November-2018
Connecticut State Historic Preservation Office Review	November-2017	November-2018
Connecticut Call before you Dig		
City of Bridgeport Building Permit		
City of Bridgeport Plumbing/ Electrical Permit		
City of Bridgeport Street and Sidewalk Excavation		
City of Bridgeport Sidewalk Permit		
City of Bridgeport Public Right of Way Occupancy		
City of Bridgeport Planning and Zoning Commission Approval	October-2018	November-2018
City of Bridgeport Sewer Extension Approval		
City of Bridgeport City Council Resolution		
Board of Police Commissioners Resolution		
Right of Way Easement Landowners		
RBD Project Construction	**November-2018**	**September-2021**
BID Documents Released	November-2018	December-2018
Construction	April-2019	September-2021

I. Implementation Partnership

The State of Connecticut Department of Housing (DOH), the state's grantee for CDBG-DR funds from HUD, continues to be the lead agency implementing the project within the City of Bridgeport and will be managing the day-to-day implementation of the project. As the design phase of the project continues, and all the way through implementation, DOH will routinely assess its own staffing needs and, if additional staffing is required, will use program delivery funds to bring on resources to meet needs (subject to applicable federal laws and regulations on the permissible use of CDBG-DR funds). DOH is in the process of hiring additional grant administrative and finance staff and is expecting to bring on construction management staff for the project as the environmental review process is progressing in approximately one year's time. DOH has a robust consultant team that has been supplementing staff capacity for the planning and preliminary design and engineering phases led by Waggonner & Ball based in New Orleans, LA. Additionally, for the environmental review work, final design, construction oversight, and bidding and inspection services, DOH is currently procuring additional consultant support expecting to result in a contract in the middle of 2017. Representative of the close coordination amongst state agencies that will support the implementation of the project, the Department of Energy and Environmental Protection, the Department of Economic and Community Development, and the Connecticut Institute for Resilience and Climate Adaptation, are all members of the RFQ review panel selecting the next consultant team to be engaged by DOH.

Though a Technical Advisory Committee will be launched at the start of the environmental review process in the middle of 2017 as described in the State's last Substantial Amendment and reiterated in the Citizen Participation Plan component of this Substantial Amendment below, over the last several months staff from DOH has met regularly with implementation partners responsible for permitting at both the state level (at the Department of Energy and Environmental Protection) and at the city level (at the Public Facilities Department, the Office of Planning and Economic Development, the City Council, and the Water Pollution Control Authority). Working closely with HUD staff, engagement with counterpart federal agencies will begin in earnest through the environmental review process in the middle of 2017.

The incorporated municipality within which the project is located is the City of Bridgeport. DOH staff and project consultants have been meeting regularly with leadership and representatives from Public Facilities, the Office of Planning and Economic Development, the Mayor's Office, the City Council, and the Water Pollution Control Authority. They have played an invaluable role to this point, vetting project concepts and helping the project team evolve from the original Resilient Bridgeport proposal to the project described above that is able to be implemented with the available time and resources in a way that provides the targeted benefit to the target neighborhoods within the City. Their ongoing informal participation, to be formalized through the Technical Advisory Committee) will be a crucial component of meeting permitting and approval timelines and city leadership has demonstrated a commitment to such support.

The most significant relationship for implementation is that between DOH and both Park City Communities and their private development partner, the JHM Group. While elements of the project will take place within the public right of way, significant elements will be located on the parcels of Marina Village slated for redevelopment. In addition to the necessary utility easements within city streets, therefore, the project will require either easements from Park City Communities on portions of their owned property dedicated for the project carved out of the long-term land lease with the JHM Group that will be executed in phases as components of the development is financed or easements from the JHM Group on portions of their leased property dedicated for the project. While these easements have not yet been executed, the project team meets regularly with these key stakeholders and, based on the project description contained herein, is currently having the surveys completed so that the easements can be drafted but will not be executed until the environmental review and final design are complete and the project boundaries are definite.

J. OPERATIONS AND MAINTENANCE

The table below documents typical anticipated operations and maintenance (O&M) activities associated with the conceptual design of the RBD Project. As design progresses, a Storm Water Management Plan, as well as O&M Manual will be developed, which will further detail and expand upon many of the activities listed in Table 4 below. In addition, industry standard best management practices, as well as recommendations from CT DEEP and the City of Bridgeport will be incorporated.

Most of the O&M activities noted below for the storm sewer system are anticipated to require annual or bi-annual inspections, with the maintenance of roadside areas and the stormwater park requiring more frequent upkeep (e.g., lawn mowing). Also, repairs, while not noted on the list below, may be required for certain items, such as pumps, over the design life of the project.

Table 4. Resilient Bridgeport O&M Tasks

Maintaining the Storm Sewer System
Force main and pump maintenance
Pipe inspection
Catch basin/inlet cleaning (e.g., sediment removal and oil/water separator, if needed)
Outfall cleaning
Maintaining & Repairing Roadways
Street cleaning
Pavement maintenance (e.g., patching, resurfacing)
Signage and Pavement marking
Snow and ice control
Maintaining Roadside Areas
Roadside ditch cleaning
Vegetation management
Erosion control
Litter control
Wall and slope maintenance
Pedestrian facilities maintenance (e.g., snow and ice removal, signage maintenance)
Guardrail and fence maintenance
Stormwater Park Activities
Erosion controls
Sediment controls
Paving maintenance
Snow Removal
Sediment and Debris Removal (e.g., clean stormwater filter(s) and filtration medium
Site Lighting Maintenance
Maintenance of Park Amenities TBD (e.g., benches, terraces, fields, etc.)
Tree, Lawn and Shrub Maintenance
Tree and Shrub Pruning
Lawn Mowing and maintenance (e.g., weeding and patching)
Mulch Application
Irrigation Maintenance and Winterization
Non-glyphosate Disease and Pest Management
Invasive Species Management
Leaf Mulching and Nutrient Cycling

The City of Bridgeport Public Facilities Department has committed to maintaining those aspects of the project that would fall within their typical responsibilities of park and road maintenance, addressing the majority of the tasks listed in the chart above. The Bridgeport Water Pollution Control Authority will continue to perform the maintenance functions that they currently do within their citywide service area including catch basin and outfall cleaning. As the City is currently developing their MS4 plan for concurrence with State regulations and it is anticipated that the final responsibilities related to the MS4 micro grid being created with this project will be codified as a component of the City's overall MS4 plan.

K. Public Notice and Inclusive Decision Processes (Citizen Participation)

The State's CDBG-DR Substantial Amendment planning process has been coordinated through a collaborative effort of local, state, federal and private sector partners. The State has offered numerous opportunities for public notice and comment on previous Substantial Amendments including, but not limited to:

- Holding meetings and/or teleconferences with the mayors and first selectman of affected communities as part of the Long Term Recovery Working Group;
- Attending monthly meetings of CONN-NAHRO (housing authorities);
- Notice of a seven-day public comment period to solicit input in the development of the Substantial Amendment was posted from December 11, 2014 through December 18, 2014;
- Holding a Public Hearing on December 18th, 2014 in the City of Bridgeport in coordination with the continued community involvement relative to Resilient Bridgeport;
- Submitting an Allocation Plan to the Connecticut Legislature for the distribution of the third tranche of funding of $11.459M and an update of the first and second tranche of funding in the amount of $137.82M;
- Posting the full Substantial Amendment to the Action Plan Tranche 3 on the Department of Housing web site on January 8, 2015 for 30 days of public comment;

- Holding a Legislative Public Hearing on the full Amendment, with an emphasis on the Allocation of funds.

Pursuant to Section 4-28b of the Connecticut General Statutes, the Joint Standing Committees of Connecticut's General Assembly that have cognizance, are required to meet to review Community Development Block Grant Allocation Plans.

In addition, Resilient Bridgeport was created through a robust public participatory process that spanned the Rebuild by Design timeframe in 2013 and 2014. City staff worked to continue the stakeholder engagement process since the conclusion of the competition in the spring of 2014 so that there was not a major gap in the public's awareness and involvement in the initiative's progress.

DOH is committed to a robust and meaningful community and stakeholder outreach process throughout the multi-year effort to plan, design, and implement the RBD project, Resilient Bridgeport. DOH has demonstrated this commitment and its ability to achieve this desired outcome through the several month effort leading up to the competition submission and the multi-year post-award planning initiative that has allowed us to arrive with the community at this stage in the process. The meetings, workshops, events, and digital and personal outreach that has occurred to this point serve as the template for the future activities articulated in this plan.

As the grantee receiving CDGB-DR funds, DOH has a Citizen Participation Plan in place which can be found on its website at http://www.ct.gov/doh/lib/doh/citizen_participation_plan.pdf .

The following is the project-specific Citizen Outreach Plan (COP) designed to provide a transparent and inclusive community engagement process that allows all citizens and stakeholders in the affected neighborhoods of Bridgeport and beyond the opportunity to shape, with their local knowledge and expertise, the scope, outcome, and implementation of the identified pilot project. The upcoming stages of this initiative, including the environmental review, will produce additional technical analysis that will further define the pilot project beyond its current identification. Local citizens and stakeholders will provide instrumental feedback as new information emerges to ensure that the outcomes of the ultimate pilot project are consistent with those determined through the participatory process.

Community stakeholders will be engaged during the feasibility/environmental review, design, and construction/implementation phases of the project. In developing this COP, DOH complied with all HUD citizen participation plan requirements described in Section VI of Federal Register Notice FR-5696-N-11 and will comply with the public involvement requirements of the National Environmental Policy Act (NEPA), 40 CFR Sec. 1506.6 Public Involvement.

The purpose of the Resilient Bridgeport COP is to engage and collaborate with the general public, including vulnerable and underserved populations, racial and ethnic minorities, persons with disabilities, and person with limited English proficiency, as well as municipal officials, community organizations, and the academic community, in the RBD planning, design, and implementation process.

This COP builds off of the success of the robust stakeholder engagement process that has taken place throughout the RBD competition and since the award in 2014 which has included:

- The creation of a Resilient Bridgeport website: www.resilientbridgeport.com,
- Robust use of social media including but not limited to Facebook,
- Formation of a "Think Tank" composed of neighborhood leaders to help structure the outreach process thus far,
- Approximately bi-monthly workshops utilizing participatory techniques for stakeholder engagement and resulting in detailed project feedback and direction,
- Tailored presentations and participatory opportunities for affected public housing residents, hosted at their community center, to target this underserved population,
- Attendance and presentation at various local community groups' regularly scheduled meetings with project updates,
- Approximately bi-monthly meetings with City agency representatives,
- Approximately bi-monthly meetings with State agency representatives,
- Regular individual meetings with affected property owners, developers, and institutions,
- Production and distribution of the Resilient Bridgeport Atlas, Resilient Bridgeport broadsheets, and YouTube videos of lectures from outside experts, and

- The establishment of a project storefront where materials related to the project progress are posted on boards and windows, meetings and events are held, and drop-ins are
- Welcome from neighborhood stakeholders interested in learning more.

Both the Community Advisory Committee (CAC) and the Technical Advisory Committee (TAC) that were described in the State's 4th Substantial Action Plan Amendment will be established, as planned, at the initiation of the environmental review stage of the process set to begin in the summer of 2017. While not formally established, all individuals, agencies, representatives, businesses, and civic organizations slated to participate formally through the CAC and TAC have been engaged in the process to date and have continued to be consulted for their input since the last Substantial Action Plan Amendment was submitted three months ago. This engagement has taken place in meetings, public workshops, and individual consultations in addition to formal public hearings.

Community Advisory Committee (CAC).

The CAC will be composed of elected representatives from the public sector, representatives of neighborhood organizations and the most impacted public housing and adjacent co-op, and key institutions and businesses located proximate to the pilot project. The CAC will replace the "Think Tank" utilized thus far in the planning stage of the process. The CAC will meet regularly and may include representatives from the following:

- Mayor's Office
- City Council (2)
- Connecticut General Assembly
- Connecticut Senate
- Marina Village Resident Association
- Park City Communities (a/k/a Housing Authority of the City of Bridgeport)
- South End Neighborhood Revitalization Zone
- Seaside Village Board of Directors
- University of Bridgeport

- Santa Energy
- The Green Team
- Sikorsky Aircraft

Members of the CAC will be expected to share information with their constituents as the process progresses, determine community priorities to be factored into the project design, and help drive participation in project workshops and public hearings.

Technical Advisory Committee (TAC)

The TAC will be composed of City, State, and regional agencies that will be able to provide technical feedback on the pilot project design and may play a role in ultimately permitting the designed project for construction. The TAC will meet at critical junctures in the design process and may include representatives from the following:

- Bridgeport Office of Planning and Economic Development
- Bridgeport Public Facilities Department (including both Parks and Engineering)
- Bridgeport Water Pollution Control Authority
- Greater Bridgeport Transit
- Metro COG
- Connecticut Department of Energy and Environmental Protection
- Connecticut Department of Transportation
- Connecticut Department of Economic and Community Development
- Connecticut Institute for Resilience and Climate Adaptation

The Outreach Process

The process whereby stakeholder input will be gleaned will include three primary components: public hearings; workshops and special events; and the website and social media.

Public Hearings:

All public hearing activities will be conducted in accordance with the public engagement requirements found in 24 CFR Part 58 (Environmental Review Procedures for Entities Assuming HUD Environmental Responsibilities) for environmental impact statements (EIS) and the public engagement requirements for substantial amendments noted above.

The required public comment periods, public hearings, and responses to comment will be followed and documented.

Workshops and Special Events:

In addition to, and in alignment and coordination with, the required public hearings associated with the completion of the environmental review and any necessary substantial amendments to the approved Action Plan, public participatory workshops for stakeholder engagement will be hosted by the project in keeping with the nearly 15 that have been coordinated by the project to this point. These events will be designed to combine public education with robust opportunities for feedback on the project scope and direction. Going forward, these workshops will be organized around key project milestones and will merge the outreach processes for the RBD-funded components of Resilient Bridgeport with those components funded through the National Disaster Resilience Competition. As has been done at previous workshops, special attention will be paid to ensure that materials, structure, and location are designed to facilitate the participation of underserved populations, specifically residents of the most affected public housing project. Targeted stakeholder workshops were held on February 15, 2017, targeting eco-technology park business stakeholders and Neighborhood Revitalization Zone leadership. Both workshops focused on the Black Rock Harbor strategy. There were also two public workshops on April 12, 2017, one focusing on youth and the other on the pilot project, specifically the design of the stormwater management park.

Website and Social Media:

Resilientbridgeport.com has been completely updated since the State's 4th Substantial Action Plan Amendment to be more engaging and user friendly, presenting robust information about the project to date and continuing opportunities for input. Concurrent to the expansion of the website providing a venue project information, it is also expected that the use of other social media applications will continue to grow, building an increasingly large and robust mechanism for reaching stakeholders for their input.

Vulnerable Populations

The Resilient Bridgeport COP includes transparent and inclusive outreach to community groups that serve vulnerable and underserved populations, including racial and ethnic minority populations, persons with limited English proficiency, and persons with disabilities. Representatives from these communities will be part of the Resilient Bridgeport CAC and they will assist the project team in continuing to identify the communication networks that reach the broader underserved and vulnerable population. All outreach to these populations will be in accordance with 24 CFR Part 570 (HUD Community Development Block Grants). Information will be made available in forms accessible to persons with disabilities and persons of limited English proficiency (LEP) at all public hearings.

This draft Substantial Amendment to the Action Plan will be made available for a 30 day public comment period, starting on Thursday, April 20, 2017 and ending on Monday, May 22, 2017. A Legal Notice requesting comment on the draft Substantial Amendment was published in three newspapers, including one in Spanish on Thursday, April 20, 2017 (Attachment E). A copy of the legal notice was sent to all the municipalities and public housing authorities, applicable tribes, DOH's Community Partners, and the members of the State Legislature's Appropriations Committee, Commerce Committee, Planning and Development Committee, and the Chairs of the Housing Sub-Committee. The legal notice and the Substantial Amendment to the Action Plan were posted to the designated Hurricane Sandy page on the DOH website for the 30 day comment period. Comments were accepted in written or electronic versions. Hard copies of documents were also made available upon request. Limited English Proficiency (LEP) is addressed by the availability of a Google translation browser button.

Summary of Comments Received and Response

- **Public Hearing, May 1, 2017**

  Please see Attachment F-1 for a transcript of the Hearing.

No comments were received, so no response has been generated.

- **Public Hearing, May 10, 2017**

Please see Attachment F-2 for a transcript of the Hearing.

All comments received were in support of the final pilot project. The Department appreciates all comments and input received and looks forward to the continued participation of the community, the stakeholders, and the public at large.

Written Comments Received between April 20, 2017 and May 22, 2017

Please see Attachment G.

The Department received two written sets of public comments.

The first comment was a letter in support of: the final pilot project; the integrated, cooperative and inclusive process to date; the flexibility of the planning process to accommodate the redevelopment needs of other concurrent projects in the neighborhood.

The second comment identified some specific concerns. In response,

- The Department has received extensive participation from citizens across the entire City of Bridgeport at more than a dozen events/workshops. Sign in sheets including individual contact information of attendees are available.
- There are representatives of the affected neighborhood, adjacent neighborhoods, the City of Bridgeport, as well as members of both the nonprofit and for profit sectors of the community. The input of all of the participants to date has been invaluable in focusing the plan on achievable and realistic opportunities for improvement in the South End, and has provided significant insight to City representatives with regard to the needs of other parts of Bridgeport.
- The impact of both current damage to and the potential for future damage associated with the Fayerweather Island breakwater has been part of the planning discussion. However,

the scope of any project associated with the reparation of the breakwater is well beyond the scope of this initiative.

- Although a valuable neighborhood and community resource, support for and/or the preservation of the community gardens is well beyond the scope of this initiative, whose primary function is to reduce flood risk for the most vulnerable public housing stock in and around Black Rock Harbor.

- The respondent appears to believe that a local nonprofit is "spearheading" this initiative. The nonprofit in question is one of a number of nonprofit participants, but this initiative is being spearheaded by the State of Connecticut Department of Housing, with input from the City of Bridgeport (including both staff and political leadership), neighborhood residents, neighborhood and citywide businesses and commercial organizations, and other state agencies.

- The Department believes in an open and fully inclusive process. This is reflected in significant detail throughout Section K of this Plan, and in particular, in the membership in the CAC, which is detailed on page 26 of this Plan.

Citizen Complaint Procedures

The State will accept written citizen complaints from citizens related to the disaster recovery programs, Action Plans, Substantial Amendments, or quarterly performance reports. Written complaints should be submitted via email to CT.Housing.Plans@ct.gov or be mailed to:

Program Manager
CDBG-NDR Program
Department of Housing
505 Hudson Street
Hartford, CT 06106-7106

The State will make every effort to provide a timely written response to every citizen compliant within fifteen working days of the receipt of the complaint, where practical. All citizen complaints relative to Fair Housing/ Equal Opportunity violations involving discrimination will be forwarded to the following address for disposition: Commission on Human Rights and Opportunities, 25 Sigourney Street, Hartford, CT 06106.

Limited English Proficiency

Requests for this Amendment to the Action Plan or related documents in alternate formats consistent with the provisions of federal requirements related to limited English proficiency must be directed to the ADA (504) Coordinator, of the Department of Housing.

L. Certification of Resilience Standards

The State of Connecticut certifies that it will apply the Infrastructure Resilience Guidelines that are identified in the Hurricane Sandy Rebuilding Strategy and identified in this Action Plan Substantial Amendment dated March 23, 2014 to the extent that is practicable and reasonable. In addition, the State will use the methodology, priorities and principals identified in the Connecticut Natural Hazard Mitigation Update when selecting infrastructure projects for funding.

M. Attachments to the Substantial Amendment

Attachment A – PE Letter of Certification for Code Relevance
Attachment B – Resilient Bridgeport Benefit Cost Analysis, Summary Report, Arcadis
Attachment C – Potential Permits or Requirements for Resilient Bridgeport
Attachment D – Timeline
Attachment E – Legal Notice for Public Hearing/Public Comment Period
Attachment F – Public Hearing Transcripts
Attachment G – Written Comments

Attachment A - PE Letter of Certification for Code Relevance

ARCADIS Design & Consultancy for natural and built assets

Mr. J. David Waggonner, President
Waggonner and Ball
2200 Prytania Street
New Orleans, LA 70130-5804

Arcadis U.S., Inc.
75 Glen Road
Suite 305
Sandy Hook
Connecticut 06482
Tel 203 364 9700
Fax 203 364 9800
www.arcadis.com

Water Management

Subject:
RBD Demonstration Project
Concept Design Certification

Date:
April 7, 2017

Contact:
Joseph F. Marrone, PE

Phone:
203.395.1294

Email:
Joseph.Marrone
@arcadis.com

Our ref:
LA003323.

Dear Mr. Waggonner:

As required for the Substantial Action Plan Amendment (SAPA) for the Bridgeport Rebuild By Design (RBD) project, this letter provides a certification that the concept design has considered the appropriate codes and industry standards for design and construction, and that the final design will adhere to relevant codes when it is completed during future project phases.

The scope for the Bridgeport RBD work has been refined and the current proposal includes a phased approach to implementation. The first phase will be for a demonstration scale project incorporating resilient design principals into the South End neighborhood in the vicinity of the Marina Village redevelopment project. The conceptual design for the demonstration project has been completed and is the basis for the SAPA request.

The concept design work for the demonstration project has been completed in conformance with the applicable design standards as appropriate for the current conceptual design level. The concept design is based on available information and where adequate information is not currently available, assumptions have been made to progress the design. Future phases for the demonstration project will include additional field work, concept refinement, and additional design and analysis, including preliminary and detail design.

It should be noted that drawings, figures and other deliverables accompanying this letter are diagrammatic, representative of the current level of design, and are not intended for construction.

Sincerely,

Arcadis U.S., Inc.

Joseph F. Marrone

Joseph F. Marrone, PE
Coastal and Urban Resiliency Technical Expert

Attachment B – Resilient Bridgeport Technical Memorandum, Arcadis

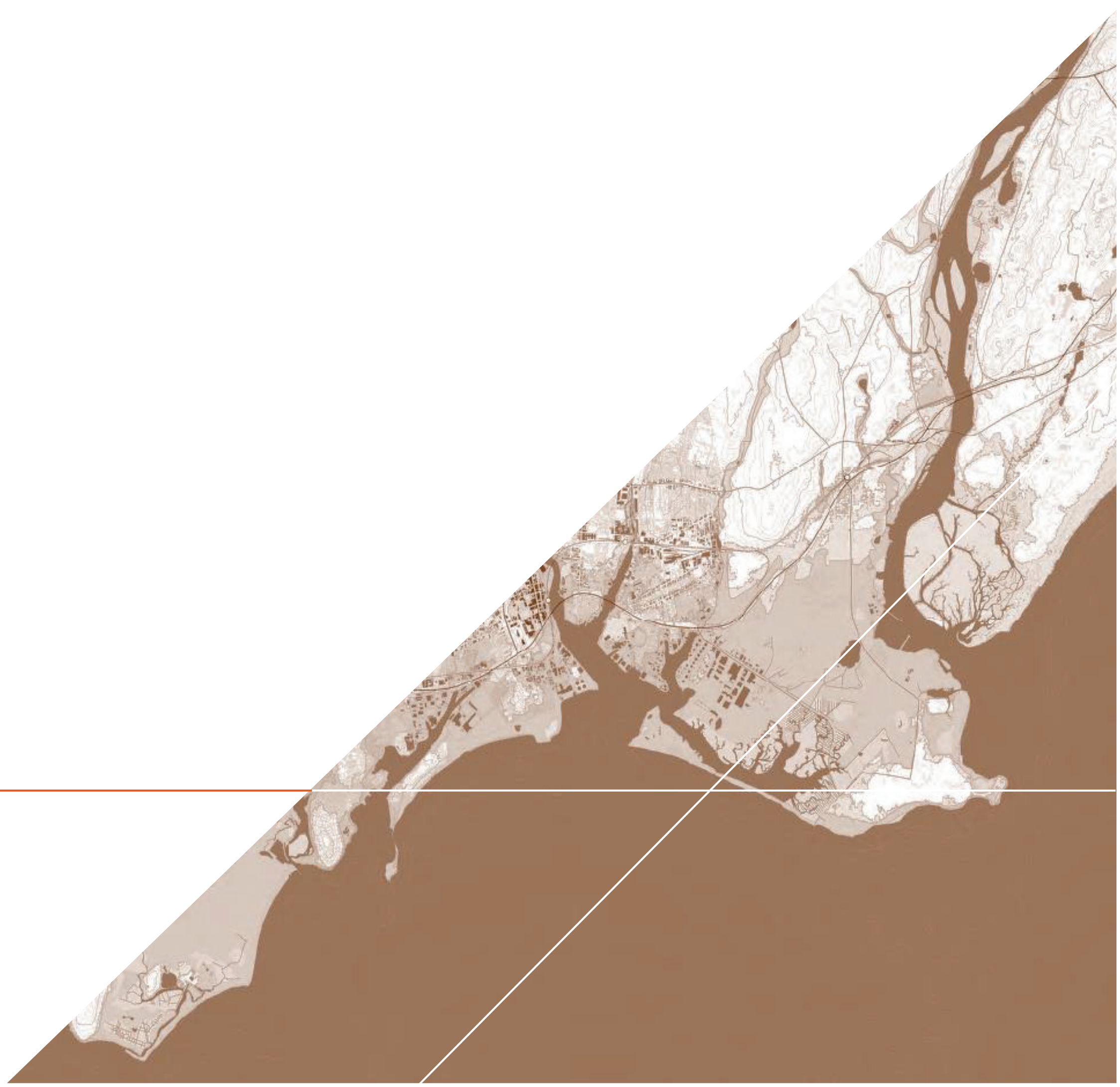
ARCADIS
Design & Consultancy
for natural and
built assets

RESILIENT
BRIDGEPORT

TECHNICAL MEMORANDUM

BENEFIT COST ANALYSIS SUMMARY REPORT

April 13, 2017



TECHNICAL MEMORANDUM

Benefit Cost Analysis Summary Report

Prepared for:

Connecticut Department of Housing

Prepared by:

Arcadis U.S., Inc.

Our Ref.:

LA003323.0000

Date:

April 13, 2017

This document is intended only for the use of the individual or entity for which it was prepared and may contain information that is privileged, confidential and exempt from disclosure under applicable law. Any dissemination, distribution or copying of this document is strictly prohibited.

Macy Fricke, CFM
Management Consultant

Edward Fernandez, CFM
Senior Management Consultant

Hugh Roberts, PE
Associate Vice President

VERSION CONTROL

Issue	Revision No	Date Issued	Page No	Description	Reviewed by
001	Rev. 1	03/31/2017		Draft	E. Fernandez
002	Rev. 2	04/05/2017		Draft	E. Fernandez
003	Rev. 3	04/07/2017		Draft	R. Deitz
004	Rev. 4	04/09/2017		Draft	H. Roberts
005	Rev. 5	04/12/2017		Draft	R. Deitz
006	Rev. 6	04/13/2017		Final	R. Deitz

CONTENTS

TABLES AND FIGURES

1 INTRODUCTION

Bridgeport, Connecticut experienced significant coastal flooding during Tropical Storm Irene (Federal Emergency Management Agency [FEMA] Major Disaster Declaration [DR] -4023) and Hurricane Sandy (DR-4087). Floodwaters from Long Island Sound submerged roadways, critical infrastructure, businesses, and homes in low-lying areas, directly affecting the South End's residents and businesses. Following the devastation from Hurricane Sandy in the Tri-State Area, the U.S. Department of Housing and Urban Development (HUD) and the Presidential Hurricane Sandy Rebuilding Task Force launched Rebuild by Design (RBD) to seek community and policy-based solutions to protect U.S. cities most vulnerable to intense weather events. This innovative design competition brought together interdisciplinary teams to craft innovative and replicable solutions to protect our at-risk coastal communities against future events and redevelop them in environmentally friendly and economically viable ways. The City of Bridgeport with the support of HUD and Connecticut Department of Housing (DOH) and alongside local stakeholders, worked to develop a comprehensive waterfront resiliency plan. The plan included a set of integrated flood protection measures, as well as waterfront revitalization strategies, that comprise a comprehensive, multi-layered approach to reduce flood risk.

The DOH was awarded $10 million to reduce flood risk for the most vulnerable public housing stock in Bridgeport – specifically to continue planning and evaluation of long-term resiliency strategies, as well as to design a RBD project aimed at alleviating acute and chronic flooding in the South End neighborhood. The Resilient Bridgeport Team, led by Waggonner & Ball with Arcadis, Yale Urban Design Workshop and Reed Hilderbrand Landscape Architects, has developed an innovative and multifaceted RBD project in the South End to provide benefits to the neighborhood by means of dry egress and stormwater management in a way that improves ecological function of nearby waterways and offers recreational space.

As part of the design process, the Resilient Bridgeport Team completed a benefit cost analysis (BCA) to evaluate the RBD project at its current level of design. The BCA assesses resiliency, social, environmental, and economic benefits that will result from the implementation of the RBD project. In accordance with HUD guidance, the BCA uses federally accepted standard figures and methods to assess project benefits and help inform decision making related to public infrastructure investment.

This report serves to describe the BCA process, methods, and results. This BCA report includes the following principle sections:

- **Section 1 Introduction** includes a description of the RBD project, the BCA process, and the benefits captured by the BCA.
- **Section 2 Risk Context** describes acute and chronic flood risk and existing social and economic conditions related to vulnerable populations in the South End.
- **Section 3 Benefit Cost Analysis Findings** provides a summary of BCA findings and a sensitivity analysis.
- **Section 4 Qualitative Benefits** describes project benefits that analysts did not quantify monetarily.
- **Section 5 Benefit Cost Analysis Methodologies Summary** presents a detailed description of each benefit quantified, as well as a summary of the methodology used to calculate each benefit.
- **Section 6 No Action Alternative** characterizes what may happen in the future if Bridgeport does not implement the RBD project.

- **Section 7 Project Risks and Challenges** details potential risks to project benefits and potential implementation challenges.
- **Section 8 Conclusion** summarizes BCA findings and presents results.

1.1 Rebuild by Design Project

1.1.1 Project Location

The RBD project will be centered around the Marina Village public housing redevelopment site, situated in Bridgeport, Connecticut's South End neighborhood. The project area is roughly bounded by Park Avenue to the east, Iranistan Avenue to the west, Ridge Avenue to the south and South Avenue to the north. Some elements, such as the location of the stormwater outfall along Cedar Creek, extend this project area boundary beyond the above-described rectangle.

The project is designed to serve the broader lower- and moderate-income South End neighborhood adjacent to Marina Village, including Seaside Village to the west, which is an historic post-WWI cooperative community. These are all low-lying areas that are often flooded during chronic rainfall events and are vulnerable to severe flooding from acute coastal storm events.

1.1.2 Project Objectives

Through stakeholder meetings, community meetings, mapping, and modeling, the Resilient Bridgeport Team has come to understand the different impacts that chronic and acute flooding have on the community, and the risks posed by climate change and sea level rise (SLR). Through a transparent and fluid public dialogue, as well as guidance from HUD and DOH, the design team has worked to establish a clear and comprehensive framework for resiliency. With the available funds the project seeks to:

- Address acute and chronic rainfall flooding by reducing stormwater runoff from the upland portion of the neighborhood, which will translate into additional capacity available in the combined sewer system, and ultimately less flooding at neighborhood low points. The project will be the first phase of a municipal storm sewer separate system (MS4), providing the infrastructure and capacity needed for the City to later capture and remove additional stormwater runoff from the combined sewer system. Reducing the inflows into the combined sewer system will minimize the frequency of combined sewer overflow (CSO) events. The MS4 system is being designed to detain and convey the 25-year Natural Resources Conservation Service (NRCS) rainfall event, additionally providing partial benefits during more severe events (e.g., the 50-year NRCS rainfall event).
- Address acute coastal flooding by providing residents a raised roadway and a means of access out of the 500-year floodplain. Raised roadway portions will be at or above 15 feet, NAVD88 based on the FEMA effective Flood Insurance Rate Maps 500-year stillwater elevation (11.3 feet), plus 3 feet. In addition, this raised roadway will provide entry into the floodplain for emergency services during storm events. Johnson Street will provide dry egress, in accordance with Connecticut Department of Energy & Environmental Protection (CT DEEP) guidance and CT building code, which deems the Marina Village housing redevelopment as "critical development" and thus the minimum elevation for dry egress as the 0.2% flood elevation plus 2 feet.[1]

[1] "A Guide for Higher Standards in Floodplain Management". Association of State Floodplain Managers. October 2010.

- Accounting for SLR and changing climate by utilizing design standards and flood elevations that reflect projections for SLR. Stormwater infrastructure (i.e., elevation of outfall, pump sizing, and slope of gravity pipes) will be designed for anticipated future sea level conditions rather than current conditions, in accordance with guidance provided by Connecticut Institute for Resilience and Climate Adaptation (CIRCA), which references NOAA CPO-1, "Global Sea Level Rise Scenarios for the United States National Climate Assessment."

1.1.3 Project Outcomes

The success of this project will be measured in terms of the following project outcomes:

Positive Impact on Flooding: To address acute coastal flooding, the project will provide egress from the project area for evacuation during storm surge events. Additionally, the project will target acute and chronic rainfall flooding in the South End through parallel stormwater infrastructure to complement the existing combined sewer system. The stormwater infrastructure equips the City of Bridgeport with the first phase of a MS4 for the South End. While the project currently reduces on-street flooding in the project area by roughly 60 percent, it provides the City of Bridgeport with the spine it needs to extend the MS4 system and continue to reduce chronic rainfall flooding by removing stormwater from the existing combined sewer system.

Visibility: The project aims to be visible to the surrounding community as well as to make the processes (i.e., filtration of stormwater runoff) visible to the larger public. The goal of the project is to serve as an interactive educational tool. The project will also strengthen the neighborhood's sense of place and identity, generate prime economic investment, and create a recreational attraction for the area.

Leverage and Catalyze: This project will encourage a more resilient redevelopment of the adjacent former public housing site. Egress for this large site within the floodplain will catalyze its development, and will also allow for the project to leverage additional investment from the City and the State of Connecticut. An additional goal is to stabilize neighborhood property values and increase public amenities by incentivizing public and private investment in this area.

Strengthen Local Ecology: The project will strengthen ecological function of the area through expansion of the urban tree canopy, creation of new habitat, and stabilization of soil and groundwater levels by filtering stormwater runoff and allowing it to infiltrate into the ground. This also provides a water quality benefit to the South End.

Enhance Quality of Life: The project includes new community space that encourages physical activity to improve public health, will improve urban aesthetics, and will improve the quality of air and water within the neighborhood.

Set a Precedent for Design and Collaboration: The project is designed to be a proof of concept for broader resilience principles that are applicable to all the low-lying areas in Bridgeport and coastal cities in Connecticut and the region. The project and the collaboration that it requires will result in the demonstration of best practices for agencies and private entities. It is intended for this effort to set a precedent for future developments and design throughout the City, where Bridgeport becomes a role model for urban coastal resiliency. For the Bridgeport Water Pollution Control Authority and Public Facilities, as well as city agencies, this project will be a demonstration of best practices for the development of "green" and "grey" stormwater management systems, which is an ongoing effort throughout the city.

1.1.4 Project Description

The project objectives are addressed through a system that integrates both green and grey water retention features that center on the Marina Village redevelopment site. In the upland portion of the project area, Johnson Street will be extended, providing dry egress for future Marina Village residents out of the current FEMA 500-year floodplain as well as a future SLR condition of 3 feet. Additionally, a shorter route to access dry egress will be provided to Seaside Village residents. The Johnson Street Extension will also improve east-west neighborhood connectivity from Iranistan Avenue to Park Avenue, and will incorporate green infrastructure to divert surface runoff away from the combined sewer system and into a multiuse "stormwater park."

The multifunctional neighborhood stormwater park component creates a new community gathering-place, which is currently lacking in the neighborhood. The 2.5-acre stormwater park will be the most visible and public component of the project. The park will receive water from adjacent parcels and will retain, delay and improve the quality of the stormwater runoff. This will be achieved through a series of surface features, such as terraced basins, intermittent streams, and underground storage features. Positioned along the southern edge of the Marina Village redevelopment site, the park will also function as a "zipper" between new mixed income housing on the future redevelopment site and the adjacent existing neighborhood. It will provide an attractive amenity for current and future residents, and provide a space for community programs, environmental education, and passive and active recreation. The park component will also provide expanded habitat for flora and fauna, and extend the urban tree canopy, all within an innovative landscape design intended to become a regional landmark and identity marker within the South End.

Where ponding occurs at the park, water will be collected and gravity drained to a new pump station located at the southeast corner of South Avenue and Iranistan Avenue. There, the flows from the stormwater park will meet stormwater flows from direct upland areas that have also been disconnected from the combined sewer system. The flow will then be pumped via a new underground force main to an existing outfall at Cedar Creek, the Little Regulator Outfall. By removing tens of thousands of cubic feet of stormwater from entering the combined sewer system, additional capacity is available for sanitary flows to be treated by the wastewater treatment plant on the west side of Bridgeport. Similarly, bringing additional stormwater to the head end of Cedar Creek will improve flushing and overall ecological function of the creek. The conveyance features of this system are designed to protect against a 25-year NRCS rainfall event, in accordance with City of Bridgeport Public Facilities stormwater guidelines, as well as CT DEEP.

In addition, the extension of Johnson Street will be a "green" street; that is, it will incorporate green infrastructure, such as bioswales and rain gardens, to enhance the detention capacity of the project site. By enhancing the detention capacity, the combination of green infrastructure and the MS4 system will be able to capture more stormwater runoff while minimizing project costs (e.g., the cost of the stormwater pump).

The grey infrastructure, in concert with the stormwater park, are the beginnings of a MS4 system for the South End of Bridgeport. While the project currently has a flood reduction volume of roughly 6,000 CF for the NRCS 25-year storm event, with the potential to accommodate more stormwater for low intensity and long duration storm events, it provides the City of Bridgeport the with the spine it needs to extend the MS4 system and continue to reduce chronic flooding by removing stormwater from the existing combined sewer system.

1.1.4.1 Project Useful Life

The project useful life is the estimated amount of time that the RBD project will be effective. The analysis should represent an understanding of project benefits, as well as operations and maintenance costs, for each year the project is effective. The project team designed the RBD project for a 50-year useful life, although the team expects the project to remain effective beyond this period, particularly with appropriate maintenance and as-needed upgrades.

1.2 Benefit Cost Analysis Process Overview

Per HUD Notice: CPD-16-06, this BCA incorporates methodologies from the Federal Emergency Management Administration (FEMA), the United States Army Corps of Engineers (USACE), the Federal Aviation Administration (FAA), the Environmental Protection Agency (EPA), and other published sources. The report provides sufficient detail to help the reader understand the research and processes used to arrive at the benefit cost ratio (BCR) and to duplicate results following the same procedures. Benefits fall into two broad categories: resiliency benefits and value added benefits. Resiliency benefits consist of estimated flood impacts to structures, roads, and the population that the pilot project will reduce. Value added benefits consists of additional benefits beyond flood protection, such as environmental, aesthetic, and recreational benefits. Costs incorporated into the BCA include all project life-cycle costs, or costs incurred over the life of the project. Such costs include capital costs and operations and maintenance costs. Table 1 provides a breakdown of benefit categories, benefits calculated, and methodology sources and descriptions. **Section 4 Qualitative Benefits** describes project benefits not quantified.

Table 1. Summary of Resiliency and Added Value Benefits

Benefit Category	Benefits Captured	Description	Sources
Resiliency Benefits			
Resilient Redevelopment			
Direct Physical Damages	- Structure Damage - Content Loss	Analysts applied USACE depth-damage functions (DDFs) to certain structures in the project area. DDFs consider the type of structure, replacement values, and expected flood depth within the structure to estimate the dollar value of contents loss or structure damage.	- FEMA (Methodology) - USACE (DDF)
Displacement Costs	- Relocation Costs	Displacement occurs as a direct result of the threat and impact of flood events. Displacement within this BCA is a function of direct physical damage and flood depth and is based on FEMA and USACE source material.	- FEMA (Methodology) - USACE (DDF)
Mental Stress and Anxiety	- Mental Health Costs	Natural disasters threaten or cause the loss of health, social, and economic resources, which can lead to psychological distress. Methodologies used to calculate expected benefits for mental stress are a product of expected flood depth and damage to people's homes.	- FEMA
Loss of Productivity	- Lost Work Productivity	Loss of productivity can occur during and after a storm event. Analysts expect the pilot project will reduce the number of stressors caused by natural disasters, thereby reducing mental health impacts and lost work productivity.	- FEMA
Dry Egress			
Evacuation / Roadway Loss of Service Impacts	- Additional Travel Time and Miles	Analysts used a FEMA methodology to evaluate the loss of function of a roadway which serves as an evacuation route with no available detour. This methodology is based on the number of vehicles, additional travel time, and additional miles travelled, and is modified per FEMA guidance to reflect an evacuation scenario.	- FEMA

Benefit Category	Benefits Captured	Description	Sources
Casualties	- Loss of Life - Injuries	Casualties are an unfortunate risk inherent to hazard events. Methodologies to estimate avoided casualties are based on flood depth and damage to homes and are based on FEMA approved methods, as well as a study by the United States Center for Disease Control (CDC) post-Hurricane Sandy.	- FEMA (Methodology) - FAA (Value of Statistical Life) - CDC (Post- Hurricane Sandy statistics)
Value Added			
Social Value			
Recreation Benefits	- Increased Recreation Opportunity	Recreational benefits are based on added public amenities. There is willingness to pay values associated with these amenities for both recreational benefit and aesthetic values. Analysts used federally approved willingness to pay values to estimate recreation benefits.	- FEMA (Methodology) - USACE (Methodology)
Aesthetic Benefits	- Increased Willingness to Pay	Benefits are based on added public amenities and increased natural vegetation. Analysts used FEMA's Final Sustainability Benefits Methodology Report to value the aesthetic benefit of specific park improvements and USDA values to estimate aesthetic benefits of trees.	- FEMA (Methodology) - United States Department of Agriculture (USDA) (Methodology - Trees)
Environmental Value			
Ecosystem Goods and Services Benefits	- Water Quality - Air Quality - Climate Regulation - Energy Savings	Green spaces, trees, and shrubs benefit water and air quality, and support climate regulation. There are several ways to quantify environmental benefits provided by natural vegetation depending upon the good or service being evaluated.	- FEMA (Methodology) - USDA (Methodology – Trees)
Combined Sewer Overflow Reduction Benefits	- CSO Reduction	A benefit of this project is the ability to retain stormwater, preventing it from entering the combined sewer system, and ultimately entering Long Island Sound untreated. By increasing the ability to store and treat stormwater more systematically, Bridgeport will see an added benefit of lower frequency CSO events.	- EPA (Clean Water Act standards) - City of Bridgeport (Long Term Control Plan)

Benefit Category	Benefits Captured	Description	Sources
Economic Value			
Economic Revitalization Benefits	- New Employment - Economic Output	Economic gains are based on the addition of commercial space. Analysts utilized methods based on FEMA's Hazus-MH 3.2 software and local economic data.	- IMPLAN (Local economic data) - FEMA (Methodology)

2 RISK CONTEXT

2.1 Major Storm Impacts

Bridgeport was impacted by two severe storms in the last 6 years – Tropical Storm Irene and Hurricane Sandy. Tropical Storm Irene reached Bridgeport on August 28, 2011 and brought up to 6.5 inches of rainfall on top of an already high tide of 8.3 feet NAVD88. The peak wind speed recorded in the City was 63 mph. More than 120 streets in the city suffered damages due to flooding, downed trees, or downed wires, and approximately 35,000 residents lost power. A mandatory evacuation was enforced, reaching 4,700 households (13,000 residents). City shelters housed almost 700 people, and the City delivered over 3,000 meals to residents in need. [2] The train tracks at Bridgeport Station were flooded and wires were damaged, impacting rail service along the Connecticut shoreline.[3]

Hurricane Sandy impacted the City of Bridgeport on October 29th, 2012 and brought extreme tidal surge as well as tropical sustained winds and hurricane-force gusts. The South End experienced extreme flooding, causing millions of dollars of damage to buildings, infrastructure, and property. Storm surge flooded 50 streets, downed approximately 150 utility wires, caused 242 downed trees, and placed 48,000 people without electricity. Four emergency shelters protected 1,770 people, and a fifth shelter was used to house National Guard Troops and first responders.[4] Flood depths reached up to four feet in certain parts of the South End, and flood waters spread all the way up to I-95. Almost all streets west of Iranistan Avenue experienced some flooding, and it was especially severe in Seaside Village and the neighborhoods north of Cedar Creek.[5]

2.1.1 Hurricane Sandy Impacts

An analysis was conducted using the evaluation methods described in **Section 5 Benefit Cost Analysis Methodologies Summary** to understand the costs that might be avoided if a disaster like Hurricane Sandy struck again. Analysis results reveal Hurricane Sandy caused an estimated **$31M** of damage to buildings and contents within the RBD project area. Further damages in the form of displacement costs, mental stress, lost productivity, and injuries are estimated at **$5.2M**. Hurricane Sandy has a 50-year return period, or a 2% annual chance of occurrence[6], therefore annualized[7] damage would be **$620,000** for buildings and contents, and **$104,000** for displacement costs, mental stress, lost productivity, and injuries.

2.2 Acute and Chronic Flooding

The South End is subject to acute flooding during extreme weather events, such as hurricanes and nor'easter storms, as well as chronic flooding during modest rainfall events. Acute and chronic flooding, as it relates to Bridgeport, is described in more detail in the following paragraphs.

2.2.1 Acute Flooding (Coastal)

Storm surge associated with extreme weather inundates the South End's waterfront and low-lying areas. Public housing was constructed in this low-lying area, beginning with the historic post-WWI housing project Seaside Village in 1919 and Marina Village in 1949. Seaside Village is today a private cooperative

[2] http://onlyinbridgeport.com/wordpress/court-decision-countdown-finchs-irene-response-impact/
[3] https://www.weather.gov/media/okx/coastalflood/Bridgeport%20impacts.pdf
[4] City of Bridgeport. Incident Breifing.
[5] FEMA MOTF Hurricane Sandy Impact Analysis. https://www.arcgis.com/home/item.html?id=307dd522499d4a44a33d7296a5da5ea0.
6 http://www.greenwichct.org/upload/medialibrary/d01/Sandy-A_Look_at_Coastal_Flooding.pdf
[7] Annualization in this context is a method to "normalize" damages to communicate risk, which is the product of flood-related loss and probability of occurrence. Probability of occurrence refers to the percent chance of an expected flood event being met or exceeded in any given year.

community and Marina Village is currently being demolished for redevelopment as a mixed income community, including 33% low income, 33% workforce and 33% market rate housing. During major storm events, like Hurricane Sandy, low-lying areas were substantially flooded by storm surge, experiencing inundation depths of 5 to 6 feet (Figure 1). The project will provide dry egress from areas currently below the 500-year flood elevation plus 3 feet of SLR.

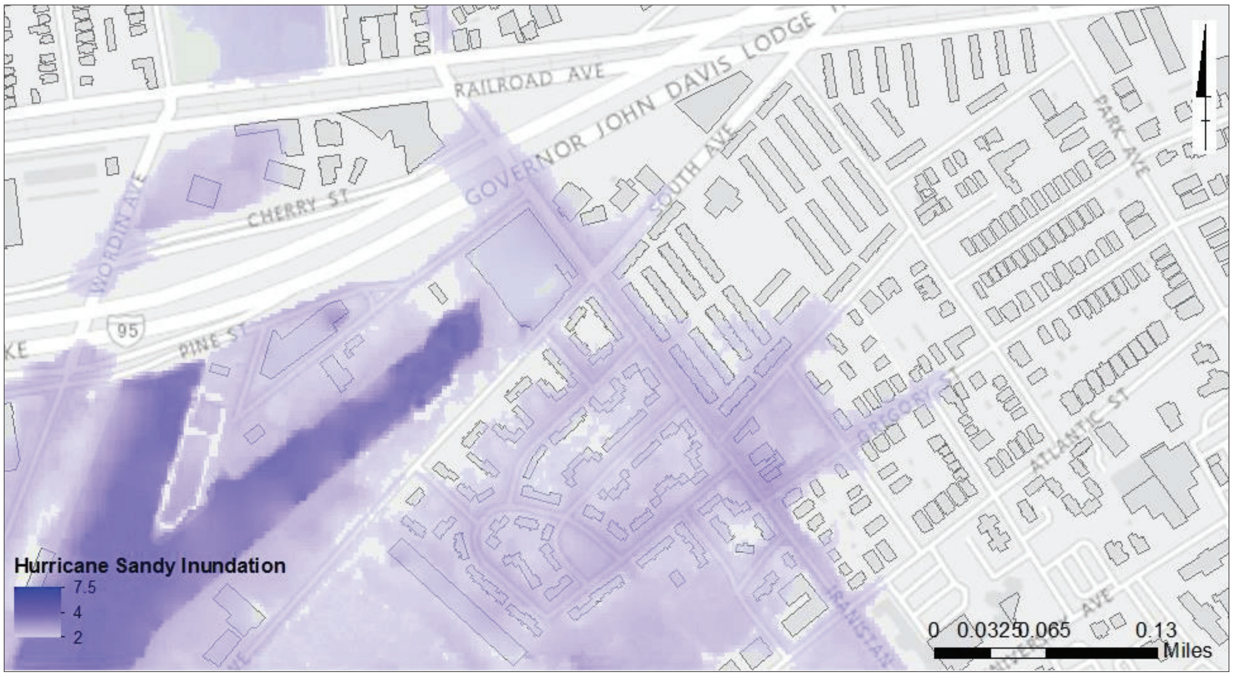


Figure 1. Hurricane Sandy Flood Impacts in the South End (Source: FEMA MOTF).

2.2.2 Chronic Flooding (Rainfall)

Bridgeport's South End is a coastal urban neighborhood situated on Long Island Sound, constructed on a peninsula and partly on former wetlands that were filled in during the 19th and 20th century. The historic development of the peninsula protruded south from the mainland towards Long Island Sound, and at its center, Park Avenue, an important street in the City, ran north from the coast along a higher ridge line. As regions west of the peninsula were filled to make more developable land, natural drainage patterns were disrupted, and filled land was constructed close to sea level.

Residential development constructed in these low-lying areas has long been prone to chronic flooding, from even modest storm events. Its low elevation, coupled with a high-water table, poor infiltration rates, and combined sewer system catch basins that are some of the lowest in the City (thus most likely to surcharge when the treatment plant meets capacity), makes it frequently difficult for water to drain effectively through the existing combined sewer system. In some instances, the pressure on the sewer system from higher elevation areas can cause raw dilute sewage to back up into the streets. Adjacent combined sewer outfalls, which would otherwise relieve the pressure on this system, are submerged below the surface of the receiving waters during high tide. It is anticipated that future SLR projections of 3 feet by the 2070s will make this problem significantly worse.

2.3 Existing Social and Economic Conditions

Bridgeport's economy is depressed compared to those of other cities on the Connecticut shoreline. After the decline of the manufacturing industry in Bridgeport, the city has gradually been shifting to a service-based economy, but large swaths of the population have been left behind. The South End, in particular, faces significant economic hardship. The neighborhood has some of the highest unemployment and lowest median salaries in Connecticut.[8] There is a noticeable lack of economic development in the neighborhood, with very few businesses or employment opportunities. These factors all contribute to a community's social vulnerability. Social vulnerability refers to how well communities respond when faced with external stresses such as natural disasters, disease outbreaks, and human-caused disasters.[9]

2.3.1 Social Vulnerability Index

The Department of Health and Human Services, Agency for Toxic Substances & Disease Registry (ATSDR) publishes a Social Vulnerability Index (SoVI) to help identify communities that may be underprepared to handle hazards or disaster recovery. The SoVI uses U.S. Census Bureau data to determine the social vulnerability of every Census tract. The index indicates the relative vulnerability of an area based on fifteen factors, including poverty, lack of vehicle access, and crowded housing, and groups them into four related themes. These themes are socioeconomic status, household composition, race/ethnicity/language, and housing/transportation. Each tract receives individual theme ratings, as well as an overall ranking.

The entire project area is considered highly vulnerable relative to its surroundings, per analysis by the ATSDR.[10] The social and economic conditions in Bridgeport that contribute to this vulnerability are discussed in more detail below.

2.3.1.1 Socioeconomic Factors

The South End as a whole, and the project area specifically, have a disproportionately high population of minority and disadvantaged residents. The area is approximately 20% white, 32% African-American, 31% Hispanic, and 14% Asian.[11] In Bridgeport, as in many urban centers, race and poverty are linked, and neighborhoods with larger minority populations tend to have higher levels of poverty.

Approximately 42% of the population of the South End is below the national poverty level, and the median household income is $24,304. Even within Bridgeport that level of poverty is disproportionate; an estimated 16% of the population is below the poverty level city-wide.[12] Those in poverty face particular challenges before and after a disaster because a lack of financial resources makes preparation and recovery even more difficult. Additionally, for those living in poverty, lost or damaged property can represent a larger proportion of total household assets compared to other households.

A related indicator of social vulnerability is the unemployment rate in a neighborhood. The project area has an average unemployment rate of 27%, over four times higher than the average in Connecticut, which is 6.3%.[13] If residents are not working and earning income, they face increased challenges in recovering from a disaster.

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[8] https://www.census.gov/programs-surveys/acs/
[9] https://svi.cdc.gov/
[10] https://svi.cdc.gov/map.aspx?
[11] http://www.city-data.com/city/Bridgeport-Connecticut.html
[12] http://www.city-data.com/city/Bridgeport-Connecticut.html
[13] http://www.city-data.com/city/Bridgeport-Connecticut.html

2.3.1.2 Educational Factors

Education level is directly associated with income and property ownership, and residents with more education are more likely to have access to and act upon hazard information. In the project area, approximately 19% of the population has less than a high school education, while the Connecticut average is approximately 11%.[14]

2.3.1.3 Housing and Transportation

Due to the large proportion of low-income residents, housing in the project area is not considered affordable. The median home price in the neighborhood is $208,519, while the median household income is $24,304. According to the mortgage calculator Bankrate, to afford a home of median value in the project area, a household would need to make $45,280 annually, almost twice the actual median income of the neighborhood.[15] Lack of homeownership can increase vulnerability and prolong disaster recovery if landlords delay repairs or maintenance.

2.3.1.4 Other Factors

Seniors and young children are especially vulnerable during disasters, as they may depend on family care and may be more susceptible to the stress of disasters. The median age in the South End is only 22, slightly more than half of the median age in Connecticut, which is 40.[16] Seaside Village is an outlier in the neighborhood because it has a larger population of adults at or nearing retirement age; the median age there is 51.

[14] http://www.higheredinfo.org/analyses/Connecticut_State_Profile.pdf
[15] http://www.bankrate.com/calculators/mortgages/income-required-mortgage-calculator.aspx
[16] http://www.city-data.com/city/Bridgeport-Connecticut.html

3 BENEFIT COST ANALYSIS FINDINGS

The pilot project will alleviate acute and chronic flood impacts to vulnerable populations and public housing in the South End by implementing stormwater management elements, such as bio-retention features, and providing dry egress out of the FEMA 500-year flood zone, plus SLR. The RBD project BCA is based on the conceptual design as this is the current phase being addressed in the Substantial Action Plan Amendment.[17] Analysts consider two broad categories for the BCA: resiliency benefits and added value benefits. This allowed the project team to consider all project benefits including resiliency, social, environmental, and economic factors. **Section 5 Benefit Cost Analysis Methodologies Summary** describes analysts' quantified project benefits.

The BCA generates results in four ways: annual benefits, present value of benefits and costs, net present value (NPV), and the BCR. To obtain annual resiliency benefits, the BCA evaluates losses avoided for certain, expected flood events and "normalizes" those results to communicate risk, which is the product of flood-related loss and probability of occurrence. Probability of occurrence refers to the percent chance of an expected flood event being met or exceeded in any given year and incorporates sea level rise (SLR), when appropriate. In accordance with current FEMA BCA guidelines, analysts express percent annual chance as event probability for the year at which the sea level rise projection is used to develop the project's level of protection. It is important to note that anticipated SLR projections were used only in the development of dry egress benefits as the design elevation of the roadway is at or above the 500-year flood elevation plus projected SLR.

Analysts apply a discount rate to annual benefits expected over the life of the project to calculate the present value of those benefits. The BCA for the ESCR project is based on a 7% or 3% discount rate to account for the fact that investors and federal agencies value cost savings in several decades' time at a lower rate than cost savings today. The Federal Office of Management and Budget (OMB) requires a discount rate of 7%, but HUD also considers a 3% discount rate for review per HUD Notice: CPD-16-06.

NPV is the difference between the present value of a project's total benefits and the present value of a project's total life-cycle costs. The BCR is the project's total present value of benefits divided by the project's total present value of life-cycle costs. Both the NPV and BCR inform the RBD project's cost effectiveness and ensure the project is fiscally beneficial.

3.1 Benefits

Table 2 reveals resilient redevelopment benefits represent the largest benefit category followed by dry egress benefits. The social benefits represent the largest value added benefit category followed by environmental benefits and economic revitalization. This BCA presents all annual benefits in 2016 dollars.

[17] The BCA is subject to change as the City refines the pilot project to reach final design.

Table 2. Summary of Losses Avoided and Value Added Benefits

Benefit	Annualized Benefit	Present Value (7% Discount Rate)	Present Value (3% Discount Rate)
Resiliency Benefits			
Resilient Redevelopment			
Direct Physical Damages	$ 720,690	$ 9,272,460	$ 17,843,370
Displacement	$ 1,150	$ 14,800	$ 28,470
Mental Stress and Anxiety	-	$ 1,050,280	$ 1,050,280
Lost Productivity	-	$ 653,610	$ 653,610
Dry Egress Value			
Evacuation / Roadway Loss of Service	$ 10,910	$ 149,370	$ 270,120
Casualties	$ 86,690	$ 1,115,389	$ 2,146,390
Value Added Benefits			
Social Value			
Recreation Benefits	$ 135,910	$ 1,910,160	$ 3,929,180
Aesthetic Benefits	$ 5,130	$ 71,660	$ 142,700
Environmental Value			
Ecosystem Goods and Services Benefits	$ 8,830	$ 126,030	$ 279,090
CSO Reduction Benefits	$ 3,300	$ 45,630	$ 85,070
Economic Value			
Economic Revitalization Benefits	$ 5,400	$ 69,480	$ 133,700
Total Project Benefits	**$978,010**	**$14,478,870**	**$26,561,980**

3.2 Costs

RBD project costs include direct capital costs, as well as operation and maintenance (O&M) costs over the project useful life. Table 3 summarizes the total value of each cost category.

Table 3. Summary of Costs

Cost Category	Costs (7% Discount Rate)	Costs (3% Discount Rate)
Capital Costs	$ 8,200,000	$ 8,200,000
Annual O&M Costs	$ 75,000	$ 75,000
Present Value O&M Costs	$ 1,035,060	$ 1,912,620
Total Project Costs	**$ 9,235,060**	**$ 10,112,620**

3.3 Benefit Cost Analysis Results

The RBD project seeks to serve as a catalyst and example of how the City and the State of Connecticut can begin to adapt their urban environment to become more resilient to an unpredictable future. The RBD project proposes to implement a series of components designed to improve the City's flood resiliency, foster community cohesion, increase economic opportunities, and promote redevelopment through growth, prosperity, awareness, and beauty. The Resilient Bridgeport Team developed this project to meet the project objectives and produce a project that is both practical and implementable given the available funding and site conditions.

The BCA findings indicate that the project would not only reduce the impacts of chronic and acute flooding, but would also enhance the quality of the surrounding communities by providing increased recreational amenities and aesthetic enhancements; resulting in greater physical, social, ecological, and environmental resilience for the South End.

BCA analysts compared the present value of RBD project costs and benefits, and found the project to be cost beneficial based on the current level of design. The project is expected to provide a range of resilience, social, environmental, and economic benefits totaling to **$14,469,860** in today's dollars, compared to an overall investment of **$9,235,060**, both at a 7% discount rate. The NPV of the RBD project is **$5,234,800**, and the BCR using a 7% discount rate is **1.57**. Table 4 provides the total present value of costs and benefits, as well as the benefit cost ratio of the medium scenario at both the 3% and 7% discount rate scenario.

Table 4. Resilient Bridgeport Results, Medium Scenario

Scenario	Total Present Value of Costs	Total Present Value of Benefits	Benefit Cost Ratio
Calculation	*A*	*B*	*C = B/A*
7% Discount Rate			
RBD Project	$ 9,235,060	$ 14,469,860	1.57
3% Discount Rate			
RBD Project	$ 10,112,620	$ 26,561,970	2.63

4 QUALITATIVE BENEFITS

4.1 Health Benefits

Several studies have found that physical improvements and increased access to parks can increase both the number of users in the park and the frequency of exercise. There is strong evidence from the Centers for Disease Control and Prevention which demonstrates that access to parks and/or recreation areas results in more exercise taking place at that location. The addition of a public park at the center of the project area has the potential to increase residents' health and physical fitness. It has also been shown that outdoor recreation increases mental health and overall wellbeing.[18]

4.2 Emergency Response and Recovery Efforts

During and after both Hurricane Irene and Superstorm Sandy, the South End experienced major flooding that impeded roadway travel in the area due to a significant number of flooded streets. Although no lives were lost due to the flooding situation, floods associated with future coastal storms and low-frequency rainfall events could prevent emergency response vehicles, such as police vehicles, ambulances, and firefighting equipment from reaching vulnerable populations in time. The addition of a dry egress corridor on Johnson Street will allow residents to evacuate safely, if necessary, during a hazard event. Additionally, mitigating flood risk in the project area will serve to reduce emergency response times and give adequate access to first responders that typically address fallen trees, downed power lines, or other disaster related impacts.

4.3 Affordable Housing

The project area contains a high concentration of low-income populations, and focuses on the site of the future Marina Village mixed-income housing redevelopment. Given than over half of Marina Village is in the floodplain, dry egress during a 500-year flood event is required for new development. The funding required to advance construction of Marina Village has yet to be realized. The RBD project would extend Johnson Street from Columbia to Iranistan at an elevation of 15 feet (the FEMA effective Flood Insurance Rate Maps 500-year stillwater elevation of 11.3 feet NAVD88 plus 3 feet to account for SLR), which would provide the Marina Village redevelopment a dry egress corridor, and subsequently allow the new mixed income housing development to be constructed.[19] Nearby streets, such as portions of Columbia Street, will also be regraded to intersect the elevated Johnson Street and maintain dry egress.

The availability of affordable housing in a neighborhood is directly related to the economic resilience of that neighborhood. In a national survey of more than 300 companies, 55% or respondents acknowledged an inadequate amount of affordable housing in the area, and two-thirds or those respondents believed that the lack of housing negatively affected their ability to retain qualified employees.[20] Studies indicate that the construction of approximately 100 affordable housing units through the Low-Income Housing Tax Credit program can support as many as 30 new jobs in the local economy.[21] Therefore, the availability of housing not only attracts employers to the area, but could also increase the amount of disposable income residents are able to reinvest in the local economy. Additionally, when families spend a smaller portion of their income

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[18] http://www.ajpmonline.org/article/S0749-3797(04)00304-6/abstract
[19] Bridgeport Municipal Building Code, 15.44.140.4.h – "Provisions for flood hazard reduction."
https://www.municode.com/library/ct/bridgeport/codes/code_of_ordinances?nodeId=TIT15BUCO_CH15.44FLDAPR_15.44.150PRFLHARE
[20] *Urban Land Institute (2007). Lack of Affordable Housing near Jobs: A Problem for Employers and Employees.*
[21] *Cohen, Rebecca and Wardrip, Keith (2011). The Economic and Fiscal Benefits of Affordable Housing. The Planning Commissioners Journal.*

on housing, they have more resources available to allow them to resist shocks and stresses, thereby increasing community resilience.

Trends in land use show continued development and redevelopment within low-lying areas, which is likely to continue due to land ownership patterns and desired access to the waterfront. The Master Plan for University of Bridgeport aims to improve connections to the neighborhood with an elevated pedestrian promenade that may provide dry egress. Redevelopment of large sites in the neighborhood may increase affordable housing and employment options near the project area, while integrating more resilient design. The neighborhood's proximity to regional transportation of the commuter rail lines and I-95 would assist in an evacuation.

4.4 Workforce Benefits

The South End has some of the highest unemployment and lowest median household income in Connecticut. There is a distinct lack of economic development in the neighborhood, with very few businesses or employment opportunities for the community. As a result, unemployment in the South End is approximately 30%, higher than 6 times the national average, and almost half of residents are below the poverty level.[22]

The RBD project provides opportunity for economic revitalization to the South End, and with it, job creating economic investment. The redevelopment of Marina Village will include a community center with job-training and education programs. These amenities will attract new residents to the neighborhood, creating a larger potential consumer base. Additionally, when the RBD project is completed and the frequency of flooding is reduced, there will be less risk to businesses of flood-related closures, further incentivizing investment in the neighborhood.

4.5 Historic Preservation

The South End includes several important buildings and neighborhoods with rich histories that would benefit from the implementation of the RBD project. The Marina Park Historic District is almost entirely within the project area, and contains 14 buildings of historic significance along Park Avenue, all of which are listed on the National Register of Historic Places. The buildings represent an intact section of a late-19th century upper class neighborhood, forming a Victorian streetscape.[23] The majority of these buildings are owned by the University of Bridgeport, whose campus is directly adjacent to the neighborhood.

Seaside Village is also listed on the National Register of Historic Places, and is immediately adjacent to the project area. It is a housing community that was constructed during World War I and consists of about 200 single-family dwellings. The neighborhood represents an almost completely unaltered example of government-subsidized housing, and was the first such development in Bridgeport.[24] The community is located directly adjacent to Cedar Creek and is very low-lying, the houses in this neighborhood flood frequently, and residents face high flood insurance premiums. The RBD project would have a positive impact on chronic flooding in this neighborhood, as it is downstream from the project location.

In addition to the Marina Park Historic District and Seaside Village, there are 3 other historic districts in the South End that would be indirectly affected by the RBD project. They are: the Barnum/Palliser Historic District, Seaside Park, and the William D. Bishop Cottage Development Historic District.

[22] http://www.city-data.com/city/Bridgeport-Connecticut.html
[23] National Register of Historic Places. http://pdfhost.focus.nps.gov/docs/NRHP/Text/82004382.pdf
[24] National Register of Historic Places. https://npgallery.nps.gov/pdfhost/docs/NRHP/Text/90001424.pdf

4.6 Economic Impact Analysis

Resiliency projects and infrastructure investments have additional economic benefits beyond losses avoided. Implementing such projects often benefit the local and regional economy by providing employment opportunities, increasing economic output (sales and revenues), and contributing to Gross Domestic Product (GDP). BCA analysts evaluated the economic impacts of the RBD project using IMPLAN input-output economic modeling software. The IMPLAN software evaluates the relationships between employment, labor income, economic output, and value added to GDP in three ways: 1) direct impacts, which include industries directly related to project implementation; 2) indirect impacts for industries that support those which are directly impacted; and 3), induced impacts, or benefits created through employee spending. The software estimates such impacts through multipliers and social accounting matrices; thus, the economic benefits of project implementation cannot be counted toward the RBD project's BCA.[25]

Nevertheless, it is important to identify the employment and economic benefits of resiliency projects to the Bridgeport economy. Project expenditures were entered into the IMPLAN software for evaluation include those associated with project implementation: planning, design, materials, labor, equipment, and maintenance. Results show that the Johnson Street Extension[26] is expected to generate nearly 20 jobs[27], $3.7 million in sales and revenues, and contribute $2.4 million in GDP throughout Fairfield County alone.[28] Implementation activities mainly benefit the construction and maintenance, architectural and engineering services, and water system industries. The majority of these industries operate locally, meaning that the reverberating impacts of changes in spending patterns are likely to remain local. Table 5 details expected top-benefitting economic industries, should implementation occur.

Table 5. Economic Impact Analysis Total Results and Top Economic Industries

Sector	Output	Labor	Employment	Value Added
Construction and related equipment	$ 1,001,270	$ 451,840	5	$ 626,050
Architectural, engineering, and related services	$ 816,530	$ 463,990	5	$ 465,530
Water, sewage and other systems	$ 370,970	$ 189,960	1	$ 285,660
Asphalt paving mixture and block manufacturing	$ 152,220	$ 118,780	0	$ 122,240
Wholesale trade	$ 115,750	$ 44,350	0	$ 89,870
Owner-occupied dwellings	$ 108,720	$ 0	0	$ 72,770
Real estate	$ 93,320	$ 18,880	0	$ 77,060
Insurance carriers	$ 45,280	$ 14,950	0	$ 30,930
Management consulting services	$ 43,990	$ 33,090	0	$ 31,930
Hospitals	$ 42,690	$ 21,410	0	$ 27,510
All other industries	$ 950,880	$ 475,500	7	$ 612,950
Total	**$ 3,741,620**	**$ 1,832,750**	**18**	**$ 2,442,500**

[25] According to OMB Circular A-94, "employment or output multipliers that purport to measure the secondary effects of government expenditures on employment and output should not be included in measured social benefits or costs."
[26] Cost estimates with enough detail for an economic impact analysis were available for only the John Street Extension portion of the RBD.
[27] IMPLAN presents jobs created as all full-time, part-time, and temporary employment.
[28] Results are considered conservative, as economic relationships can and do extend to geographic areas beyond Fairfield County. It is expected that project implementation will generate economic benefits at a national level.

5 BENEFIT COST ANALYSIS METHODOLOGIES SUMMARY

The pilot project seeks to implement initiatives designed to improve the City's flood resiliency, foster community cohesion, increase economic opportunities, improve the natural environment, and promote redevelopment through growth, prosperity, awareness, and beauty. While the primary objective of the pilot project is to reduce acute and chronic flood impacts to public housing and residents, there are other added value benefits that analysts can consider when comprehensively analyzing increased community resilience. Investment in increased flood resilience may foster commercial and residential redevelopment, which in turn, can promote a more diverse and healthy economy. A resilient environment can provide protective functions that stabilize and contribute to improved air and water quality systems, and may also improve the health of residents. Community gathering space provides an opportunity for increased social interactions and cohesion, creating additional networks for support during and after disaster events.

The sections below provide a summary of the methods analysts used to determine Resiliency Benefits and Value Added Benefits that Bridgeport will realize once the pilot project is implemented.

5.1 Resiliency Benefits

Resiliency Benefits are the result of the RBD project's expected effectiveness at protecting against future flooding impacts. Resiliency Benefits relate to resilient redevelopment or dry egress, and are the largest category of benefits quantified for the RBD project. Resilient redevelopment benefits include direct physical damages, displacement costs, mental stress and anxiety, and lost productivity. Dry egress benefits include loss of road service and casualties. The BCA estimates these losses as probabilistic outcomes of flood risk from acute and chronic flooding events.

5.1.1 Resilient Redevelopment

Marina Village, the site of a former public housing development and the future home of a mixed income residential development, is the focal point of the RBD project. The Resilient Bridgeport Team designed project components to benefit the future mixed income redevelopment by reducing stormwater flooding impacts and providing dry egress out of the FEMA 500-year flood zone plus SLR. Because Connecticut building code requires dry egress from the 500-year flood zone for critical developments (e.g., public housing developments), the Johnson Street Extension of the RBD project serves as a catalyst for the resilient redevelopment of the site.

The BCA analysis captures the benefits of the resilient redevelopment by evaluating the flood impacts that would otherwise occur within Marina Village, as well as the economic benefits realized through realizing the development of the site. The following sections describe the methods to evaluate resilient redevelopment. The economic revitalization methodology is described in **5.2.3 Economic Revitalization**.

5.1.1.1 Direct Physical Damages – Buildings and Contents

Resilient redevelopment is expected to reduce the risk of direct physical damage to the future development on the Marina Village site by reconstructing buildings to the 500-year flood elevation. Direct physical damages include the degradation and destruction of property and are quantified through monetary losses. The BCA categorizes property loss as both structural damage (i.e., damage that applies to real property) and content damage (i.e., damage to personal property or inventory). BCA analysts can predict flood impacts by modeling expected damages of hypothetical storms. The following section provides a description of how BCA analysts calculated expected losses avoided for different flood scenarios, sourced from the Fairfield County Flood Insurance Study.

5.1.1.1.1 Methodology

BCA analysts calculated direct physical damages associated with different flood scenarios using standardized depth-damage functions (DDFs) specific to the characteristics and occupancy of a structure. A DDF correlates the depth, duration, and type of flooding to a percentage of expected damage to a structure and its contents, including inventory. Following Hurricane Sandy, the USACE developed DDFs specific to the North Atlantic region in a report titled the North Atlantic Coast Comprehensive Study (NACCS); analysts used these functions to evaluate direct physical damages. Steps to complete the direct physical damage analysis are listed herein.

1. Develop asset inventory: Analysts identified benefitting structures (e.g., the redevelopment of Marina Village) and gathered building attributes necessary for analysis, such as number of stories, area, and building use; Bridgeport tax assessment data provides building data. BCA analysts assigned building replacement values (BRVs) and contents replacement values (CRVs) based on building use. BRV is based on RSMeans 2016 Square Foot Costs, and CRV is based on a contents-to-structure ratio values (CSRV) from the West Shore Lake Pontchartrain Hurricane and Storm Damage Risk Reduction Study.[29]

2. Determine flood depth: BCA analysts compared flood elevations from the FIS to grade elevations to determine a flood depth at each structure. The NACCS DDFs consider first floor elevations, therefore analysts use ground elevation rather than first floor elevations when estimating flood depth.

3. Estimate Percent Damage and Monetary Losses: Once BCA analysts established the expected flood depth for each flood scenario, they applied the DDF to estimate the percent of structural or contents damage. The DDF relates 1-foot depth increments to a percent of structural or contents damage, which is applied to a structure’s BRV or CRV to produce a physical loss value in dollars. Analysts applied the probability of each flood scenario to expected impacts to calculate annual benefits. Ultimately, benefits represent the present value of the sum of expected annual avoided damages over the project useful life.

(i) Uncertainties, Limitations, and Assumptions

The following are assumptions that BCA analysts made to account for uncertainties, as well as the limitation of the analysis:

- Benefits begin the year Marina Village redevelopment is complete, which is 2023.
- Costs associated with the redevelopment of the Marina Village site are not included in the project BCA life-cycle costs. In Connecticut, activities such as the construction of public housing in the floodplain are considered a “critical activity.” Critical activities are regulated to the 500-year flood elevation when applying to the Department of Energy and Environment Protection for a Flood Management Certification.[30] These costs are not included in the analysis, since they are activities associated with the minimum standards per the Regulations of Connecticut State Agencies and not an additional expense to develop to a higher standard.

[29] USACE. 2014. West Shore Lake Pontchartrain Hurricane and Storm Damage Risk Reduction Study – Final Integrated Feasibility Study Report and Environmental Impact Statement. November.
[30] Sections 25-68h-1 through 25-68h-3, Regulations of Connecticut State Agencies

5.1.1.2 Displacement Costs

Residents of impacted structures may experience displacement costs during the time when a building becomes uninhabitable due to flood damage. Relocation costs are associated with moving a household or a business to a new location and resuming business in that new location. Relocation costs are derived from displacement time, which is derived from DDFs that relate a depth of flooding to an amount of time a structure is not usable.

5.1.1.2.1 Methodology

Displacement costs, or relocation costs, are a product of percent damage, impacted square footage, disruption costs per occupancy, rental costs, displacement time, and percent owner occupied.

$$Relocation\ costs = If\ percent\ damage\ is\\ > 10\ percent\colon Impacted\ floor\ area \times (1 - percent\ owner\ occupied) \times disruption\ cost\\ + percent\ owner\ occupied \times (disruption\ cost + rental\ cost \times displacement\ time)]$$

Analysts identified structures experiencing flood impacts at different flood scenario, and determined the total flooded floor area. Census block level data provided the percent owner occupied for residential structures and Hazus-MH 3.2 provided default owner-occupancies for non-residential uses. Analysts used Zillow and Loopnet to develop location specific rental costs for residential and non-residential structures. Flood depths estimated in the direct physical damage analysis are correlated to USACE displacement DDFs to estimate displacement time for each flood scenario. Analysts processed relocation costs to building occupants based on occupancy type.[31] Analysts applied the probability of each flood scenario to expected impacts to calculate annual benefits.

5.1.1.3 Mental Stress and Anxiety

Post-Hurricane Sandy research demonstrates there was a measurable spike in mental stress disorders after the event, including PTSD, anxiety, and depression.[32] FEMA has incorporated post-disaster mental health impacts into its standard values for benefit-cost analysis and assumes that a person will be mentally affected if they experience damage to their residence. Therefore, it is appropriate to estimate the costs of mental health treatment in post-disaster scenarios and consider them as losses avoided that should be included in the BCR.

5.1.1.3.1 Methodology

The principle resource used to conduct the analysis is FEMA's Final Sustainability Benefits Methodology Report that accompanies the FEMA BCA Toolkit. Mental health treatment costs can be measured using three factors: cost, prevalence, and course. Prevalence is the percentage of people who experience mental health problems after a disaster event, and course is the rate at which mental health symptoms reduce or increase over time. Cost is the cost of treatment to those who seek it.

[31] It is important to note that this equation incorporates only owner-occupied structures when calculating displacement values. The reason for this is that a renter who has been displaced would likely cease to pay rent to the building owner of the damaged property, and instead would pay rent to a new landlord. As such, the renter could reasonably be expected to incur no new rental expenses. Conversely, if the damaged property is owner-occupied, then the owner will have to pay for new rental costs in addition to any existing costs while the building is being repaired. This model assumes that it is unlikely that an occupant will relocate if a building is slightly damaged (less than 10% structure damage).

32 Beth Israel Medical Center data indicate a 69% spike in psychiatric visits in November 2012. Healthcare Quality Strategies Inc. reviewed Medicare claims before and after Hurricane Sandy in select communities in New Jersey and found that PTSD was up 12.2%, anxiety disorders were up 7.8%, and depression or proxy disorders were up 2.8%.

FEMA's Final Sustainability Benefits Methodology Report[33] uses prevalence percentages and mental health expenses from Schoenbaum (2009) to derive a standard value for mental stress and anxiety costs. Prevalence percentages are adjusted over different time periods. Mild to moderate impacts will reduce over time as treatment is provided, while severe mental health problems may persist much longer, possibly never being fully resolved.[34] The FEMA methodology only captures mental health impacts for the first 30 months because prevalence rates after this time period are not available.

Schoenbaum provides an estimate of treatment costs in an ideal scenario where all needs are met. FEMA contends that treatment costs from the study must be adjusted to consider only those with mental health problems who will actively seek out treatment (41%).[35] FEMA uses the following steps to adjust total treatment costs from Schoenbaum for a percentage of individuals who seek treatment and for prevalence.

$$Cost\ per\ person\ seeking\ treatment = Treatment\ cost\ per\ person^{36} \times 0.41 \times prevalence$$

Once an appropriate treatment cost was determined, the cost per person was applied to the total number of Marina Village residents that are expected to be impacted by flooding. Per FEMA methodology, benefits are not annualized; rather, benefits at the design level of protection are added, the 500-year flood scenario, are incorporated into the BCR as a one-time benefit.

5.1.1.4 Lost Productivity

FEMA's standard values for mental health impacts also include lost productivity due to mental stress and anxiety. Historical impacts indicate that mental health issues will increase after a disaster, and this, paired with research related to lost productivity due to mental illness, indicates that economic productivity can be impacted by an increase in mental health issues post-disaster.[37] A study of 19 countries by the World Health Organization showed a lifetime 32% reduction in earnings for respondents with mental illness.[38] Implementation of the RBD project will help reduce the number of stressors caused by natural disasters, thereby reducing mental health impacts. Fewer mental health impacts will reduce lost work productivity.

5.1.1.4.1 Methodology

FEMA's Final Sustainability Benefits Methodology Report that accompanies the FEMA BCA Toolkit is the primary resource used to estimate lost productivity. Analysts first established the value of work productivity per FEMA's methodology:

$$Loss\ of\ Work\ Productivity = (EC_{NA} \times H_{NA}) \times 25.5\%$$

Where

EC_{NA}: Average Employment Compensation

H_{NA}: Average Number of Hours Worked per Day

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33 FEMA. 2012. Final Sustainability Benefits Methodology Report. August 23.
34 Schoenbaum, Michael; Butler, Brittany; Kataoka, Sheryl; Norquist, Grayson; Springgate, Benjamin; Sullivan, Greer; Duan, Naihua; Kessler, Ronald; and Kenneth Wells. 2009. Promoting Mental Health Recovery After Hurricanes Katrina and Rita: What Can Be Done at What Cost. Archives of General Psychiatry, Vol. 66, #8, August.
35 Wang, Philip S., MD, DrPH; Lane, Michael, MS; Olfson, Mark, MD, MPH; Pincus, Harold A., MD; Wells, Kenneth B., MD, MPH; Kessler, Ronald C., PhD. 2005. Twelve-Month Use of Mental Health Services in the United States: Results from the National Comorbidity Survey Replication. Archives of General Psychiatry, v. 62, June.
A., MD; Wells, Kenneth B., MD, MPH; and Ronald C. Kessler, PhD. 2005. Twelve-Month Use of Mental Health Services in the United States: Results from the National Comorbidity Survey Replication. Archives of General Psychiatry, v. 62, June.
36 Schoenbaum, Michael; Butler, Brittany; Kataoka, Sheryl; Norquist, Grayson; Springgate, Benjamin; Sullivan, Greer; Duan, Naihua; Kessler, Ronald; Wells, Kenneth. 2009. Promoting Mental Health Recovery After Hurricanes Katrina and Rita: What Can Be Done at What Cost. Archives of General Psychiatry, Vol. 66, #8, August 2009.
37 Insel, Thomas. Assessing the Economic Costs of Serious Mental Illness. American Journal of Psychiatry. 165:6 June 2008. / Kessler et al. Individual and Societal Effects of Mental Disorders on Earnings on the United States: Results from the National Comorbidity Survey Replication. American Journal of Psychiatry. 165:6. June 2008.
38 Levinson, et al. 2010. Associations of Serious Mental Illness with Earnings: Results from the WHO World Mental Health Surveys. British Journal of Psychiatry. August; 197(2): 114–121. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2913273

FEMA references Levinson et al (2010)[39] in which research was conducted using the World Health Organization's Mental Health Surveys in 19 countries; the study found that individuals in the United States with mental health illnesses experience as much as a 25.5% reduction in earnings.

Using the above equation, analysts found the value of work productivity to be $1,767 per capita, monthly.

Analysts apply $1,767 to the amount of time lost productivity is expected to occur, 30 months. Prevalence factors from Schoenbaum (2009) are used to adjust the value of productivity loss over 30 months, to account for the fact that only a portion of the population will experience mental health impacts post-disaster. The prevalence factor is based on severe mental health issues because there is insufficient literature to document the impacts of mild/moderate mental health issues on productivity.[40] Accounting for prevalence, the value of work productivity for 30 months is $3,394 per capita. This value is applied to the number of wage-earning residents who will experience flooding to value productivity losses avoided. Benefits are incorporated into the BCR in the same fashion as mental stress and anxiety benefits.

5.1.2 Dry Egress

Dry egress is a development practice in Connecticut that requires critical developments, such as public housing, located within the 500-year floodplain, to have a means of evacuation, as well as route for emergency vehicles, constructed to the 500-year flood elevation plus 2 feet.[41] Elevated roads also prevent residents from being stranded during flood events, reduce flood damage, reduce the need for water rescues, and increase public safety. The RBD project will provide dry egress for Marina Village, as well as a shorter route to access dry egress for Seaside Village residents and adjacent properties. Dry egress will be constructed to the 500-year flood elevation plus 3 feet to account for future SLR. The BCA captures the benefits of dry egress by evaluating the value of road service and avoided casualties.

5.1.2.1 Loss of Roadway Service

Transportation assets and systems in the South End may flood during both acute and chronic events. Loss of roadway service is a function of the per-hour value of time, detour route, and number of vehicles evacuating. Analysts focused on the residents of the Marina Village redevelopment that will benefit from dry egress.

5.1.2.1.1 Methodology

This FEMA methodology is centered around the value of time, which is described in FEMA's Benefit Cost Analysis Re-engineering Guide, Development of Standard Economic Values report. In summary, analysts evaluate additional travel time needed for an alternative travel route because floodwaters inundate a roadway. Roadway loss of service can be characterized using the following equation:

$$Roadway\ Loss\ of\ Service = \left[\left((UpPD \times ER) \times VpH \times VT\right) \times DT\right] \times TV$$

Where:

UpPD: Number of Units per Property Description

ER: Expected Evacuation Rate

39 Levinson, et al. 2010. Associations of Serious Mental Illness with Earnings: Results from the WHO World Mental Health Surveys. British Journal of Psychiatry. August; 197(2): 114–121. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2913273
40 FEMA. 2014. Updated Social Benefits Methodology Report. December 18.
41 "A Guide for Higher Standards in Floodplain Management". Association of State Floodplain Managers. October 2010.

VpH: Average Number of Vehicles per Household

VT: Vehicle Trips to Evacuate

DT: Delay Time

TV: Hourly Value of Time per Vehicle

Analysts reviewed the FEMA flood zones to determine whether Marina Village residents have an evacuation route available that would not be inundated during a 100-year flood event. Analysts found there is no evacuation route in this scenario. When no alternative route is available, FEMA uses a delay time of 12 hours as a standard value.[42]

The US Census Bureau American Community Survey provided the number of households in Marina Village, and The New England Hurricane Evacuation Study (2016) provided vehicles per household and evacuation rates. Analysts assumed vehicles trips to be one. To place a monetary value on lost roadway service, analysts normalized and applied FEMA's value of time, $32.09 per hour.[43]

5.1.2.2 Casualties

Casualties, which include loss of life and injuries, are an unfortunate risk inherent to hazard events. Flood events are considered some of the most frequently occurring natural hazards, contributing to 44% of natural hazard-related fatalities worldwide.

The approach chosen to estimate reduced fatalities within Marina Village is based on a study completed by the BRNO University of Technology in 2013.[44] Through this approach, analysts consider the number of fatalities expected at different flood scenarios. Additional data required to supplement the BRNO approach include standard life safety values from the Federal Aviation Administration (FAA): the FAA's Willingness to Pay value for one fatality is $5.8 million.

Casualties also includes injuries related to identified flood events. In October 2014, the CDC published another report titled "Nonfatal Injuries 1 Week after Hurricane Sandy." The report suggests that 10.4% of residents in the inundation zone were injured within the first week after Hurricane Sandy, mostly during attempts to evacuate or navigate and clean up debris.

5.1.2.2.1 Methodology – Injuries

To quantify the value of injuries, analysts developed the below equation based on the CDC study titled "Deaths Associated with Hurricane Sandy". It is assumed that all injuries reduced are categorized as FAA AIS1 minor injuries. This injury category is the lowest value within the FAA study ($13,590) allowing for a conservative analysis of injuries associated with a flood event.[45]

$$Value\ of\ Injuries = \left(Population \times (1 - Evacuation\ Rate)\right) \times 10.4\% \times \$13{,}590$$

Analysts consider the number of residents in Marine Village and Seaside Village that did not evacuate as the impacted population. The US Census Bureau American Community Survey provided the population in Marina Village and Seaside Village, and The New England Hurricane Evacuation Study (2016) provided evacuation rates.

[42] FEMA Supplement to the Benefit-Cost Analysis Reference Guide (2011). Page 5-14. http://www.fema.gov/media-library-data/1396549910018-c9a089b8a8dfdcf760edcea2ff55ca56/bca_guide_supplement__508_final.pdf
[43] Normalization in this report refers to the process of converts past dollar values to current dollar values using the CPI inflation calculator.
[44] Brazdova, M. and J. Riha. 2014. A simple model for the estimation of the number of fatalities due to floods in central Europe. Nat Hazards Earth Syst Sci. 14. June 12.
[45] Value normalized to 2016 dollars.

5.1.2.2.2 Methodology – Fatalities

The BRNO University of Technology approach is based on three main factors: material loss (in dollars), population preparedness, and warning. The relationship of these factors is expressed in the equation presented below. There are additional factors that are important to consider in estimating the loss of life in a natural hazard event. Nevertheless, factors such as debris, climatic conditions, water quality, and time of day, were not available for analysis due to a lack of data.

The equation for fatality estimates is presented below:

$$LOL = 0.075 \times D^{0.384} \times (P + 2)^{-3.207} \times (W + 2)^{-1.017}$$

Where:

LOL: Loss of Life

D: Material Loss ($)

P: Population Preparedness (aggregated population preparedness factors)

W: Warning (factor-based)

D Factor

The D factor (material loss) consists of building damage and contents loss; both values are determined through the approach described in estimating direct physical damages. For the purposes of this analysis, only structure and contents damage for residential structures are evaluated for the appropriate flood scenarios. Analysts assumed these losses reflect both the destructive ability of the event and the number of endangered inhabitants. Damage to constructed assets, such as roads or utility systems, are not considered. The values used as D in the formula are listed in Table 6.

Table 6. Expected Material Loss (D) Values by Percent Annual Chance Flood Event

Percent Annual Chance Flood Event	Expected Material Loss
10%	$4,333,630
2%	$7,905,860
1%	$9,795,560
0.2%	$15,625,020

P Factor

The P Factor (population preparedness) expresses the preparedness of the community for flood management and resiliency, and is intended to reflect the population's general awareness of flooding and required preparations. This value is determined by rating eight sub-factors on a scale of -1 to 1. Because of the frequency and amount of flood prevention and awareness activities present in Bridgeport, analysts assumed that the same P sub-factors apply for all flood scenarios.

W Factor

The W factor (warning) includes factors that influence warning of the community that an event is forecasted. The contributing factors include a hydrological forecast, the type of warning system employed, the speed of flooding, and the rate of water level rise; as these factors are somewhat based on the frequency and extent of flooding, the W Factor is evaluated for the identified flood scenarios. For factor W4, water rise rates were determined based on event data.

Loss of life is then obtained by placing all determined factor values (D, P, and W) into the previously mentioned equation. The benefits associated with avoiding these fatalities can be calculated using Federal Aviation Administration (FAA) Willingness to Pay values for a fatality ($5.8 million).

5.2 Value Added Benefits

Value added benefits include social, environmental, and economic revitalization benefits resulting from the RBD project's stormwater park and resilient redevelopment. These benefits include:

- Social benefits in the form of recreational value;
- Aesthetic benefit generated from making the surrounding more desirable for businesses and residents;
- Environmental benefits in the form of reduced energy use, air pollution, water pollution, and carbon dioxide emissions; and,
- Economic revitalization benefits related to added commercial space.

5.2.1 Social Benefits

Urban parks and green space help improve the quality of life and social sustainability of cities by providing recreational opportunities and aesthetic enjoyment, promoting physical health, contributing to psychological well-being, enhancing social ties, and providing opportunities for education.[46] The RBD project will improve the project area by adding a new public park. Public amenities include basketball courts, sidewalks, green open spaces, and passive seating areas. New public amenities will increase resident's opportunity to participate in a variety of recreation activities, thereby enhancing their health and well-being, increasing social capital[47] and improving the quality of life in the greater community.[48]

5.2.1.1 Recreation Benefits

Recreation benefits quantify the consumer value of increased outdoor recreation expected to occur after completion of the new stormwater park. There are two approaches to quantifying new outdoor recreation opportunities: the low value method is based on FEMA's Final Social Sustainability Methodology Report, and assigns a value per square foot of recreation space. The high value method uses United States Army Corps of Engineers (USACE) sources to value an increase in recreation activity based on Unit Day Values. The medium method is the average results of high and low estimated benefits.

5.2.1.1.1 Methodology

Low Value Method: FEMA's standard annual recreational value per acre was normalized to current dollars and converted to square feet, $0.13 per square foot. FEMA generated this value using nationwide, rural,

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46 Zhou, X. and M.P. Rana. 2011. Social benefits of urban green space. A conceptual framework of valuation and accessibility measurements. Management of Environmental Quality: An International Journal.
47 Gomez, E., Baur, J.W.R., Hill, E., and S. Georgiev. 2015. Urban Parks and Psychological Sense of Community. Journal of Leisure Research.
48 Lestan, K.A., Erzen, I., and M. Golobic . 2014. The Role of Open Space in Urban Neighbourhoods for Health-Related Lifestyle. 2014. International Journal of Environmental Research and Public Health. June

and suburban willingness to pay studies. Analysts apply FEMA's willingness to pay value to the total area of new park amenities to estimate the recreational value.

High Value Method: The recreational benefit is quantified by applying USACE unit day values (UDVs) [49] to an amenity's expected useful life. Analysts estimated the useful life of new park features using standardized average estimated useful life values set by the Federal government.[50] The USACE UDVs provide a range of possible recreation values based on activity type, general or specialized recreation. Analysts used the lowest value available for general recreation ($3.90) to produce conservative estimates.

Medium Value Method: Analysts found the medium value by averaging the results of the low and high value methods.

5.2.1.2 Aesthetic Benefits

The RBD project will implement flood protection measures that integrate concepts of green infrastructure coupled with the addition of usable park space which will create a more appealing project area to existing and future residents. This attention to aesthetic detail may create a positive effect for residential property and the local economy. One measurable example of an aesthetic benefit that can contribute to this positive effect is attractive views and willingness to pay for these views. The benefits of increased aesthetic amenities, including attractive views, may be quantified through hedonic pricing demonstrated in the housing market, and on a standard value-per-square foot basis.

5.2.1.2.1 Methodology

Analysts used methods described in FEMA's Final Sustainability Benefits Methodology Report to value aesthetic benefits of the RBD project. FEMA's report uses a benefit transfer methodology[51] to obtain an aesthetic value per acre per year of green open space. Analysts normalized this value to 2016 dollars and converted it to square feet; this value is $0.04 per sqaure foot. This value is applied to the area of new park space to value aesthetic benefits. New trees may also increase the aesthetic quality of the surrounding areas. The U.S. Forest Service's Northeast Community Tree Guide (2007) provides an annual asethetic value per public tree, and analysts applied this value to the total number of added trees to generate benefits.

5.2.2 Environmental Benefits

The RBD project proposes to add new natural vegetation that will produce a range of environmental benefits, also known as ecosystem goods and services. Ecosystem goods and services provided by natural vegetation may be quantified to estimate their economic benefit to society. Such benefits can be categorized through measures such as carbon sequestration, air pollutant reduction, energy savings, increase in water quality, and pollination. The RBD also implements stormwater management measures that will reduce water treatment needs and environmental impact of CSO events. Environmental benefits can be grouped into two categories based on valuation methods: those associated with the ecosystem goods and services and those associated with reduction CSO events.

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49 United States Army Corps of Engineers. 2016. Economic Guidance Memorandum, 16-03 Unit Day Values for Recreation for Fiscal Year 2016. Located at: http://planning.usace.army.mil/toolbox/library/EGMs/EGM16-03.pdf
50 Fannie Mae. Instructions for Performing A Multifamily Property Conditions Assessment. Appendix F. Estimated Useful Life Tables. Located at: https://www.fanniemae.com/content/guide_form/4099f.pdf
51 The benefit transfer method applies the results of previously conducted primary studies to another geography.

5.2.2.1 Ecosystem Goods and Services

Natural capital is the world's stock of natural assets, such as soil, air, water, and all living things that provide a good or service that benefits society. For example, natural capital, such as forests and soils, provide the ecosystem service of filtering water independent of treatment plants.

Ecosystem services can be grouped into four broad categories:[52]

- **Provisioning services:** produce physical materials that society uses such as minerals, gases, and living things;
- **Regulating services:** create and maintain a healthy environment such as climate stability and flood protection;
- **Supporting services:** maintain conditions for life such as habitat and genetic diversity; and,
- **Cultural services:** provide meaningful human interaction with nature including spiritual, recreational, aesthetic, educational, and scientific uses.

5.2.2.1.1 Methodology

The USDA's Northeast Community Tree Guide (Tree Guide) and FEMA's Final Sustainability Benefits Methodology Report are the sources analysts used to develop environmental benefits for various vegetation types. Table 7 summarizes the approach taken to develop a benefit value per vegetative unit.

Table 7. Approach Summary by Vegetative Type

Vegetation Type	Approach
Tree	Annual benefits per tree are sourced from the Northeast Tree Guide
Vegetation	Annual benefits per vegetative square foot are sourced from FEMA's Final Sustainability Report.

5.2.2.2 Combined Sewer Overflow Reduction

A significant added benefit of the RBD project is the ability to retain stormwater. The City of Bridgeport currently uses a combined sewer system. When rain events occur, the City's sewer system can become overwhelmed and untreated wastewater can spill into nearby waterways as a relief mechanism to avoid damaging property or treatment plants; this is commonly referred to as a CSO event. The RBD project proposes to implement a stormwater management features that will capture flow, preventing it from entering the combined sewer system and contributing to CSO events. This benefit is not captured in ecosystems services benefits, therefore requiring a separate analysis.

5.2.2.2.1 Methodology

CSOs have a major impact on water quality and pose significant health and safety risks. Bridgeport is acting to meet water quality requirements under the Clean Water Act. The City has developed a Long-Term Control Plan to reduce the frequency of CSO events. The Plan reveals it will cost the City $384,900,000 over 30 years to reduce CSO output by 43 million gallons. Given this information, analysts generated a

[52] Earth Economics. 2015. Earth Economics Ecosystem Valuation Toolkit. [Web page] Located at: http://esvaluation.org/ecosystem-services/

damage cost for CSO abatement: $0.29 per gallon per year. Analysts modeled CSO reduction and applied the damage cost to the total volume of CSO reduction to estimate water quality benefits.

5.2.3 Economic Revitalization

The resilient redevelopment of Marina Village includes added commercial space that will generate economic revitalization benefits. These benefits can be measured through anticipated added economic output and employment compensation.

5.2.3.1 Methodology

Commercial output per square foot and employment compensation per square foot are sourced from FEMA's Hazus-MH 3.2 software. Analysts use the equation below calculate the economic benefits of added commercial space.

$$Added\ Output\ per\ Year = Added\ Annual\ Output\ per\ Square\ Foot \times Added\ Space\ (SF)$$

IMPLAN defines output as the value of industry production. Employment compensation may be defined as the payroll cost of employees paid by an employer, including wages and benefits.

5.3 Economic Impact Analysis

In addition to the benefits of increased resiliency from reduced future disaster loss, project expenditures for construction are expected to stimulate economic activity within Bridgeport and Fairfield County. This economic impact evaluation is accessory to the RBD project; the intent is to evaluate the expected economic benefits generated by project construction in the form of employment, labor income, value added, and sales and revenues (output).

5.3.1 Methodology

This methodology presents the approach used to model economic impacts for project expenditures. Generally, analysts evaluate the cost of each proposed project element using IMPLAN modeling software to determine the economic impacts that will result from the change in the local economy directly related to project expenditures. IMPLAN software provides economic data and modeling to users for assessing the economic impacts of project implementation in all industry sectors, with the intent of predicting how projects or policies interact with and shape the economy.

Analysts used IMPLAN Version 3.1 software, an input-output system that uses a combination with social accounting matrices (SAMs) and economic multipliers to estimate the result of changes or activities in an economic region. SAMs provide a complete picture of the economy and generate multipliers to measure the impacts from one activity for a given sector throughout the entire economy. Analysts used the 2015 Fairfield County Package for the economic impact analysis, which includes the economic profile for each zip code. Table 8 and Table 9 below describes the IMPLAN analysis report outputs and types of relationships reported. Each result category presented in Table 8 is reported in terms of relationships measured, displayed in Table 9.

Table 8. Economic Impact Analysis Result Outputs

Analysis Result	Definition
Output	The value of industry production, which varies by industry. For example, the output of the service sector is measured in sales, hospital output is measured in the total service package that a patient receives during their entire length of stay, and output for non-profit organizations is based on the cost of production or the expenses that the organization must incur to operate.
Labor Income	The expected combined income of employment in each industry sector generated by project implementation expenditures. Including wages and benefits for employees and proprietor income.
Value-Added	Measure of the project's contribution to Gross Domestic Product (GDP).
Employment	All jobs (full-time, part-time, and temporary) that are created or lost as a result of an economic activity in the year of the activity.

Table 9. Economic Impact Analysis Relationships Measured

Analysis Result	Definition
Direct Effects	Represents the initial impacts that occur as a result of an economic activity.
Indirect Effects	The impact of direct economic effects on supporting industries, such as those that provide equipment and materials.
Induced Effects	The response to a direct effect that occurs through re-spending of income.

To estimate economic impacts of the RBD project, the team compared project estimates with IMPLAN industries. IMPLAN has a total of 440 economic industries, derived from the North American Industry Classification System (NAICS). To run IMPLAN, analysts must choose the economic industry expected to be impacted by a project related activity, and estimate how much that industry will change (in dollars). Analysts created an IMPLAN model for each county with impacted mitigation projects and populated the software with appropriate project costs listed in Step 1. Once this was completed, the team reviewed outputs generated from IMPLAN software for appropriateness.

6 NO ACTION ALTERNATIVE

It is important to realistically consider what would happen in the future if no action is taken. The risks identified within the **Section 2 Risk Context** will not only continue to occur in the future, but will be exacerbated by the effects of climate change. As storm events occur more frequently and the severity of these storms intensify, impacts of flooding and the likelihood of CSO events will increase and more residents and structures will become more susceptible to flood impacts.

6.1 Resiliency Impacts

The largest benefit category of the RBD project BCA is the resiliency benefit category. This BCA examines resilient redevelopment value through identifying potential avoided physical damages to structures and contents, avoided displacement costs, evaded mental health and anxiety costs, and lost productivity costs; as well as assesses dry egress benefits by analyzing evacuation / roadway loss of service impacts and potential casualties. It is possible to project future storm impacts in five, twenty, and fifty year intervals using annualized losses avoided. Annualized losses avoided account for SLR when appropriate; this includes dry egress losses avoided.

If the project is not implemented, acute and chronic flooding will continue to negatively impact this community's ability to withstand and recover from periodic storm events. With projected climate change and SLR, flooding in this area is likely to get worse and occur more frequently. During major storm events, community residents may be stranded, unable to evacuate to higher ground without the proposed dry egress. Flooding events in the project area disproportionately impact vulnerable low-income and minority residents, who form much of the residential population. If the RBD project is implemented, a range of losses could be avoided, including property damage, property loss, business interruption, evacuation, sheltering, relocation of residents receiving housing assistance, and rebuilding, along with disaster recovery efforts.

If the project is not implemented, significant areas of concentrated poverty would be adversely affected. As previously mentioned, all census block groups in the larger project area neighborhood are considered low income. Roughly half of the community is considered very low income, and the public housing redevelopment site area is categorized as extremely low income. Without the proposed dry egress, the public housing site cannot be redeveloped because safe evacuation to outside the 500-year floodplain is currently not possible. Residents of the adjacent low lying areas, who are predominantly low-income, will also continue to be at risk if this project is not implemented.

Based on an evaluation of the probabilities and consequences of the 10-percent, 2-percent, 1-percent, and 0.2-percent annual chance flood event, the cumulative costs to residents within the RBD project area could exceed **$5 million** over five years, **$10.3 million** over 20 years, and **$13 million** over 50 years. Table 10 summarizes the potential losses avoided by category.

Table 10. Potential Impacts of No Action Alternative

Loss Category	Five Years	Twenty Years	Fifty Years
Resiliency Benefits			
Resilient Redevelopment			
Direct Physical Damages	$ 2,954,960	$ 7,634,960	$ 9,946,010
Displacement	$ 4,720	$ 12,180	$ 15,870
Mental Stress and Anxiety	$1,050,280	$1,050,280	$1,050,280
Lost Productivity	$ 653,610	$ 653,610	$ 653,610
Dry Egress Value			
Evacuation / Roadway Loss of Service	$ 44,732	$ 115,580	$ 150,560
Casualties	$ 355,450	$ 918,410	$ 1,196,410
Total	**$5,063,750**	**$10,385,020**	**$13,012,740**

6.2 Social Impacts

The BCA also considers value added by the RBD project including expected social, environmental, and economic benefits. Such benefits would not be realized if the RBD project is not implemented. The multifunctional neighborhood stormwater park component creating a new community gathering place, which is currently lacking in the neighborhood would be non-existent. These amenities are critical to provide an attraction for current and future residents, and provide a space for community programs, environmental education, and passive and active recreation. The no action alternative would also eliminate the planned expansion of habitat for flora and fauna, and extended urban tree canopy providing aesthetic value and encouraging future development.

Based on an evaluation of the estimated added annual benefits, the cumulative benefits not realized to residents within the RBD project area could exceed **$650,000** over five years, **$1.6 million** over 20 years, and **$2.1 million** over 50 years. Table 11 summarizes the potential value added by category.

Table 11. Potential Social Impacts of No Action Alternative

Loss Category	Five Years	Twenty Years	Fifty Years
Value Added Benefits			
Social Value			
Recreation Benefits	$ 557,260	$ 1,439,830	$ 1,875,660
Aesthetic Benefits	$ 21,040	$ 54,360	$ 70,810
Environmental Value			
Ecosystem Goods and Services Benefits	$ 36,210	$ 93,570	$ 121,890
CSO Reduction Benefits	$ 13,560	$ 35,020	$ 45,630
Economic Value			
Economic Revitalization	$ 22,140	$ 57,210	$ 74,520
Total	**$ 650,210**	**$ 1,679,990**	**$ 2,188,510**

7 PROJECT RISKS AND CHALLENGES

7.1 Risks to Project Benefits

The robust partnerships and stakeholder support enjoyed by the project, coupled with significant public sector property ownership, ensure that the project can adapt to unforeseen challenges and continue to meet its intent as the environmental review and design process progresses.

7.1.1 Relationship to National Disaster Resilience Competition (NDRC)

While both the RBD Project and the NDRC Pilot are located in the South End of Bridgeport, the two projects target distinctly different study areas, with RBD focusing on the neighborhood west of Park Avenue, and NDRC focusing on the neighborhood east of Park Avenue. Compared to the RBD project, which address dry egress and stormwater improvements, the NDR pilot includes a protection strategy that raises University Avenue, builds an integrated protection layer to support development at 60 Main Street and extends protection and connection back towards downtown Bridgeport.

Part of the scope of work for RBD included developing a long-term flood protection strategy for the South End. While funding has yet to be identified to further design and construct the full flood protection vision for the region, the alignments proposed to date for NDRC are in accord with the vision set forth by RBD. As such, efforts for NDRC will not duplicate efforts from RBD, and both projects will retain relevance to the South End after construction.

7.1.2 Sea Level Rise Scenario and Adaptation

The design team used a specific SLR projection when establishing the project level of protection. This was based upon guidance from Rebecca French, the Director of Community Engagement at CIRCA. In her 2016 piece, "Current Policies on Sea Level Rise in Connecticut," French states, "[NOAA CPO-1 requires that] the state plan of conservation and development, municipal plans of conservation and development, the civil preparedness plan and program, and the municipal evacuation or hazard mitigation plans must 'consider' the sea level change scenarios from the NOAA report." Based on this guidance, the Team referenced the scenarios published in NOAA CPO-1, "Global Sea Level Rise Scenarios for the United States National Climate Assessment", as well as coordinated with key project stakeholders to determine the project's useful life and the criticality of assets, to determine the appropriate SLR planning scenario of 3 feet for Johnson Street. While that projection is conservative, there is always the possibility of climate change and SLR accelerating faster than predicted.

7.2 Potential challenges to Project Implementation

7.2.1 Political or Stakeholder Risks

Political or stakeholder risks are very limited. The project team has conducted a robust participatory stakeholder engagement process resulting in broad support that minimizes political and stakeholder risk. There is no Mayoral election between now and construction initiation. There is a City Council election between now and construction initiation, but the supportive council people from the district within which the project is located have held their seats long term and the broad stakeholder support ensures that, should they unlikely be replaced, their successors would support the will of the people. The project is being designed to limit the necessary approval by the City Council to one that is technical in nature: acceptance of the new street per city standards.

7.2.2 Technical Risks

At the time of the Substantial Action Plan Amendment, the RBD project design is still in a conceptual phase. Topographic survey, and geotechnical and groundwater data are outstanding. This data and information will be collected and incorporated as the project reaches 100% final design. It is expected that any technical risks will be identified and addressed prior to the RBD project reaching final design.

7.2.3 Procedural Risks

The procedural risks associated with the project are very limited. There are legal agreements that remain to be executed with the Housing Authority of the City of Bridgeport and/or their private development partner, JHM Group of Companies. These include property easements for construction of the stormwater park and underground pipes. Constant engagement with both these stakeholders ensure that these necessary agreements will come as no surprise to them and their support of this process and the RBD project enhance the likelihood of success and minimize risk. Feedback from these key stakeholders on all legal issues will be addressed and incorporated into the project as design advances.

7.2.4 Community Support

There is broad community support for the project. The project has emerged from a robust and participatory stakeholder engagement process that included regular, well-attended meetings, workshops, and discussions. Various constituencies were typically represented at these project events including local homeowners (e.g., Seaside Village residents), renters, public housing tenants (e.g., PT Barnum and Marina Village tenants), business owners, institutional representatives, and local government representatives and elected officials. Based on positive feedback at these events and positive public comments on the action plan and previous substantial amendments, there is broad community support for the project.

8 CONCLUSION

The Resilient Bridgeport Team has developed a holistic RBD project to protect public housing, provide dry egress, and manage stormwater in a way that improves ecological function of the project area and nearby waterways. The project seeks to strengthen the neighborhood’s identity, incentivize economic investment, create recreational attraction for the neighborhood, and provide a multitude of other benefits described in this report. In total, the RBD project will benefit over **1,000 residents** in Bridgeport’s South End. The BCA finds the City can expect to realize a total of **$10,991,150** in added resilient redevelopment benefits and **$1,255,760** in dry egress value benefits over the life of the project. Additionally, the project is expected to add approximately **$1,981,820** in social value benefits, **$171,660** in environmental value benefits, and **$69,480** in economic revitalization benefit over the next 50 years.

The BCA reveals the RBD project is cost effective based on the current design. At a 7% discount rate, the RBD project will provide a total of **$14,469,860** in present value benefits compared to **$9,235,060** in present value costs over the life of the project, resulting in a BCR of **1.57**.

The RBD project is designed to set a precedent for resiliency design and collaboration, and be an example of comprehensive resilience principles that are applicable to all low-lying areas in Bridgeport. It is the hope local agencies will advance resilient design strategies and replicate them throughout coastal areas in Bridgeport, as well as Connecticut. The RBD collaboration between Bridgeport and private agencies offers an opportunity to display resiliency best practices that become a standard in Connecticut and the larger region for urban and coastal resiliency.

TABLES

FIGURES

APPENDIX A

[Subtitle, F9, then “Appendix TOC” Style for letters in TOC]

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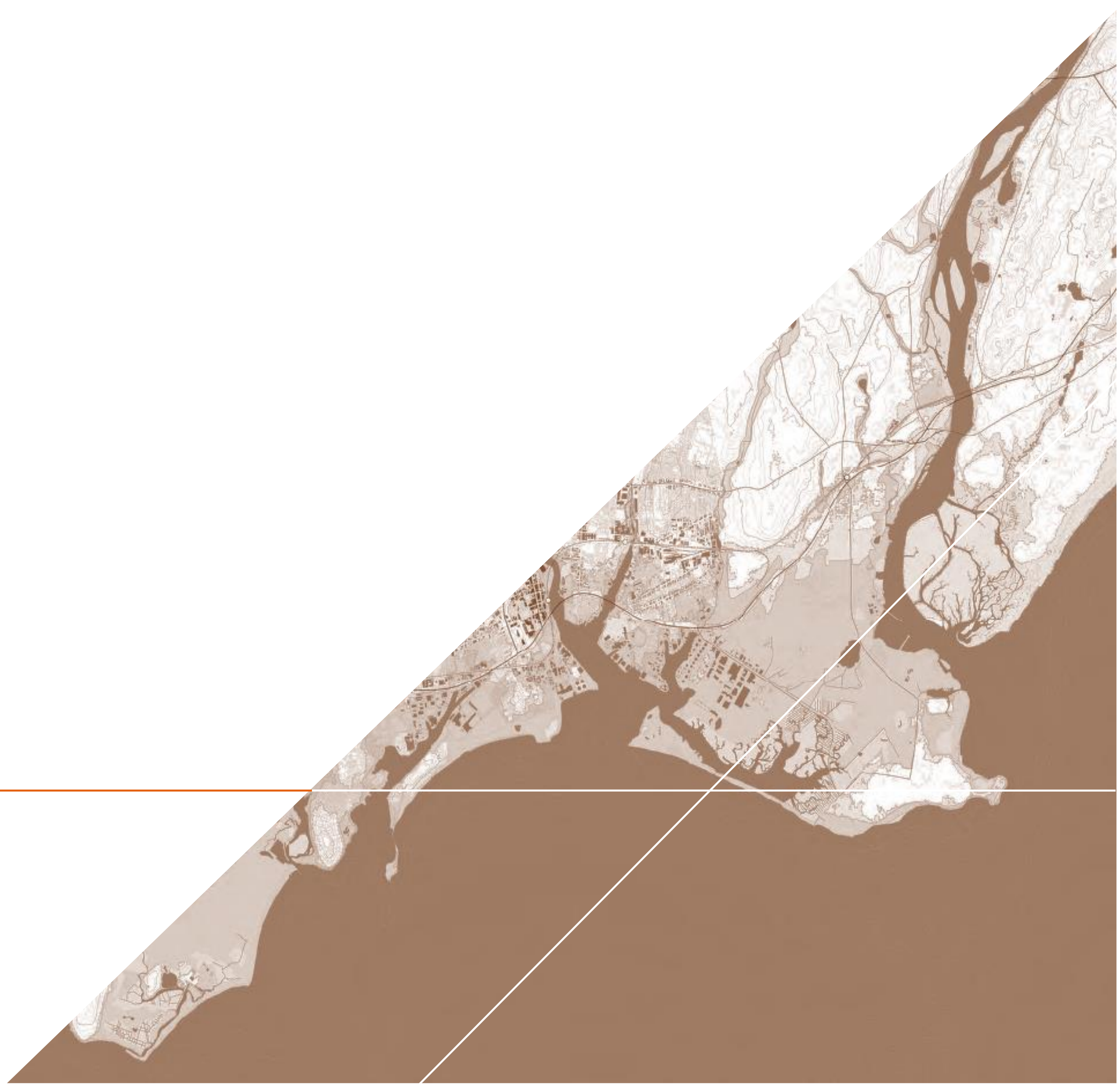
RESILIENT BRIDGEPORT

BENEFIT COST ANALYSIS

METHODOLOGY REPORT

April 21, 2017



BENEFIT COST ANALYSIS

Methodology Report

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Connecticut Department of Housing

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TABLES AND FIGURES

APPENDICES

ACRONYMS AND ABBREVIATIONS

ARC: American Red Cross

BCA: Benefit Cost Analysis

BCAR: BCA Re-Engineering Report

BCR: Benefit Cost Ratio

BEA: Bureau of Economic Analysis

BLS: Bureau of Labor Statistics

BRV: Building Replacement Value

CDC: Centers for Disease Control

CRV: Contents Replacement Value

CSRV: Contents-to-Structure Ratio Value

CSO: Combined sewer overflow

CSS: Combined sewer system

DDF: Depth-Damage Function

DEEP: Connecticut Department of Energy and Environment

DEM: Digital Elevation Model

DOH: Connecticut Department of Housing

EPA: U.S. Environmental Protection Agency

EIS: Environmental Impact Statement

FAA: Federal Aviation Administration

FEMA: Federal Emergency Management Agency

FIS: Flood Insurance Study

FIRM: Flood Insurance Rate Map

FFE: First Floor Elevation

GCP: Gross city product

GDP: Gross domestic product

GIS: Geographic Information System

HUD: United States Department of Housing and Urban Development

LiDAR: Light Detection and Ranging

MEP: Mechanical/Engineering/Plumbing

NACCS: North Atlantic Coast Comprehensive Study

NAICS: North American Industry Classification System

NAVD88: North American Vertical Datum of 1988

NDR: National Disaster Resilience

NOAA: National Oceanic and Atmospheric Administration

NPV: Net present value

NRCS: Natural Resources Conservation Service

OMB: United States Office of Management and Budget

PTSD: Post-traumatic stress disorder

RBD: Rebuild by Design

SAM: Social Accounting Matrix

SF: Square Feet

SLR: Sea Level Rise

TM: Technical Manual

UDV: Unit Day Value

USACE: U.S. Army Corps of Engineers

WTP: Willingness to Pay

1 INTRODUCTION

During Tropical Storm Irene (Federal Emergency Management Agency [FEMA] Major Disaster Declaration [DR] -4023) and Hurricane Sandy (DR-4087), floodwaters from Long Island Sound inundated roadways, critical infrastructure, businesses, and homes in low-lying areas, directly affecting the South End's residents and businesses. Following the devastation from Hurricane Sandy, the U.S. Department of Housing and Urban Development (HUD) launched Rebuild by Design (RBD) to inspire innovative community and policy-based resilience solutions to protect cities most vulnerable to intense weather events.

HUD awarded the Connecticut Department of Housing (DOH) $10 million to reduce flood risk for the most vulnerable public housing stock in Bridgeport through continued planning and evaluation of long-term resiliency strategies, as well as designing a RBD pilot project aimed at alleviating acute and chronic flooding in the South End neighborhood. To this end, the Resilient Bridgeport Team, led by Waggonner & Ball with Arcadis, Yale Urban Design Workshop and Reed Hilderbrand Landscape Architects, has developed an innovative and multifaceted RBD project in the South End to provide benefits to the neighborhood by means of dry egress and stormwater management.

The Resilient Bridgeport Team completed a benefit cost analysis (BCA) to evaluate the RBD project at its current level of design as part of the design process. The BCA assesses resiliency, social, environmental, and economic benefits that will result from the implementation of the RBD project. In accordance with HUD Notice: CPD-16-06, the BCA uses federally accepted standard figures and methods to assess project benefits.

This appendix serves to provide a detailed description of the BCA methods summarized in the BCA Report, and includes the following principle sections:

- **Section 1 Introduction** includes a BCA overview.
- **Section 2 RBD Project Description** summarizes the RBD project and project costs.
- **Section 3 Resiliency Benefits** includes detailed methodologies used to determine resilient redevelopment and dry egress benefits.
- **Section 4 Value Added** describes in detail the methods used to evaluate social, environmental, and economic benefits.
- **Section 5 Sensitivity Analysis** includes a describes how analysts approached BCA assumptions and the discount rate.
- **Section 6 Double Counting** describes how analysts approached potentially overlapping benefits in the BCA.
- **Section 7 Benefit Cost Analysis Results** presents BCA findings.
- **Section 8 Economic Impact Analysis** is a detailed description of the methodology used to evaluate economic impacts of project implementation.

To facilitate HUD's review of the BCA Summary Report and BCA Methodology Report, analysts completed two crosswalks:

1. **Appendix A: HUD Crosswalk** summarizes the pilot project's benefits, costs, and BCA methods.
2. **Appendix B: BCA Crosswalk** relates CPD Notice 16-06 requirements to report sections.

1.1 Benefit Cost Analysis Overview

A benefit cost analysis (BCA) helps inform sound decision making related to public infrastructure investment. BCA benefits represent the present value of the total expected annual losses avoided and value added over the RBD project's useful life. The BCA accounts for:

- Probabilities of flood events and losses
- Project useful life
- Time value of money (discount rate)

Resiliency benefits are future losses prevented or reduced by the RBD project. Analysts estimate losses avoided for certain modeled flood scenarios, then apply the annual probability of occurrence to losses at each flood scenario to determine expected annual losses avoided. Probability of occurrence refers to the percent chance of an expected flood event being met or exceeded in any given year.

$$Annual\ Resiliency\ Benefits = \sum_{s=1}^{s=4} Expected\ Losses\ Avoided \times Annual\ Probability\ of\ Occurence$$

Where:
S = annual flood event scenario

Analysts project and discount annual benefits and project life-cycle costs[1] over the RBD project's useful life (50 years) using a 7 percent discount rate to find the present value of project benefits. The project useful life is the estimated amount of time the project will be effective. The discount rate determines the time value of money; in other words, the discount rate accounts for the fact that monetary value tomorrow will not be as much as it is in the present. The Office of Management and Budget (OMB) mandates the discount rate to be 7 percent, but HUD also considers a 3 percent discount rate for review per HUD Notice: CPD-16-06.

The BCR is the project's total present value of benefits divided by the project's total present value of life-cycle costs. NPV is the difference between the present value of a project's total benefits and the present value of a project's total life-cycle costs. Both the NPV and BCR inform the RBD project's cost effectiveness and ensure the project is fiscally beneficial.

$$Net\ Present\ Value = Present\ Value\ of\ Project\ Benefits - Present\ Value\ of\ Project\ Costs$$

$$Benefit\ Cost\ Ratio = \frac{Present\ Value\ of\ Project\ Benefits}{Present\ Value\ of\ Project\ Costs}$$

This BCA presents benefits and costs in 2016 dollars. The sections below describe the RBD project and the detailed methods analysts used to determine annual resiliency benefits and value added benefits that Bridgeport will realize once it implements the pilot project.

[1] Project life cycle costs include direct capital costs and operations and maintenance cost over the life of the project.

2 REBUILD BY DESIGN PILOT PROJECT

Through stakeholder meetings, community engagement, mapping, and modeling, the RBD project team has come to understand the different impacts that chronic and acute flooding have on the community, and the risks posed by climate change and sea level rise (SLR). Though the primary intent of the RBD project is to reduce these impacts on the project area, the project team has also designed the project to serve as a proof of concept for broader resilience principles within Bridgeport and the region. The project and the collaboration that it requires will result in the demonstration of best practices for agencies and private entities. It is intended to provide a precedent for future development, as well as encourage the adoption and implementation of updated local policies, zoning regulations, and building code standards by the City of Bridgeport.

Further, the State of Connecticut has committed to developing and implementing a set of resilience performance standards for the RBD project. The State will coordinate the standards developed or the project with those that are being developed for the National Disaster Resilience (NDR)-funded infrastructure of similar nature being implemented in the South End of Bridgeport. Overtime, these performance standards will be refined based on the outcomes of the RBD project and South End NDR project so that they can continually be applied to any future development projects throughout the State.

The RBD project will extend Johnson Street to provide dry egress for future Mariana Village residents out of the FEMA 500-year flood zone, as well as future SLR conditions of 3 feet. The Johnson Street Extension will incorporate green infrastructure, such as bioswales, to divert surface runoff away from the combined sewer system and into a multifunctional stormwater park. Stormwater park components such as terraced basins and underground storage features will retain, delay, and improve the quality of stormwater runoff. Community gathering spaces, play equipment and courts, and walkways in the stormwater park will provide space for community programs, environmental education, and passive and active recreation. The park component will also include new flora and fauna.

The stormwater park will collect surface water, which will be gravity drained to a new pump station located at the southeast corner of South Avenue and Iranistan Avenue. A new underground force main will pump the flow to an existing outfall at Cedar Creek, the Little Regulator Outfall. By removing stormwater from the combined sewer system, a reduced load will be routed to the wastewater treatment plant on the west side of Bridgeport. Similarly, bringing additional stormwater to the head end of Cedar Creek will improve flushing and overall ecological function of the creek. RBD project costs include direct capital costs, as well as operation and maintenance (O&M) costs over the project useful life. **Table 1** summarizes the total value of each cost category. Refer to **Appendix D: Rebuild by Design Pilot Project Cost Estimates** for a detailed description of project costs.

Table 1. Summary of RBD Project Costs

Cost Category	Costs (7 Percent Discount Rate)	Costs (3 Percent Discount Rate)
Capital Costs	$ 8,200,000	$ 8,200,000
Annual O&M Costs	$ 75,000	$ 75,000
Present Value O&M Costs	$ 1,035,060	$ 1,912,620
Total Project Costs	**$ 9,235,060**	**$ 10,112,620**

2.1 Project Timeline

It is anticipated that the RBD project will be completed by the end of 2021. The project has not yet been permitted, but preliminary permitting requirements have been identified and additional permit requirements may be identified during the development of an Environmental Impact Statement (EIS). An aggregated EIS to include both the RBD project and the Bridgeport resilience projects is being funded through the State of Connecticut's National Disaster Resilience Grant award. The State is currently concluding a public procurement process that will result in a consultant team being engaged under contract to complete the Environmental Impact Statement and other tasks designed to move forward the projects funded by both RBD and NDR.

Concurrent to this procurement process, the State's existing consultant team is also advancing the project to a 30% design stage. It is expected that environmental review, preliminary design, and permitting will continue into the last quarter of 2018 and construction will commence in early 2019 and continue into the middle of 2021. A Notice of Intent to Prepare an EIS as required under 24 CFR Part 58.55 is anticipated to be published in the Federal Register in September 2017 thereby launching the public scoping process. **Table 2** below delineates the major milestones for project completion including remaining design and engineering work, permitting, bidding, and construction.

Table 2. RBD Project Milestone Timeline

Activity Milestone	Start Date	End Date
CDBG-DR Action Plan Substantial Amendment	February 2017	June 2017
30 Percent Design Completion	February 2017	June 2017
Resilience Strategies Finalization	December 2016	June 2017
Environmental Impact Statement	June 2017	July 2018
Final Design Documents	July 2017	November 2018
Project Permitting	October 2017	November 2018
RBD Project Construction	November 2018	September 2021

3 RESILIENCY BENEFITS

Resiliency benefits are the result of the RBD project's expected effectiveness at protecting against future flooding impacts. Resiliency benefits are related to resilient redevelopment or dry egress. These benefits are the largest category of benefits quantified for the RBD project. Resilient redevelopment benefits include direct physical damages, displacement costs, mental stress and anxiety, and lost productivity. Dry egress benefits include loss of road service, injuries and fatalities (**Table 3**). The BCA estimates these losses as probabilistic outcomes of flood risk from acute and chronic flood events. This BCA evaluates losses at the 10-precent, 2-percent, 1-percent, and 0.2-percent annual chance flood event, sourced from the Fairfield County Flood Insurance Study (FIS). Analysts calculate resiliency benefits for current or future Marina Village buildings.

Table 3. Resiliency Benefits Matrix

Benefit Category	Measurable Benefit/Metric	Stormwater Park	Johnson Street Extension		Marina Village Redevelopment
			Green Infrastructure	Raised Road	
Resilient Redevelopment	Physical Damages				X
	Displacement Costs				X
	Mental Stress and Anxiety				X
	Lost Productivity				X
Dry Egress	Fatalities			X	
	Injuries			X	
	Loss of Roadway Service			X	

The stormwater park and John Street Extension's green infrastructure contribute to reduced flood risk during chronic flood events, resulting in resiliency benefits. Acute flood events are more severe and result in greater flood impacts; therefore, resiliency benefits for acute flood events inherently capture benefits of lesser magnitude events. As such, analysts have not conducted a separate analysis.

3.1 Resilient Redevelopment

Marina Village, the site of a former public housing development and the future home of a mixed income residential development, is the focal point of the RBD project. The Resilient Bridgeport Team designed project components to benefit the future mixed income redevelopment by reducing stormwater flooding impacts and providing dry egress out of the FEMA 500-year flood zone plus SLR. Because Connecticut building code requires dry egress from the 500-year flood zone for critical developments (e.g., public housing developments), the Johnson Street Extension of the RBD project serves as a catalyst for the resilient redevelopment of the site.

The BCA captures the benefits of the resilient redevelopment by evaluating the flood impacts that would otherwise occur within Marina Village, as well as the economic benefits realized after the redevelopment of the site. The following section describe the methods used to evaluate losses avoided due to resilient redevelopment. Section **5.2.3 Economic Revitalization** describes the economic revitalization methodology.

3.1.1 Direct Physical Damages – Buildings and Contents

Resilient redevelopment will reduce the risk of direct physical damage to the future development on the Marina Village site by reconstructing buildings to the 500-year flood elevation. Direct physical damages include the degradation and destruction of property and are quantified through monetary losses. The BCA categorizes property loss as both structural damage (i.e., damage that applies to real property) and content damage (i.e., damage to personal property or inventory).

Analysts evaluate property losses using Depth Damage Functions (DDFs) developed by the United States Army Corps of Engineers (USACE); DDFs relate the flood depth at a structure to an expected percent damage for structures and contents. This percent damage is applied to a building or contents replacement value to estimate monetary loss. Analysts calculate property damage results using building data as of 2015 and RS Means 2016 replacement cost values.

3.1.1.1 Depth Damage Functions

Analysts calculated expected property losses associated with the Fairfield County FIS flood scenarios using standardized depth-damage functions (DDFs) specific to the characteristics and occupancy of a structure. A DDF correlates the depth, duration, and type of flooding to a percentage of expected damage to a structure and its contents, including inventory. The USACE produces DDFs that analysts can use to model direct physical damages. Following Hurricane Sandy, the USACE developed DDFs specific to the Northeast for coastal flooding in a report titled the North Atlantic Coast Comprehensive Study (NACCS). As this information contains the most current and best available data, analysts used these functions to evaluate direct physical damages. **Figure 1** provides a sample depth damage relationship from the USACE NACCS.

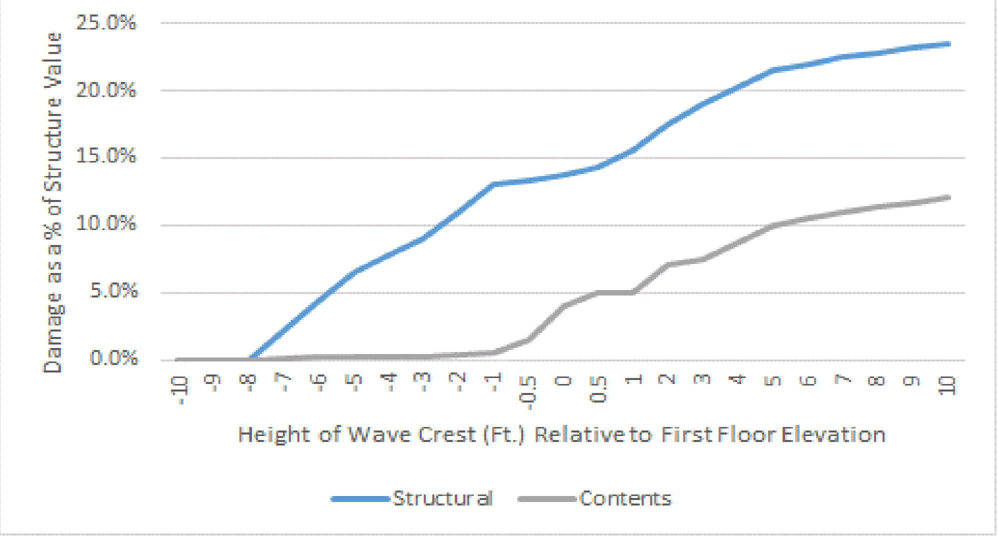

Figure 1. Expected Structural and Contents Damage from Inundation, NACCS Urban High Rise Prototype. Damage at negative flood depths accounts for impacts to mechanical, electrical, and plumbing systems that may be located at or below grade.

3.1.1.2 Data Sources

BCA analysts utilized the following data sources to calculate expected structure, contents, and inventory losses avoided:

- **City of Bridgeport Tax Assessor Data (2015):** Attributes from this dataset used in the direct physical damage analysis include: square footage, number of stories, building elevation, and building use. This dataset also provided building footprints.
- **RS Means Building Construction Cost Data (2016):** This publication provides location-specific building replacement square foot costs for 160 building occupancy types. Using RS Means, analysts calculated building replacement square foot costs for the various structure types in Bridgeport.
- **USACE North Atlantic Coast Comprehensive Study (NACCS) Physical Depth Damage Function Summary Report (2015):** Following Hurricane Sandy, the USACE collected empirical data to estimate the damages that would occur from future events. This report produced damage functions for residential, non-residential, and public property. Analysts used DDFs from this study to estimate direct physical damages.
- **USACE West Shore Lake Pontchartrain Hurricane and Storm Damage Risk Reduction Study (2014):** This study conducted by the USACE produced contents-to-structure ratio values (CSRVs) for residential and non-residential structures. CSRVs are a percentage of the total building replacement values, and analysts used CSVR's determine total contents replacement values for structures in the project area. While produced for a separate region, analysts determined this study to be the best and most recent data available for use with the DDFs.
- **Connecticut Department of Energy and Environmental Protection Digital Elevation Model (2011):** A Department of Energy and Environmental Protection (DEEP) digital elevation model (DEM) is a model of the ground surface, and provides the ground elevation for structures. The DEM is a raster layer of high-resolution ground elevation data based on information from bare-earth LiDAR elevation data collected and compiled during December 2006 and Spring/Summer 2004.
- **Fairfield County Flood Insurance Study (2013):** provides flood elevations for the 10 percent, 2 percent, 1 percent, and 0.2 percent flood events. Analysts use flood elevations to approximate flood depths inside structures.

3.1.1.3 Approach

Analysts completed the following six steps to conduct the direct physical damages analysis.

1. Develop Asset Inventory

Analysts identified benefitting structures (e.g., the redevelopment of Marina Village) and gathered building attributes necessary for analysis, such as number of stories, area, and building use, from Bridgeport's tax assessor data (**Table 4**). Analysts used the attributes of the Marina Village building stock prior to demolition as it is the best available data at the time of analysis; analysts assumed the redevelopment of Marina Village will be a similar style and density multi-family housing complex. Analysts merged building footprints and parcel level data using the unique identification number.

Table 4. Building Attributes

Attribute	Analysis Use
Parcel ID	Key location identifier specific to a parcel
Unique ID	Key location identifier specific to a building
Address	Key location identifier
Living Area	Used in square footage analysis and replacement value calculation
Land Occupancy Description	Building use
Land Use Description	Secondary identifier of building use
Number of Stories	Used in square footage analysis

Ground Elevation

Structure grade elevation is an essential field used to estimate the approximate flood depth within structures. To determine the structure grade elevation, analysts extracted the average elevation within a structure footprint from the DEEP DEM.

2. Map Building Use to Depth Damage Functions, Replacement Values, and Hazus Occupancy Types

Buildings may be classified according to both construction features (type) and use (occupancy); analysts use these classifications to determine further information about the structure. For example, BCA analysts mapped land occupancy descriptions to classifications used by RS means to estimate replacement value for a structure. Analysts completed the following mappings based on land occupancy descriptions:

- Land occupancy description to USACE NACCS DDFs. Refer to **Appendix C: Depth Damage Functions** for a listing of land occupancies and damage functions.
- Land occupancy description to contents/inventory value shares described in the USACE Lake Pontchartrain Study to assign the appropriate CSRV's. Refer to **Appendix E: Occupancy Mapping** for the full mapping scheme
- Land occupancy description to Hazus occupancy classes to estimate a replacement value for structures, as well as apply the appropriate business interruption time multipliers, one-time disruption costs, and for certain uses, the percent owner occupancy. Refer to **Appendix E: Occupancy Mapping** for the full mapping scheme.

3. Conduct Square Footage Analysis

Damages must be assessed based on the square footage within a certain number of stories NACCS identifies for each DDF.[2] The number of stories analysed by the DDF is related to the structure type and the expected location and value of mechanical, electrical, and plumbing (MEP) in buildings. A significant portion of a building's value is captured in such assets; damage costs to these assets can therefore be disproportionate to those of other assets. Urban high rise damage functions, for example, analyse damages as a percent of the square footage of the first ten floors given the NACCS assumption that MEP assets are located within the basement or first floor of the structure.

[2] U.S. Army Corps of Engineers. North Atlantic Coast Comprehensive Study (NAACS). http://www.nad.usace.army.mil/CompStudy

To calculate the structure square footage for the analysis, analysts multiplied the square footage per floor by the DDF's number of stories identified by NACCS (**Table 5**) or the total number of stories, whichever is less, for each structure. Analysts use the analysis square footage to calculate the building and contents replacement value, as described in the next steps.

Table 5. USACE NACCS, Number of Stories per Depth Damage Function

DDF No.	Building Types	Stories (for Analysis)
1A-1	Apartment 1-Story, No Basement	1
1A-3	Apartment 3-Story, No Basement	3
2	Commercial Engineered	2
3	Commercial Non-Engineered	1
4A	Urban High Rise	10
4B	Beach High Rise	10
5A	Residential 1-Story, No Basement	1
5B	Residential 2-Story, No Basement	2
6A	Residential 1-Story, With Basement	1
6B	Residential 2-Story, With Basement	2
7A	Building on Open Pile Foundation	1
7B	Building on Pile Foundation with Enclosures	1

Source: North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk. Physical Depth Damage Function Summary Report. January 2015.

4. Determine Building and Contents Replacement Value

Building replacement values (BRVs) and Contents Replacement Values (CRVs) are necessary to place a value on expected damage to buildings. Analysts used RS Means 2016 Square Foot Costs to estimate the BRV.

Building Replacement Value

The BCA Re-engineering Guide defines the BRV as, "the building replacement value for a specific component of the building, expressed in dollars".[3] Analyst used RS Means square foot costs to estimate building replacement values for each Hazus occupancy class[4]. RS Means is a construction cost estimating resource published each year often used by engineers to evaluate different construction cost possibilities. RS Means square foot costs capture labor and material costs, and other information such as city cost

[3] Federal Emergency Management Agency. Benefit Cost Analysis Re-engineering Guide. Full Flood Data. 2009. Located at: http://www.fema.gov/media-library-data/20130726-1738-25045-2254/floodfulldata.pdf

[4] Hazus occupancy classes represent a certain building type based on use, and the FEMA Hazus-MH Flood Technical Manual applies an average square footage to each occupancy class. This average square footage was used to choose the appropriate replacement value per square foot from the RS Means cost data book.

indexes, productivity rates, crew composition, and contractors overhead and profit rates are also available. Analysts used the appropriate RS Means city cost indices of 1.12 for residential uses and 1.09 for commercial uses to accommodate construction conditions in Bridgeport. **Table 6** shows the BRV values determined from RS Means with the city cost index increase for Fairfield County. The building replacement value represents the cost to repair or rebuild damaged buildings in current dollars.

Contents Replacement Value

The USACE NACCS does not include content replacement ratios, therefore analysts used the next best available data. The CRV is based on the contents-to-structure ratio values (CSRV) for residential and non-residential structures from data obtained through surveys in the *West Shore Lake Pontchartrain Hurricane and Storm Damage Risk Reduction Study (***Table 6***).*[5] To calculate the CRV, analysts multiplied the total BRV by the appropriate CSRV, mapped to the Hazus occupancy class. Because the contents values are based on percentages, they increase coincident with an increase in the BRV and do not need to be updated to Bridgeport specific values.

Table 6. Replacement Values

Hazus Occupancy Code	Occupancy Code Description	BRV	CSVR	CRV
RES1	Single Family Dwelling	$130.34	0.69	$89.93
RES2	Mobile Home	$125.17	1.14	$142.70
RES3A	Multi Family Dwelling - Duplex	$107.23	0.69	$73.99
RES3B	Multi Family Dwelling – 3-4 Units	$206.99	0.69	$142.82
RES3C	Multi Family Dwelling – 5-9 Units	$206.99	0.69	$142.82
RES3D	Multi Family Dwelling – 10-19 Units	$197.06	0.69	$135.97
RES3E	Multi Family Dwelling – 20-49 Units	$191.07	0.69	$131.84
RES3F	Multi Family Dwelling – 50+ Units	$184.55	0.69	$127.34
RES4	Temporary Lodging	$192.14	0.69	$132.57
RES5	Institutional Dormitory	$220.99	0.69	$152.49
RES6	Nursing Home	$224.80	0.69	$155.11
COM1	Retail Trade	$127.17	1.19	$151.33
COM2	Wholesale Trade	$123.23	2.07	$255.09
COM3	Personal and Repair Services	$148.21	2.36	$349.78
COM4	Business/Professional/Technical Services	$183.48	0.54	$99.08
COM5	Depository Institutions	$276.60	0.54	$149.36
COM6	Hospital	$394.26	0.54	$212.90
COM7	Medical Office/Clinic	$223.50	0.54	$120.69
COM8	Entertainment & Recreation	$233.01	1.70	$396.13
COM9	Theaters	$195.78	0.54	$105.72

[5] USACE. 2014. West Shore Lake Pontchartrain Hurricane and Storm Damage Risk Reduction Study – Final Integrated Feasibility Study Report and Environmental Impact Statement. November.

Hazus Occupancy Code	Occupancy Code Description	BRV	CSVR	CRV
COM10	Parking	$82.52	0.54	$44.56
IND1	Heavy	$140.17	2.07	$290.16
IND2	Light	$123.23	2.07	$255.09
IND3	Food/Drugs/Chemicals	$189.91	2.07	$393.10
IND4	Metals/Minerals Processing	$189.91	2.07	$393.10
IND5	High Technology	$189.91	2.07	$393.10
IND6	Construction	$123.23	2.07	$255.09
AGR1	Agriculture	$123.23	N/A	N/A
REL1	Church/Membership Organizations	$197.03	0.55	$108.36
GOV1	General Services	$157.02	0.55	$86.36
GOV2	Emergency Response	$262.05	1.50	$393.07
EDU1	Schools/Libraries	$210.99	1.00	$210.99
EDU2	Colleges/Universities	$185.28	1.00	$185.28

5. Determine Flood Depth

Analysts subtracted grade elevations from the FEMA defined 10 percent, 2 percent, 1 percent, and 0.2 percent flood elevations to determine the expected flood depths in structures. The USACE NACCS DDFs account for expected first floor elevation (FFE) by occupancy type and age, as well as the presence of mechanical, electrical, and plumbing (MEP) located in the basement. Since the DDFs incorporate these building attributes, it is not necessary to account for FFE in the asset inventory. To determine the flood depths, analysts obtained the flood elevation within a building footprint for each flood scenario, and subtracted the average grade elevation from the respective flood elevations to obtain a flood depth for each flood scenario.

6. Estimate Percent Damage and Monetary Losses

As previously mentioned, DDFs are a relationship between the depth of floodwater in a structure and the percent of flood damage. Once BCA analysts established the expected flood depth for each flood scenario, they applied the DDF to estimate the percent of structural or contents damage; this percentage is applied to a structure's BRV or CRV to produce a physical loss value in dollars. Analysts applied the annual probability of each flood scenario to expected flood impacts to calculate annual benefits (**Table 7**). Ultimately, benefits represent the present value of the sum of expected annual avoided damages over the project useful life.

Table 7. Direct Physical Damage Results

Flood Scenario (Percent Annual Chance Event)	Loss Category		Total Direct Physical Damages
	Building Losses	Contents Losses	
10 Percent	$2,007,510	$2,326,120	$4,333,630
2 Percent	$3,285,290	$4,620,570	$7,905,860
1 Percent	$4,003,460	$5,792,100	$9,795,560
0.2 Percent	$6,171,770	$9,453,250	$15,625,020
Annualized Losses Avoided	*$318,840*	*$401,850*	*$16,772,570*

3.1.1.4 Assumptions

BCA analysts made the following assumptions to account for uncertainties and limitation of the analysis:

- The USACE NACCS DDFs account for underground vulnerabilities by applying a percent damage for negative flood depths.
- The NACCS DDFs did not provide percent loss for all flood depth intervals for all occupancies, and provided no percent loss above ten feet of flood depth. As such, analysts developed trend interpolations based on the preceding three available flood depths for missing DDFs. A similar approach was used for flood depth gaps below zero flood depth, using averages between flood depths, where available.
- The DDFs do not assume complete loss beyond 50 percent damage, as is often assumed for use with benefit cost analyses, as well as substantial damage determinations. Further, the analysis does not consider the impacts of codes and standards in restoration. As such, direct physical damage costs may be conservatively low.
- Benefits begin the year Marina Village redevelopment is complete, which is 2023.
- The RBD project life-cycle costs do not include the costs associated with the redevelopment of the Marina Village site. In Connecticut, activities such as the construction of public housing in the floodplain are considered a “critical activity.” Critical activities are regulated to the 500-year flood elevation when applying to the Department of Energy and Environment Protection for a Flood Management Certification.[6] These costs are not included in the analysis, since they are activities associated with the minimum standards per the Regulations of Connecticut State Agencies and not an additional expense to develop to a higher standard.
- Analysts assume the redevelopment of Marina Village will be a similar style and density multi-family housing complex. As such, analysts consider the number of future population and units within the site to be similar. The analysis does not consider an increase in development or population density, resulting in a conservative analysis.

3.1.2 Displacement Costs

Residents of impacted structures may experience displacement costs during the time when a building becomes uninhabitable due to flood damage. Relocation costs are associated with moving a household or a business to a new location and resuming business in that new location. Relocation costs are derived from

[6] Sections 25-68h-1 through 25-68h-3, Regulations of Connecticut State Agencies

displacement time, which is derived from DDFs that relate a depth of flooding to an amount of time a structure is not usable. The overall approach taken to evaluate relocations costs is:

1. Identify flood depths and damage expected at the 10 percent, 2 percent, 1 percent, and 0.2 percent annual chance flood event
2. Determine expected displacement time based on flood depth and building use
3. Calculate relocation costs

3.1.2.1 Data Sources

BCA analysts used the following data sources when evaluating displacement costs:

- **Hazus-MH 3.2 One-time Disruption Cost Defaults:** Hazus provides national one-time relocation costs per square foot based on Hazus occupancy class. These costs are provided in 2006 dollars and have been normalized to 2016 dollars based on inflation. Refer to **Appendix F: Additional Benefit Cost Analysis Resources** for Hazus-MH 3.2 manual excerpts.
- **US Census Bureau American Community Survey 5-Year Estimates (2014):** provided the percent owner occupancy by census block for residential uses. Analysts used Hazus-MH 3.2 default values for commercial structures as local figures were not readily available.
- **Hazus-MH 3.2 Percent Owner Occupancy Defaults:** Hazus provides percent owner occupancy for non-residential uses by Hazus occupancy class (local value not available).
- **Direct Physical Damages:** Flood impacts were modeled for different flood scenarios to determine which structures are expected to flood and the depth of flooding within the structure (see **2.2.1 Direct Physical Damages – Buildings and Contents**).
- **FEMA BCA Toolkit 5.3:** Depth displacement tables were not provided with the USACE NACCS DDFs used in the direct physical damage analysis, therefore analysts extracted displacement tables from the BCA Toolkit to determine displacement time for structures based on flood depth.
- **Local Rental Rates:** Analysts researched local rent rates within the project area and applied these rates by occupancy. An online survey of varied sizes and types of residential spaces currently available for rent within the South End established local residential rental rates. Local commercial rental rates were obtained in the same manner as residential rental rates. Analysts used Loopnet to obtain commercial rental values, and Trulia, and Zillow to conduct the residential survey (all online real estate services).

3.1.2.2 Approach

1. Identify Impacted Structures: The direct physical damages analysis identified structures expected to be impacted at the 10 percent, 2 percent, 1 percent, and 0.2 percent annual chance flood events.

2. Identify Impacted Square Footage: For structures that are expected to experience less than ten feet of flooding, the total impacted square footage is the area of the first floor. Analysts use the total square footage of the first two floors when a structure experiences more than ten feet of flooding.

3. Identify and Apply Percent Owner Occupied by Occupancy: For residential uses, census block level data provided the percent owner occupied. Analysts assigned all non-residential uses default percent owner occupancy obtained from Hazus-MH 3.2.

4. Identify Rental Rates by Occupancy: Analysts categorized available rental units by commercial and residential uses for the project area, and then calculated an average rent price per square foot per year for each use. The results of this analysis indicate that the average annual price per square foot for commercial properties in 2016 is $10.05, and the average annual price per square foot for residential properties in 2016 is $13.13. Analysts converted these values to an average price per square foot per day for use in the relocation cost calculation outlined below.

5. Evaluate Displacement Time: The estimated flood depth within each structure is correlated to USACE depth displacement tables to estimate displacement time for each modeled flood scenario.

6. Process Relocation Costs: Analysts processed relocation costs to building occupants based on occupancy type.[7] Displacement costs, or relocation costs, are a product of percent damage, impacted square footage, disruption costs per occupancy, rental costs, displacement time, and percent owner occupied. Analysts applied the probability of each flood scenario to expected impacts to calculate annual benefits (**Table 8**).

$$\begin{aligned} Relocation\ costs = If\ percent\ damage\ is \\ > 10\ percent\!: Impacted\ floor\ area \times (1 - percent\ owner\ occupied) \times disruption\ cost \\ + percent\ owner\ occupied \times (disruption\ cost + rental\ cost \times displacement\ time)] \end{aligned}$$

Table 8. Relocation Costs Avoided

Flood Scenario (Percent Annual Chance Event)	Relocation Costs
10 Percent	-
2 Percent	$18,180
1 Percent	$53,770
0.2 Percent	$124,300
Annualized Losses Avoided	*$1,150*

3.1.2.3 Assumptions

- Relocation costs are only calculated for floors expected to be directly impacted by floodwaters. There are times when the entire structure will be displaced because of flood impacts. As a result, this approach produces conservative results.
- Depth displacement tables used in the analysis do not consider flooding below grade. Utilities and other critical assets may lie below grade. When these areas flood, occupants may be displaced, even if flood waters do not reach above the first floor. The analysis does not capture such displacement.
- The depth displacement tables do not extend beyond 16 feet of flood depth. As such, analysts assume displacement periods for flood depths above 16 feet match the time for displacement at 16 feet.

[7] It is important to note that this equation incorporates only owner-occupied structures when calculating displacement values. The reason for this is that a renter who has been displaced would likely cease to pay rent to the building owner of the damaged property, and instead would pay rent to a new landlord. As such, the renter could reasonably be expected to incur no new rental expenses. Conversely, if the damaged property is owner-occupied, then the owner will have to pay for new rental costs in addition to any existing costs while the building is being repaired. This model assumes that it is unlikely that an occupant will relocate if a building is slightly damaged (less than 10% structure damage).

3.1.3 Mental Stress and Anxiety

Natural disasters threaten or cause loss of health, social, and economic resources, which leads to psychological distress.[8] Research indicates that individuals who experience significant stressors, such as property damage or displacement, are more likely to experience symptoms of mental illness, Post-Traumatic Stress Disorder (PTSD), and higher levels of stress and anxiety after a disaster.[9] Post-Hurricane Sandy research demonstrates there was a measurable spike in mental stress disorders after the event, including PTSD, anxiety, and depression.[10] As mental health issues increase after a disaster, it is expected that mental health treatment costs will also increase. The pilot project is expected to reduce flood impacts to homes and public transportation, and thus reduce risk of mental stress and anxiety post-disaster.

FEMA developed standard values to estimate the treatment costs of mental stress in a post- disaster situation, if a person has personally experienced damage to their residence. The following section describes FEMA's method to evaluate mental stress and anxiety impacts after a flood event.

3.1.3.1 Data Sources

- **FEMA's Final Sustainability Benefits Methodology Report (2012):** This report provides a method to calculate the cost of mental stress and anxiety treatment.
- **Direct Physical Damages:** Analysts use flood depths from Section **2.1.1 Direct Physical Damages – Buildings and Contents** to identify impacted buildings and population.
- **US Census Bureau American Community Survey (ACS) (2014) 5-Year Estimates:** This source provided population by census block.

3.1.3.2 Approach

The principle resource used to conduct the analysis is FEMA's Final Sustainability Benefits Methodology Report that accompanies the FEMA BCA Toolkit. Mental health treatment costs are measured using three factors: cost, prevalence, and course. Prevalence is the percentage of people who experience mental health problems after a disaster event, and course is the rate at which mental health symptoms reduce or increase over time. Cost is the cost of treatment to those who seek it. Analysts completed the following steps to estimate the expect cost of mental health treatment for each flood scenario.

1. Population Analysis

To analyze human impacts for each building, analysts must distribute the total population in the project area to each residential building. To do so, analysts distributed the population (from the 2014 ACS) to each building based on the ratio of a residential building's total square footage to the total residential square footage in the census block that contains the building.

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[8] Hobfoll, S.E. 1989. Conservation of resources: A new attempt at conceptualizing stress. American Psychologist. 44:513–524. [PubMed: 2648906].
[9] Rhodes, J., Chan, C.,Pacson, C., Rouse, C.E., Waters, M., and E. Fussell. 2010.. The Impact of Hurricane Katrina on the mental and physical health of low-income parents in New Orleans. Am J Orthopsychiatry. April; 80(2): 237-247.
10 Beth Israel Medical Center data indicate a 69% spike in psychiatric visits in November 2012. Healthcare Quality Strategies Inc. reviewed Medicare claims before and after Hurricane Sandy in select communities in New Jersey and found that PTSD was up 12.2%, anxiety disorders were up 7.8%, and depression or proxy disorders were up 2.8%.

2. Determine Prevalence Rate and Course

FEMA's Final Sustainability Benefits Methodology Report[11] uses prevalence percentages and mental health expenses from Schoenbaum (2009) to derive a standard value for mental stress and anxiety costs. Prevalence percentages are adjusted over different time periods: mild to moderate impacts will reduce over time as treatment is provided, while severe mental health problems may persist much longer, possibly never being fully resolved.[12] **Table 9** provides a summary of prevalence considering course over four different time periods.[13] The FEMA methodology only captures mental health impacts for the first 30 months because prevalence rates after this period are not available.

Table 9. Mental Health Prevalence Rates After a Disaster

Time after Disaster	Severe	Mild/Moderate
7-12 months	6%	26%
13-18 months	7%	19%
19-24 months	7%	14%
25-30 months	6%	9%

Source: FEMA Updated Social Sustainability Methodology Report

3. Establish Treatment Cost

Schoenbaum provides an estimate of treatment costs in an ideal scenario where all needs are met. FEMA contends that treatment costs from the study must be adjusted to consider only those with mental health problems who will actively seek out treatment (41 percent).[14] FEMA uses the following steps to adjust total treatment costs from Schoenbaum for a percentage of individuals who seek treatment and for prevalence.

$$Cost\ per\ person\ seeking\ treatment = Treatment\ cost\ per\ person^{15} \times 0.41 \times prevalence$$

This methodology is applied to each time period, adjusting for prevalence. Analysts normalized the values provided by FEMA's Final Sustainability Benefits Methodology Report (2012) using the Consumer Pricing Index (CPI) Inflation Calculator,[16] and the costs for both severe and mild/moderate mental health problems over each time period are added together to provide a total treatment cost of $ 2,707 for 30 months. **Table 10** provides a summary of treatment costs in current dollars.

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11 FEMA. 2012. Final Sustainability Benefits Methodology Report. August 23.
12 Schoenbaum, Michael; Butler, Brittany; Kataoka, Sheryl; Norquist, Grayson; Springgate, Benjamin; Sullivan, Greer; Duan, Naihua; Kessler, Ronald; and Kenneth Wells. 2009. Promoting Mental Health Recovery After Hurricanes Katrina and Rita: What Can Be Done at What Cost. Archives of General Psychiatry, Vol. 66, #8, August.
13 FEMA. 2014. Updated Social Benefits Methodology Report. December 18.
14 Wang, Philip S., MD, DrPH; Lane, Michael, MS; Olfson, Mark, MD, MPH; Pincus, Harold A., MD; Wells, Kenneth B., MD, MPH; Kessler, Ronald C., PhD. 2005. Twelve-Month Use of Mental Health Services in the United States: Results from the National Comorbidity Survey Replication. Archives of General Psychiatry, v. 62, June.
A., MD; Wells, Kenneth B., MD, MPH; and Ronald C. Kessler, PhD. 2005. Twelve-Month Use of Mental Health Services in the United States: Results from the National Comorbidity Survey Replication. Archives of General Psychiatry, v. 62, June.
15 Schoenbaum, Michael; Butler, Brittany; Kataoka, Sheryl; Norquist, Grayson; Springgate, Benjamin; Sullivan, Greer; Duan, Naihua; Kessler, Ronald; Wells, Kenneth. 2009. Promoting Mental Health Recovery After Hurricanes Katrina and Rita: What Can Be Done at What Cost. Archives of General Psychiatry, Vol. 66, #8, August 2009.
16 U.S. Bureau of Labor Statistics. Undated. CPI Inflation Calculator. [web page] Located at: http://www.bls.gov/data/inflation_calculator.htm.

Table 10. Cost of Treatment[17] After a Disaster (30 Month Duration), Per Person Expected to Seek Treatment

Time after Disaster	Severe	Mild/Moderate	Total per person
7-12 months	$ 220.00	$ 691.27	$ 911.27
13-18 months	$ 256.66	$ 451.98	$ 708.64
19-24 months	$ 256.66	$ 372.22	$ 628.88
25-30 months	$ 218.89	$ 239.28	$ 458.17
Total			**$ 2,707**

Source: FEMA Updated Social Sustainability Methodology Report

4. Identify Impacted Population and Calculate Costs

Analysts consider the total number of residents in Marina Village projected post-development that experience flooding during a 0.2 percent annual chance event as impacted. The cost per person was applied to the total number of Marina Village residents expected to be impacted by flooding. Per FEMA methodology, analysts do not annualize benefits; rather, benefits at the design level of protection (the 0.2 percent annual chance flood event) are incorporated into the BCR as a one-time benefit: **$1,050,280**.

3.1.3.3 Assumptions

- Research is limited to 30 months after a disaster; therefore, estimated losses avoided are limited to this period. Mental health avoided losses beyond two and a half years after a disaster, though expected, are not valued in this analysis.
- Benefits are calculated for only 41 percent of the impacted population because research indicates that only that portion of the population with mental health issues can be expected to seek treatment. This significantly lowers the calculated treatment costs and does not consider the full costs to society.
- The analysis does not consider population growth.
- The value of treatment is a national figure and does not consider local costs.

3.1.4 Lost Productivity

FEMA's standard values for mental health impacts also include lost productivity due to mental stress and anxiety. Historical impacts indicate that mental health issues will increase after a disaster, and this, paired with research related to lost productivity due to mental illness, indicates that economic productivity can be impacted by an increase in mental health issues post-disaster.[18] A study of 19 countries by the World Health Organization showed a lifetime 32 percent reduction in earnings for respondents with mental illness.[19] Implementation of the RBD project will help reduce the number of stressors caused by natural disasters, thereby reducing mental health impacts. Fewer mental health impacts will reduce lost work productivity.

17 Costs normalized to 2015 dollars using the CPI calculator located at: http://data.bls.gov/cgi-bin/cpicalc.pl?cost1=623.63&year1=2008&year2=2015

[18] Insel, Thomas. Assessing the Economic Costs of Serious Mental Illness. American Journal of Psychiatry. 165:6 June 2008. / Kessler et al. Individual and Societal Effects of Mental Disorders on Earnings on the United States: Results from the National Comorbidity Survey Replication. American Journal of Psychiatry. 165:6. June 2008.

[19] Levinson, et al. 2010. Associations of Serious Mental Illness with Earnings: Results from the WHO World Mental Health Surveys. British Journal of Psychiatry. August; 197(2): 114–121. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2913273

3.1.4.1 Data Sources

- **FEMA's Final Sustainability Benefits Methodology Report (2012):** This report provides a method to calculate the cost of lost productivity after a flood event.
- **US Census Bureau American Community Survey (2014) 5-Year Estimates:** Analysts use the average number of workers per household and persons per household from this data source to determine the number of impacted workers.
- **Direct Physical Damages:** Analysts use flood depths from Section **2.1.1 Direct Physical Damages – Buildings and Contents** to identify impacted buildings and population.
- **Structure Population:** provides the number of people expected to reside in impacted buildings.

3.1.4.2 Approach

FEMA's Final Sustainability Benefits Methodology Report that accompanies the FEMA BCA Toolkit is the primary resource used to estimate lost productivity.

1. Determine the Value of Work Productivity

Analysts first established the value of work productivity per FEMA's methodology:

$$Loss\ of\ Work\ Productivity = (EC_{NA} \times H_{NA}) \times 25.5\%$$

Where:

EC_{NA}: Average Employment Compensation

H_{NA}: Average Number of Hours Worked per Day

FEMA references Levinson et al (2010)[20] in which research was conducted using the World Health Organization's Mental Health Surveys in 19 countries; the study found that individuals in the United States with mental health illnesses experience as much as a 25.5 percent reduction in earnings. The national average for employment compensation in March 2015 was $33.49 per hour.[21] This, multiplied by the average number of hours worked per day (6.9),[22] produces a daily U.S. value of $231.08. Thus, a 25.5 percent reduction in earnings would equal a loss of $58.90 daily, or $1,767 per capita, monthly.

2. Determine Prevalence Rates

Analysts apply $1,767 to the amount of time lost productivity is expected to occur, 30 months. Prevalence factors from Schoenbaum (2009) are used to adjust the value of productivity loss over 30 months, to account for the fact that only a portion of the population will experience mental health impacts post-disaster. The prevalence factor is based on severe mental health issues because there is insufficient literature to document the impacts of mild/moderate mental health issues on productivity.[23] Accounting for prevalence, the value of work productivity for 30 months is **$3,394** per capita, monthly.

20 Levinson, et al. 2010. Associations of Serious Mental Illness with Earnings: Results from the WHO World Mental Health Surveys. British Journal of Psychiatry. August; 197(2): 114–121. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2913273
[21] Employer Costs for Employee Compensation. March 2015. United States Department of Labor, Bureau of Labor Statistics.
[22] Average week hours of overtime of all employees. Web page. Located at: http://www.bls.gov/news.release/empsit.t18.htm
23 FEMA. 2014. Updated Social Benefits Methodology Report. December 18.

3. Identify Impacted Population

Analysts consider the total population in residential buildings that experience flooding during a 0.2 percent annual chance event as impacted. Population data and the average number of persons per household (2.72) determined the number of households projected to be in the Marina Village redevelopment. Analysts apply the average number of workers per household in Bridgeport (1.35 workers) to the number of households impacted to determine the number of wage earning residents who will experience flooding. The total lost productivity share per worker for 30 months ($3,394) is multiplied by to the number of wage-earning residents who will experience flooding to value productivity losses avoided. Analysis results are **$653,610**; analysts incorporate benefits into the BCR in the same fashion as mental stress and anxiety benefits.

3.1.4.3 Assumptions

- Analysts assumed that the average number of workers per household and the average number of persons per household for Bridgeport is applicable to the project area.
- Value is provided for the first 30 months only because there is insufficient literature available to analyze longer periods of time.
- Prevalence rates are based on severe mental issues because there is insufficient literature related the impacts of mild or moderate mental health problems on work productivity. Thus, analysts consider results as conservative.
- The analysis does not account for population growth.

3.2 Dry Egress

Dry egress is a development practice in Connecticut that requires critical developments, such as public housing, located within the 500-year floodplain, to have a means of evacuation, as well as route for emergency vehicles, constructed to the 500-year flood elevation plus 2 feet.[24] Elevated roads also prevent residents from being stranded during flood events, reduce flood damage, reduce the need for water rescues, and increase public safety. The RBD project will provide dry egress for the Marina Village redevelopment site, as well as a shorter route to access dry egress for Seaside Village residents and adjacent properties. Dry egress will be constructed to the 500-year flood elevation plus 3 feet to account for future SLR. The BCA captures the benefits of dry egress by evaluating the value of road service and avoided casualties.

3.2.1 Loss of Roadway Service

Transportation assets and systems in the South End may flood during both acute and chronic events. Loss of roadway service is a function of the per-hour value of time, detour route, and number of vehicles evacuating. Analysts focused on the future residents of the Marina Village redevelopment that will benefit from dry egress.

24 “A Guide for Higher Standards in Floodplain Management”. Association of State Floodplain Managers. October 2010.

3.2.1.1 Data Sources

- **FEMA Benefit-Cost Analysis Re-Engineering (BCAR) Development of Standard Economic Values:** provides a standard value of detour lost time per vehicle.
- **The New England Hurricane Evacuation Study (2016):** provides the average number of vehicles per household and Bridgeport specific evacuation rates.
- **Fairfield County FIS and Flood Insurance Rate Map:** This data is overlaid with buildings to determine potential evacuation routes.
- **Direct Physical Damages:** Analysts used flood depths for each structure to identify impacted buildings and residents.

3.2.1.2 Approach

This FEMA methodology is centered around the value of time, which is described in FEMA's Benefit Cost Analysis Re-Engineering Guide, Development of Standard Economic Values report. In summary, analysts evaluate additional travel time needed for an alternative travel route because floodwaters inundate a roadway. The following equation characterizes roadway loss of service:

$$Roadway\ Loss\ of\ Service = \left[\left((UpPD \times ER) \times VpH \times VT\right) \times DT\right] \times TV$$

Where:

UpPD: Number of Units per Property Description

ER: Expected Evacuation Rate

VpH: Average Number of Vehicles per Household

VT: Vehicle Trips to Evacuate

DT: Delay Time

TV: Hourly Value of Time per Vehicle

1. Evaluate Evacuation Routes and Determine Delay Time

Analysts reviewed the FEMA flood zones and found floodwaters would inundate future Marina Village resident's evacuation route during a 2 percent annual chance flood event. When no alternative route is available, FEMA uses a delay time of 12 hours as a standard value.[25]

2. Identify Impacted Population and Evacuating Vehicles

Analysts apply the average vehicles per household sourced from the New England Hurricane Evacuation Study (2016) to the total the number of households projected to be in Marina Village, determined in Section **2.1.4 Lost Productivity**. Analysts factor evacuation rates into the analysis to account for residents that choose to shelter in place. Analysts assumed vehicles trips during an evacuation scenario to be one.

[25] FEMA Supplement to the Benefit-Cost Analysis Reference Guide (2011). Page 5-14. http://www.fema.gov/media-library-data/1396549910018-c9a089b8a8dfdcf760edcea2ff55ca56/bca_guide_supplement__508_final.pdf

3. Determine the Value of Lost Time

To place a monetary value on lost roadway service, analysts normalized and applied FEMA's value of lost time to the total number of evacuating vehicles: $32.09 per hour.[26] **Table 11** summarizes flood impacts to road service by flood scenario.

Table 11. Loss of Road Service Results by Flood Scenario

10 Percent Annual Chance Event	2 Percent Annual Chance Event	1 Percent Annual Chance Event	0.2 Percent Annual Chance Event	Annual Losses Avoided
-	$82,650	$82,650	$82,650	$10,910

Losses remain consistent across each flood event because the once floodwaters inundate the roadway residents may no longer use the road, regardless of an increase in flood elevation.

3.2.1.3 Assumptions

- Analysts assume one person per each evacuating vehicle, therefore results are conservative.
- FEMA's Supplement to the Benefit-Cost Analysis Reference Guide states that "For road or bridge losses that do not have detours, the number of daily trips should be based on the number of one-way trips, and the delay time should be 12 hours per one-way trip."
- The analysis does not account for population growth.

3.2.2 Casualties

Casualties, which include loss of life and injuries, are an unfortunate risk inherent to hazard events. Flood events are considered some of the most frequently occurring natural hazards, contributing to 44 percent of natural hazard-related fatalities worldwide.

The approach chosen to estimate reduced fatalities within the future Marina Village redevelopment is based on a study completed by the Brno University of Technology in 2013.[27] Through this approach, analysts consider the number of fatalities expected at different flood scenarios. Additional data required to supplement the Brno approach include standard life safety values from the Federal Aviation Administration (FAA): the FAA's Willingness to Pay value for one fatality is $5.8 million.

Casualties also includes injuries related to identified flood events. In October 2014, the CDC published another report titled "Nonfatal Injuries 1 Week after Hurricane Sandy." The report suggests that 10.4 percent of residents in the inundation zone were injured within the first week after Hurricane Sandy, mostly during attempts to evacuate or navigate and clean up debris.

3.2.2.1 Data Sources

- **US Census Bureau ACS 5-Year Estimate:** provides the population expected to reside in the Marina Village redevelopment; estimates are based on building square footage and total population within a census block.
- **The New England Hurricane Evacuation Study (2016):** provides local evacuation rates.

[26] Normalization in this report refers to the process of converts past dollar values to current dollar values using the CPI inflation calculator.
[27] Brazdova, M. and J. Riha. 2014. A simple model for the estimation of the number of fatalities due to floods in central Europe. Nat Hazards Earth Syst Sci. 14. June 12.

- **Federal Aviation Administration (FAA) values:** The Federal Aviation Administration (FAA) categorizes injuries and fatalities as shown in **Table 12**. FEMA has acknowledged the validity of these life safety values and permits their use in benefit cost analyses.
- **CDC injury rates:** The CDC report from October 2014 titled "Nonfatal Injuries 1 Week after Hurricane Sandy" estimates 10.4 percent of residents in the inundation zone were injured within the first week of Hurricane Sandy.
- **Brno University of Technology fatality risk methodology:** the approach is based on three main factors: materials loss, population preparedness, and warning.

3.2.2.2 Injuries

To quantify the value of injuries, analysts developed the below equation based on the CDC study titled "Deaths Associated with Hurricane Sandy". Analysts assumed that all injuries reduced are FAA AIS1 minor injuries. This injury category is the lowest value within the FAA study ($13,590[28]) allowing for a conservative analysis of injuries associated with a flood event.

$$Value\ of\ Injuries = \left(Population \times (1 - Evacuation\ Rate)\right) \times 10.4\% \times \$13{,}590$$

Table 12. FAA Category Levels and Values[29]

Injury Category	Description of Injury	Fraction of WTP Value of Life (Percent)	WTP Value (2008 Dollars)
AIS 1	Superficial abrasion or laceration of skin; digit sprain; first-degree burn; head trauma with headache or dizziness (no other neurological signs).	0.20	$12,000
AIS 2	Major abrasion or laceration of skin; cerebral concussion (unconscious less than 15 minutes); finger or toe crush/amputation; closed pelvic fracture with or without dislocation.	1.55	$90,000
AIS 3	Major nerve laceration; multiple rib fracture (but without flail chest); abdominal organ contusion; hand, foot, or arm crush/amputation.	5.75	$334,000
AIS 4	Spleen rupture; leg crush; chest-wall perforation; cerebral concussion with other neurological signs (unconscious less than 24 hours).	18.75	$1,088,000
AIS 5	Spinal cord injury (with cord transection); extensive second- or third- degree burns; cerebral concussion with severe neurological signs (unconscious more than 24 hours).	76.25	$4,423,000
AIS 6	Injuries, which although not fatal within the first 30 days after an accident, ultimately result in death.	100	$5,800,000

[28] Normalized to current dollars using the Consumer Price Index inflation calculator.
[29] Revised Departmental Guidance: Treatment of the Value of Preventing Fatalities and Injuries in Preparing Economic Analyses. Located at: https://www.faa.gov/regulations_policies/policy_guidance/benefit_cost/media/Revised%20Value%20Of%20Life%20Guidance%20Feburary%202008.pdf

Source: Revised Departmental Guidance: Treatment of the Value of Preventing Fatalities and Injuries in Preparing Economic Analyses.

3.2.2.2.1 Approach

1. Identify Impacted Population

Analysts consider the number of residents in Marine Village that experience flooding during the 0.2 percent annual chance event and did not evacuate as the impacted population.

2. Estimate and Value Injuries

Analysts apply 10.4 percent to the total impacted population, then the value of injury to determine the monetary cost of injuries. The CDC report *Nonfatal Injuries 1 Week after Hurricane Sandy* found the rate of injuries among impacted persons to be 10.4 percent.[30] **Table 13** summarizes the results of the injury analysis.

Table 13. Injury Analysis Results

Percent Annual Chance Event	Value of Injuries
10 Percent	-
2 Percent	$146,990
1 Percent	$244,510
0.2 Percent	$548,380
Annual Injuries Avoided	*$6,480*

3.2.2.2.2 Assumptions

- The results are based on historical data from a CDC survey conducted 5 to 12 months after Hurricane Sandy. The timing of the evaluation, coupled with the fact that the data is only available for one event, increases uncertainty. Nevertheless, the study performed is in an area like the project area, which means that conditions under which the survey was completed are largely transferable. The survey is thus an appropriate source from which to transfer expected results.
- Injuries reported are only for a one-week period following Hurricane Sandy. The analysis does not account for injuries sustained while repairing damages from Sandy more than one week following the event.
- Estimated injuries are all considered minor; the BCA does not account for moderate or serious injuries.
- The BCA evaluates people with multiple injuries the same as people with only one injury.
- The analysis does not include people in buildings that do not experience flooding, and neither are injuries sustained because of road damage and closures.
- The BCA does not consider worker and transient populations.
- The BCA does not account for population growth.

[30] CDC report titled "Nonfatal Injuries 1 Week after Hurricane Sandy," October 2014, page 1. http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6342a4.htm

3.2.2.3 Fatalities

Most existing methodologies that estimate fatalities use two groups of characteristics: hydraulic characteristics such as water depth, rate of water rising, flow velocities, wind, and temperature; and by area characteristics including factors such as population density, land use, warning systems, and vulnerability of the population.[31] Arcadis analysts considered material loss, population preparedness, rate of water rise, and warning capabilities. This approach is the most appropriate because it accounts both for event damage characteristics and the community's capacity to prepare for and react to flood events, both of which relate to vulnerability.

3.2.2.3.1 Approach

The Brno University of Technology approach is based on three main factors: material loss (in dollars), population preparedness, and warning. The equation presented below expresses the relationship of these factors. There are additional factors that are important to consider in estimating the loss of life in a natural hazard event. Nevertheless, factors such as debris, climatic conditions, water quality, and time of day, were not available for analysis due to a lack of data.

The equation for fatality estimates:

$$LOL = 0.075 \times D^{0.384} \times (P+2)^{-3.207} \times (W+2)^{-1.017}$$

Where:

LOL: Loss of Life

D: Material Loss ($)

P: Population Preparedness (aggregated population preparedness factors)

W: Warning (factor-based)

1. Determine D, W, and P Factor

(i) D Factor

The D factor (material loss) consists of building damage and contents loss, which analysts estimated in direct physical damages analysis. For the purposes of this analysis, analysts evaluated only structure and contents damage for residential structures for the appropriate flood scenarios. Analysts assumed these losses reflect both the destructive ability of the event and the number of endangered inhabitants. The analysis does not consider damage to constructed assets, such as roads or utility systems. The values used as D in the formula are listed in **Table 14.**

[31] Jonkman, S.N. and J.K. Vrijling. 2002. Loss of life models for sea and river floods. Flood Defence. Wu et al. (eds) Science Press, New York Ltd.

Table 14. Expected Material Loss (D) Values by Percent Annual Chance Flood Event

Percent Annual Chance Flood Event	Expected Material Loss
10 Percent	$4,333,630
2 Percent	$7,905,860
1 Percent	$9,795,560
0.2 Percent	$15,625,020

(ii) P Factor

The P Factor (population preparedness) expresses the preparedness of the community for flood management and resiliency, and it reflects the population's general awareness of flooding and required preparations. Analyst determined this value by rating eight sub-factors on a scale of -1 to 1 (**Table 16**).

The evaluation of the P sub-factors is based on existing conditions within the project area community. The flood knowledge held by the public in Bridgeport greatly increased after Hurricanes Sandy and Irene. Analysts evaluated the P sub-factors to determine the below ratings for P1 to P8. Because of the frequency and amount of flood prevention and awareness activities present in Bridgeport, analysts assumed that the same P subfactors apply for all four flood scenarios. Analysts found the final P Factor using the equation below, where P is the aggregated preparedness score presented in **Table 15**. **Table 16** describes P subfactors.

$$P = \frac{1}{8} * \sum_{i=1}^{8} Pi$$

Table 15. P Values

P Subfactor	Factor Description	Existing Conditions Evaluation
P_1	Flood awareness and general knowledge of hazards	1
P_2	Flood memory	1
P_3	Existing flood documentation	1
P_4	Understanding of activities and behavior during floods	0
P_5	Initiatives and activities of flood committees	0
P_6	Response to hydrological forecast	0.5
P_7	Response to flood warning	0
P_8	Evacuation and rescue activities	1
Aggregated Preparedness		**2.125**

Table 16. P Factor Descriptions

P_i	Score				
	-1.0	**-0.5**	**0.0**	**0.5**	**1.0**
P_1	No flood awareness or knowledge about flood hazard, sometimes ignorance	Poor awareness, underestimation of flood hazard	Common flood awareness	Fair knowledge about flood hazards obtained mostly from the media	Excellent knowledge about flood hazards via the media, education, training, etc.
P_2	Area never flooded, no experience with flooding	Area flooded decades ago, poor records concerning flood losses	Area flooded decades ago, good records concerning the risks	Flooding still in the memory of the population	Personal experience with flooding
P_3	Flood extent maps or flood management plans not available	Existing flood extent maps are outdated	Flood extent maps drawn up based on current hydrologic data, but only poor flood management plans exist	Flood extent maps drawn up, flood management and evacuation plans available	Flood extent maps drawn up, updated digital versions of flood management and evacuation plans available
P_4	Individuals have no idea about actions to take during floods	Limited (vague) understanding of what to do during floods	General understanding of what to do before and during a flood	Quite good knowledge of flood management plans and corresponding activities	Perfect knowledge of flood management plans and understand of what to do in the event of flooding, good preparedness
P_5	No flood committee established	Flood committee established but not trained, only equipped with flood fighting facilities	Flood committee established and generally trained, poorly equipped with flood-fighting facilities	Only moderately experienced but trained committee with standard flood fighting facilities	Experienced and well-trained flood committee equipped with flood-fighting facilities
P_6	No response to hydrological forecast, no understanding or belief	Poor understand of hydrological forecast and poor response	Approximate understanding of forecast and adequate response	Fair understanding of hydrological forecast and good response	Very good understanding of hydrological forecast and very good response
P_7	No response to warning, no idea about warning procedures and response	Only poor response to warning, warning system not trusted	Adequate response	Good response to warning	Immediate and fast response to warning
P_8	Rescue system does not exist, no staff or equipment available	Organized rescue system does not exist, volunteer basis, no trained staff available with randomly acquired equipment	Poorly organized but functioning rescue system, basic rescue equipment of adequate quality	Functioning rescue system, trained staff with equipment of fair quality	Efficiently functioning rescue system, well-trained, experienced and well-equipped personnel

(iii) W Factor

The W factor (warning) includes factors that influence warning of the community that an event is forecasted. The contributing factors include a hydrological forecast, the type of warning system employed, the speed of flooding, and the rate of water level rise; as these factors are somewhat based on the frequency and extent of flooding, analysts evaluate the W Factor for each flood scenario. **Table 17** shows the scale of sub-factors.

Table 17. W Factor Descriptions

W_i	Score				
	-1.0	-0.5	0.0	0.5	1.0
W_1	No hydrologic forecast, forecast not possible (e.g. at small catchments)	Only vague and general forecast	General forecast for medium size catchment	Hydrologic forecast provided in a standard way by hydrologic services	Reliable hydrologic forecast based on contemporary technical and modelling techniques
W_2	Flood may arrive within several tens of minutes	Flood arrives faster than 45 min	Flood arrives within several hours	Flood arrives within 1 day	Flood arrives within several days
W_3	Warning system does not exist	Poorly designed and functioning warning system	Only moderately reliable warning system	Fully functioning traditional warning system	Sophisticated warning system including digital online alarm systems
W_4	Water rises at a rate of several meters per hour (floods in 1998, 2009)	Water level rise about 1 m per hour (small catchments in 2013)	Rate of several meters per day	About 1 m per day (floods in 1997, 2002)	Water level rise of several meters over several days

For factor W4, water rise rates are based on event data. **Table 18** provides evaluations for W_1 to W_4 values for each flood scenario. The aggregated effect of Factor W was evaluated using the equation below, here W is the sub-factor score.[32]

$$W = \frac{1}{4} * \sum_{i=1}^{4} Wi$$

Table 18. W Values

W Subfactor	Subfactor Description	Existing Conditions (10 Percent)	Existing Conditions (2 Percent)	Existing Conditions (1 Percent)	Existing Conditions (0.2 Percent)
W_1	Reliability of hydrological forecast	0.5	0.5	0.5	0.5
W_2	Speed of flood arrival	1.0	1.0	1.0	0.5
W_3	Warning system	1.0	1.0	1.0	0.5
W_4	Rate of water level rise	0.0	0.0	0.0	-0.5
Aggregated Warning Factor Score (W Factor for each flood scenario)		**1.38**	**1.38**	**1.38**	**0.25**

32 Brazdova, M. and J. Riha. 2014. A simple model for the estimation of the number of fatalities due to floods in central Europe. Nat Hazards Earth Syst Sci. 14. June 12.

2. Value Loss of Life

Loss of life is estimated for each flood scenario by placing all determined factor values (D, P, and W) into the previously mentioned equation.

For example, the calculation to determine the number of casualties in the 1 percent annual chance event scenario includes:

D Value = $1,608,409,580
P Value = 2.13
W Value = 1.38

$$0.79 = 0.075 * \$1{,}608{,}409{,}580^{0.384} * (2.13 + 2)^{-3.207} * (1.38 + 2)^{-1.017}$$

Analysts apply Federal Aviation Administration's (FAA) Willingness to Pay values for a fatality ($5.8 million) to value loss of life.

Table 19. Estimated Fatalities Avoided by Flood Scenario

Percent Annual Chance Event	Estimated Fatalities	Value of Lost Life
10 Percent	0.08	$564,290
2 Percent	0.10	$710,820
1 Percent	0.11	$771,800
0.2 Percent	0.13	$923,370
Annual Fatalities Avoided	-	*$80,210*

3.2.2.3.2 Assumptions

- The analysis does not account for road and non-structural asset damages.
- Loss of life post-disaster can be affected by many factors not considered in this methodology, including the financial and physical health of the population, mental stress and anxiety, and other factors.
- Fatalities may not be calculated on a per-structure basis due to the nature of P values, which consider the flood preparedness characteristics of the whole study area population.
- The analysis does not account for population growth.

4 VALUE ADDED BENEFITS

Beyond improving Bridgeport's flood resiliency by reducing acute and chronic flood impacts to public housing and residents, the RBD project intends to foster community cohesion, generate economic opportunities, improve the natural environment, and stimulate redevelopment through growth, prosperity, awareness, and beauty. Analysts consider added value benefits, in addition to resiliency benefits, when comprehensively analyzing increased community resilience: Investment in increased flood resilience may foster commercial and residential redevelopment, in turn, promoting a more diverse and healthy economy. A resilient environment can provide protective services that stabilize and contribute to improved air and water quality, and may also help improve resident's health. Community gathering space provides an opportunity for increased social interactions and cohesion, creating additional networks for support during and after disaster events.

Value added benefits include social, environmental, and economic revitalization benefits resulting from the RBD project. These benefits include:

- Social benefits in the form of recreational value;
- Aesthetic benefit generated from making the surroundings more desirable for businesses and residents;
- Environmental benefits in the form of reduced energy use, air pollution, water pollution, and carbon dioxide emissions; and,
- Economic revitalization benefits related to added commercial space.

Table 20 relates RBD project elements to value added benefit categories.

Table 20. Value Added Benefit Matrix

Benefit Category		Measurable Benefit/Metric	Stormwater Park						Johnson Street Extension				Marina Village Redevelopment
			Trees	Shrubs	Green Space	Sidewalks	Playground	Basketball Courts	Trees	Shrubs	Bio-Retention	Sidewalks	
Value Added Benefits	Social	Recreation			X	X	X	X					
Value Added Benefits	Social	Aesthetic	X	X	X	X	X	X	X	X	X	X	
Value Added Benefits	Environmental	Water Quality (CSO)			X						X		
Value Added Benefits	Environmental	Ecosystem Services	X	X	X				X	X	X		
Value Added Benefits	Economic	Revitalization											X

4.1 Social Benefits

Urban parks and green space help improve the quality of life and social sustainability of cities by providing recreation opportunities and aesthetic enjoyment, promoting physical health, contributing to psychological well-being, enhancing social ties, and providing opportunities for education.[33] The RBD project's multifunctional stormwater park will be a new public amenity in the neighborhood, and includes basketball courts, a playground, sidewalks, green open spaces, and passive seating areas. The new stormwater park will provide opportunity for residents to participate in recreation activities, environmental education, and community programs, thereby enhancing their health and well-being, increasing social capital[34] and improving the quality of life in the greater community.[35]

4.1.1 Recreation Benefits

Recreation benefits quantify the consumer value of increased outdoor recreation expected to occur after completion of the new stormwater park. There are federally approved methods to quantify the value of new outdoor recreation opportunities: the low value method is based on FEMA's Final Sustainability Benefits Methodology Report, and assigns a value per square foot of recreational space. The high value method uses United States Army Corps of Engineers (USACE) Unit Day Values to value an increase in recreation activity. The medium method is the average results of high and low estimated benefits.

4.1.1.1 Data Sources

- **FEMA's Final Sustainability Benefits Methodology Report (2012):** provides a recreational value per acre of space. Refer to **Appendix F: Additional Benefit Cost Analysis Resources** for a summary of FEMA's standard values.
- **USACE Economic Guidance Memorandum, 16-03, Unit Day Values for Recreation for Fiscal Year 2016 (2015):** provides a daily recreational value by type of recreation activity.
- **RBD Project Design Drawings:** provide the total area of park features.

4.1.1.2 Approach

Analysts implemented two federal methods to evaluate the stormwater parks recreation benefits. These methods are described in detail below.

4.1.1.2.1 FEMA: Low Value Method

FEMA generates an annual recreational value per unit area using nationwide, rural, and urban willingness to pay studies.[36] Analysts normalized[37] and converted FEMA's standard annual recreational value per acre to current dollars per square foot: $0.13. Analysts apply this value to the total area of new park amenities to estimate the annual recreational value. **Table 21** summarizes results of the low value method by park feature.

33 Zhou, X. and M.P. Rana. 2011. Social benefits of urban green space. A conceptual framework of valuation and accessibility measurements. Management of Environmental Quality: An International Journal.
34 Gomez, E., Baur, J.W.R., Hill, E., and S. Georgiev. 2015. Urban Parks and Psychological Sense of Community. Journal of Leisure Research.
35 Lestan, K.A., Erzen, I., and M. Golobic . 2014. The Role of Open Space in Urban Neighbourhoods for Health-Related Lifestyle. 2014. International Journal of Environmental Research and Public Health. June
36 FEMA uses the benefit transfer methodology to apply the results of previously conducted primary studies to another geography.
37 Normalization in this context refers to converting past dollar values to current dollar values using the Consumer Price Index (CPI) Inflation Calculator: http://www.bls.gov/data/inflation_calculator.htm.

Table 21. Stormwater Park Low Annual Recreation Benefit

Park Feature	Square Feet	Annual Recreation Benefit
Playground	11,613	$1,510
Basketball	9,152	$1,190
Sidewalks	6,334	$820
Green Open Space	38,069	$4,950
Total	**65,168**	**$8,470**

4.1.1.2.2 USACE: High Value Method

The USACE produces Unit Day Values (UDV)[38] based on expert or informed opinion and judgement to estimate the average willingness to pay for recreation resources. Analysts calculate recreation benefits by applying the UDV to a park feature's expected useful life. The Federal government generates standardized average estimated useful life values that analysts used for the analysis. [39] UDVs provide a range of possible recreation values based on activity type, general or specialized recreation. Analysts used the lowest value available for general recreation ($3.90) to produce conservative estimates. **Table 22** provides results of the high value method by park feature.

Table 22. Stormwater Park High Annual Recreation Benefit

Park Feature	Expected Useful Life (Years)	Annual Recreation Benefit
Playground	10	$14,240
Basketball	25	$35,590
Sidewalks	50	$71,180
Green Open Space	100	$142,350
Total	**185**	**$263,350**

4.1.1.2.3 Medium Value Method

Analysts found the medium recreation benefit value by averaging the results of the low and high value methods (**Table 23**).

Table 23. Stormwater Park Medium Annual Recreation Benefit

Park Feature	Low Benefit Value	High Benefit Value	Medium Benefit Value
Playground	$1,510	$14,240	$7,870
Basketball	$1,190	$35,590	$18,390
Sidewalks	$820	$71,180	$36,000
Green Open Space	$4,950	$142,350	$73,650
Total	**$8,470**	**$263,350**	**$135,910**

38 United States Army Corps of Engineers. 2016. Economic Guidance Memorandum, 16-03 Unit Day Values for Recreation for Fiscal Year 2016. Located at: http://planning.usace.army.mil/toolbox/library/EGMs/EGM16-03.pdf
39 Fannie Mae. Instructions for Performing A Multifamily Property Conditions Assessment. Appendix F. Estimated Useful Life Tables. Located at: https://www.fanniemae.com/content/guide_form/4099f.pdf

4.1.1.3 Assumptions

- The results of previously conducted studies are applicable to the project area. The FEMA annual recreation value relies on studies that are limited in scope, but FEMA considers these studies applicable nationwide. This approach does not consider location-specific factors known to impact the results of recreation studies, such as population density, age, and income distribution.[40]

4.1.2 Aesthetic Benefits

The RBD project will integrate concepts of green infrastructure into the Johnson Street Extension; thoughtful "green street" design coupled with the new stormwater park will create a more appealing project area to existing and future residents. This attention to aesthetic detail may create a positive effect for residential property and the local economy. One measurable example of an aesthetic benefit that can contribute to this positive effect is attractive views and willingness to pay for these views. The benefits of increased aesthetic amenities, including attractive views, may be quantified through hedonic pricing demonstrated in the housing market, and on a standard value-per-square foot basis.

4.1.2.1 Data Sources

- **FEMA's Final Sustainability Benefits Methodology Report (2012):** provides an aesthetic value per acre of space. Refer to **Appendix F: Additional Benefit Cost Analysis Resources** for a summary of FEMA's standard values.
- **United States Department of Agriculture (USDA) Northeast Community Tree Guide: Benefits, Costs, and Strategic Planting (2007):** provides annual aesthetic value per tree.
- **RBD Project Design Drawings:** provide the total area of park features and total number of new trees.

4.1.2.2 Approach

FEMA's Final Sustainability Benefits Methodology Report uses the benefit transfer methodology[41] to convert results of hedonic pricing studies to a nationwide annual aesthetic value per acre. Analysts normalized this value to 2016 dollars and converted it to square feet; this value is $0.04 per square foot annually. Analysts apply this value to the total area of the new multiuse stormwater park to value aesthetic benefits. **Table 24** summarizes aesthics benefits by project element and feature.

Table 24. Summary of Aesthetic Benefits by Project Element

Project Element	Feature	Square Feet	Annual Aesthetic Benefit
Stormwater Park	Playground	11,613	$470
	Basketball	9,152	$370
	Sidewalks	6,334	$250

[40] Brander, L.M. and M.J. Koetse. 2011. The Value of Urban Open Space: Meta-analyses of contingent valuation and hedonic pricing results. Journal of Environmental Management. 92 (2011) 2763-2773. October
41 The benefit transfer method applies the results of previously conducted primary studies to another geography.

Project Element	Feature	Square Feet	Annual Aesthetic Benefit
	Paving	26,645	$1,070
	Green Open Space	38,069	$1,520
	Shrubs	2,740	$110
Johnson Street Extension	Shrubs	4,720	$190
	Bio-retention	9,372	$380
	Sidewalks	9,334	$370
	Paving	10,286	$410
	Total	**128,265**	**$5,130**

New trees may also increase the aesthetic quality of the surrounding area. The U.S. Forest Service's Northeast Community Tree Guide (2007) provides an annual asethetic value per public tree ($32.84). Analysts normalized this value to 2016 dollars ($38.44), and applied it to the total number of added trees to generate annual benefits. **Table 25** summarizes the annual aesthetic benefit of new trees.

Table 25. Annual Aesthetic Benefits of New Trees

Project Element	Number of Trees	Annual Aesthetic Benefit
Stormwater Park	81	$3,110
Johnson Street Extension	66	$2,540
Total	**147**	**$5,650**

4.1.2.3 Assumptions

- Analysts assumed that the results of previously conducted studies, used by FEMA to determine standard values, are transferable to the project area. FEMA values are based on studies FEMA considers to be applicable nationwide. Research indicates that higher population density results in a considerable increase in the value of urban parks and open space.[42] The analysis does not capture increased value in urban areas due to the use of FEMA standard figures.
- The Northeast Community Tree Guide provides values for small, medium, and large tree. Analysts assumed that the added trees are fully developed medium-sized trees; therefore, the benefits calculated pertain to medium trees.
- The USDA's Northeast Community Tree Guide accounts for tree morbidity over time (33.95 percent); therefore, it is not included as a separate function in the calculation.

[42] Brander, L.M. and M.J. Koetse. 2011. The Value of Urban Open Space: Meta-analyses of contingent valuation and hedonic pricing results. Journal of Environmental Management. 92 (2011) 2763-2773. October

4.2 Environmental Benefits

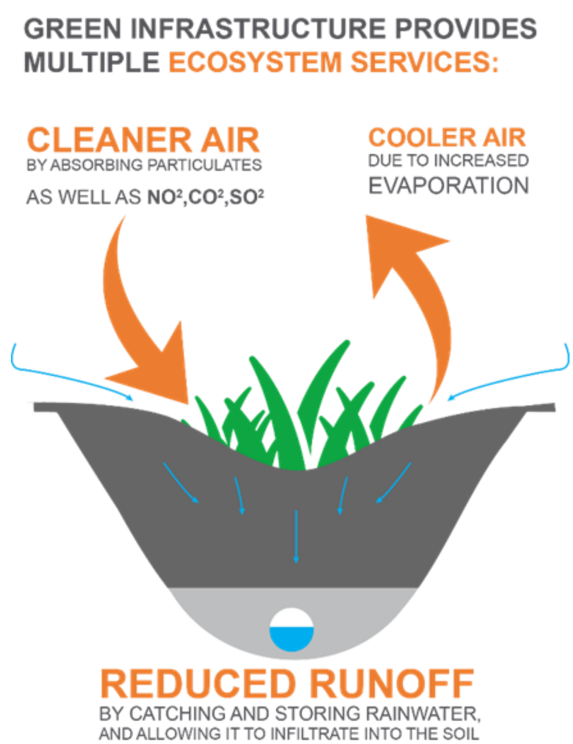
The RBD project proposes to add new natural vegetation that will produce a range of environmental benefits, also known as ecosystem goods and services. Ecosystem goods and services provided by natural vegetation may be quantified to estimate their economic benefit to society. Such benefits can be categorized through measures such as carbon sequestration, air pollutant reduction, energy savings, increase in water quality, and pollination. The RBD also implements stormwater management measures that will reduce water treatment needs and environmental impact of CSO events. Environmental benefits are grouped into two categories based on valuation methods: those associated with the ecosystem goods and services and those associated with reduction CSO events.

4.2.1 Ecosystem Goods and Services

Natural capital is the world's stock of natural assets, such as soil, air, water, and all living things that provide a good or service that benefits society. For example, natural capital, such as forests and soils, provide the ecosystem service of filtering water independent of treatment plants.

Ecosystem services are grouped into four broad categories:[43]

- **Provisioning services:** produce physical materials that society uses such as minerals, gases, and living things;
- **Regulating services:** create and maintain a healthy environment such as climate stability and flood protection;
- **Supporting services:** maintain conditions for life such as habitat and genetic diversity; and,
- **Cultural services:** provide meaningful human interaction with nature including spiritual, recreational, aesthetic, educational, and scientific uses. Sections **3.1.1 Recreation Benefits** and **3.1.2 Aesthetic Benefits** describe the methods used to evaluate these benefits.



4.2.1.1 Data Sources

- **FEMA's Final Sustainability Benefits Methodology Report (2012):** provides an annual ecosystem service value per acre of green space. Refer to **Appendix F: Additional Benefit Cost Analysis Resources** for a summary of FEMA's standard values.
- **United States Department of Agriculture (USDA) Northeast Community Tree Guide: Benefits, Costs, and Strategic Planting (2007):** provides annual environmental benefit values per tree.
- **RBD Project Design Drawings:** provide the total area of green space and number of new trees.

[43] Earth Economics. 2015. Earth Economics Ecosystem Valuation Toolkit. [Web page] Located at: http://esvaluation.org/ecosystem-services/

4.2.1.2 Approach

Table 26 summarizes the approach taken to develop a benefit value per vegetative unit.

Table 26. Approach Summary by Vegetative Type

Vegetation Type	Approach
Tree	Annual benefits per tree are sourced from the USDA's Northeast Community Tree Guide (2007).
Vegetation	Annual benefits per vegetative square foot are sourced from FEMA's Final Sustainability Report (2012).

Analysts normalized benefits values to 2016 dollars and converted FEMA's values to square feet (**Table 27**). These values are applied to the area of new vegetation or total number of new trees to estimate environmental benefits (**Table 28** and

Table 29).

Table 27. FEMA's Annual Environmental Ecosystem Service Values

Ecosystem Service	Value per Square Foot	Value per Tree
Regulating Services		
Climate Regulation	$0.0003	$0.94
Water Retention/Flood Hazard Reduction	$0.0072	$10.57
Air Quality	$0.0050	$7.88
Energy Savings	-	32.72
Support Services		
Erosion Control	$0.0016	-
Pollination	$0.0072	-
Total Environmental Ecosystem Service Value	**$0.1937**	**$52.11**

Table 28. RBD Project Elements Contributing Ecosystem Services

Project Element	Vegetative Unit	Count / Area
Johnson Street Extension	Trees	66
	Shrubs	4720
	Bio-Retention	9,372
Stormwater Park	Trees	81
	Shrubs	2,740
	Green Space	38,069

Table 29. Annual Ecosystem Service Benefits provided by the RBD Project

Ecosystem Service	Johnson Street Extension			Stormwater Park			Total
	Street Trees	Shrubs	Bio-Retention	Trees	Shrubs	Green Space	
Climate Regulation	$62	$2	$3	$76	$1	$12	$160
Water Retention/Flood Hazard Reduction	$698	$34	$68	$856	$20	$275	$1,950
Air Quality	$520	$24	$47	$638	$14	$192	$1,440
Erosion Control	-	$8	$15	-	$4	$61	$90
Pollination	-	$34	$67	-	$20	$272	$390
Energy Savings	$2,160	-	-	$2,650	-	-	$4,810
Total	**$3,439**	**$101**	**$200**	**$4,221**	**$58**	**$813**	**$8,830**

4.2.1.3 Assumptions

- The Northeast Community Tree Guide provides values for small, medium, and large tree. Analysts assumed that the added trees are fully developed medium-sized trees; therefore, the benefits calculated pertain to medium trees.
- The USDA's Northeast Community Tree Guide accounts for tree morbidity over time (33.95 percent); therefore, it is not included as a separate function in the calculation.
- The results of previously conducted studies are applicable to the project area. FEMA values are based on studies FEMA considers to be applicable nationwide.

4.2.2 Combined Sewer Overflow Reduction

A significant added benefit of the RBD project is the ability to retain stormwater. The City of Bridgeport currently uses a combined sewer system. When rain events occur, the City's sewer system can become overwhelmed and untreated wastewater can spill into nearby waterways as a relief mechanism to avoid damaging property or treatment plants; this is commonly referred to as a CSO event. The RBD project proposes to implement a stormwater management features that will capture flow, preventing it from entering the combined sewer system and contributing to CSO events. This water quality benefit is not captured in ecosystems services benefits, therefore requiring a separate analysis.

4.2.2.1 Data Sources

- **Bridgeport Long Term Control Plan:** provided information needed to derive a damage cost.
- **RBD Project Modeling:** provided total CSO reduction volume.

4.2.2.2 Approach

CSOs have a major impact on water quality and pose significant health and safety risks. Bridgeport is acting to meet water quality requirements under the Clean Water Act. The City has developed a Long-Term Control Plan to reduce the frequency of CSO events. The Plan reveals it will cost the City $384,900,000 over 30 years to reduce CSO output by 43 million gallons. Given this information, analysts generated a damage cost for CSO abatement: $0.29 per gallon per year. Analysts modeled CSO reduction at the RBD design event (25-year Natural Resources Conservation Service [NRCS] rainfall event), and applied the damage cost to the total volume of CSO reduction to estimate water quality benefits (**Table 30**).

Table 30. Annual Water Quality Benefits

25 Year NRCS event	Volume (gallons)	Annual Water Quality Benefit
Volume Reduction in CSOs at Outfall	620,000	$3,300

4.2.2.3 Assumptions

- The assessment accounts for runoff that will be retained by the stormwater park and green street's bio-retention features, as well as additional system capacity to manage flow.

4.3 Economic Revitalization

The resilient redevelopment of Marina Village includes added commercial space that will generate economic revitalization benefits. These benefits can be measured through anticipated added economic output and employment compensation. Output is the value of industry production, and employment compensation includes wages and benefits for employees.

4.3.1 Data Sources

- **FEMA's Hazus-MH 3.2:** provides a method to estimate economic losses and gains and provides national output and employment compensation values per square foot.

4.3.2 Approach

Phase I of Marine Village redevelopment includes 10,000 square feet of new commercial space. Analysts normalized Hazus' output per square foot per day and employment compensation per square foot per day, and used the equation below calculate the economic benefits of added commercial space. **Table 31** summarizes annual economic revitalization benefits.

$$\begin{aligned} &\mathit{Added\ Output\ per\ Year} \\ &\qquad = \mathit{Added\ Annual\ Output\ or\ Employment\ Compensation\ per\ Square\ Foot} \\ &\qquad \times \mathit{Added\ Space}\ (\mathit{SF}) \end{aligned}$$

Table 31. Economic Revitalization Benefits

	Marina Village Phase 1	Annual Economic Output
Commercial (square feet)	10,000	$5,400

4.3.3 Assumptions

- The analysis does not account for inflation over time, nor does it consider business turnover, vacancy rates, and changes in future land use for the analysis area.
- Analysts assume revitalization efforts will be successful

5 SENSITIVITY ANALYSIS

The relationship between BCA inputs and outputs requires certain assumptions. To ensure the BCA captures and describes uncertainty related to inputs and outputs, analysts performed a sensitivity analysis. By evaluating a variety of different model inputs, BCA analysts could identify the most appropriate values for use in the analysis and understand how assumptions impact BCA results, and thereby any decisions that may be based on BCA findings. This section provides an understanding of how a change in an uncertain variable will impact the present value of project benefits or costs, and the resulting BCR.

5.1 Analysis Uncertainties, Assumptions, and Limitations

Analysts estimated low, medium, and high benefits when more than one Federal method or value was available to evaluate a project benefit, or when uncertainties result in an alternative assumption in methodology or the use of a different methodology. This BCA report illustrates the range of benefits as low, medium, and high benefit scenarios for the pilot project's recreation and direct physical damage benefits and provides an indication of the differing variables or approaches for these benefits. Analysts limited low, medium-, and high- benefit scenarios to varying Federally approved BCA methods or values; this BCA does not explore the use of values or methods that are not accepted by Federal agencies. **Table 32** presents variable approaches explored during analysis.

Table 32. Summary of Uncertain Variables and Alternative Approaches

Benefit	Variable Approaches	Solution
Direct Physical Benefits	The BRV and CRV can have a significant impact on the monetary value of property loss. Analysts generated low-, medium-, and high- replacement values using 2016 RS Means Square Foot Costs to understand how the replacement value may impact BCA results.	Low Estimate: Economy BRV per square foot: $110.10
		Medium Estimate: Average BRV per square foot: $130.34
		High Estimate: Custom BRV per square foot: $169.74
Recreation Benefits	Analysts can calculate recreational benefits using different methods, such as willingness to pay values related to a specific recreation activity or a value per square foot of recreation space.	Low Estimate: FEMA value per square foot
		Medium Estimate: Average of low and high estimate
		High Estimate: USACE Unit Day Values

5.2 Discount Rates

The discount rate captures social "opportunity costs" (the maximum worth of an input feature as assessed among practical alternative uses), and provides an interpretation of the present value of expected annual benefits and costs. In other words, the discount rate attempts to measure the present value of future benefit, and always assumes that future benefit is of lower value than present benefit.

OMB Circular A-94: Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs requires a discount rate of 7 percent. The Federal government last updated this discount rate in the OMB Circular A-94 in 1992. Sources of literature, such as the article *Discount Rate* published by the Association of State Floodplain Managers, emphasize the uncertainty surrounding discount rates. It can also be useful to analyze discount rates used by other federal agencies. The Government Accountability Office (GAO) is a congressional agency that determines its own discount rate policy. The GAO uses the yield of United States Treasury debt with a maturity of the duration of the Project.[44] Appendix C of OMB Circular A-94 (Revised in January of 2015), states that the 30-year interest rate is 1.4 percent.[45] Furthermore it states that, "Programs with durations longer than 30 years may use the 30-year interest rate in calculating the discount rate."

To analyze the potential impact of assumptions surrounding discount rates, analysts compared the present value of project benefits and costs using two different discount rates recommended by OMB Circular A-94 (7 percent) and HUD Notice: CPD-16-06 (3 percent). **Table 33** summarizes the range of benefits individually using both discount rates, as well as the BCR for each benefit scenario.

Table 33. Summary of Benefit Range and Present Value

Benefit	Bound	Estimated Annual Benefit	Present Value of Benefits	BCR
Discount Rate: 7 Percent				
Direct Physical Damages	Low	$673,630	$8,667,050	1.32
	Medium	$720,690	$9,272,460	1.57
	High	$817,070	$10,512,500	1.91
Recreation	Low	$8,470	$119,240	1.32
	Medium	$135,910	$1,910,160	1.57
	High	$263,350	$3,701,080	1.91
Discount Rate: 3 Percent				
Direct Physical Damages	Low	$673,630	$16,678,350	2.16
	Medium	$720,690	$17,843,370	2.64
	High	$817,070	$20,229,640	3.24
Recreation	Low	$8,470	$247,030	2.16
	Medium	$135,910	$3,292,180	2.64
	High	$263,350	$7,611,340	3.24

[44] Page 4. Located at: http://www.floods.org/PDF/WhitePaper/ASFPM_Discount_%20Rate_Whitepaper_0508.pdf
[45] Web page. Located at: https://www.whitehouse.gov/sites/default/files/omb/memoranda/2015/m-15-05.pdf

6 DOUBLE COUNTING

Duplication of benefits, or "double-counting," may occur when two projects or methodologies of similar purpose have overlapping benefits. Analysts identified and removed double counting from the evaluation to maintain its integrity. Benefits may duplicate because:

1. Benefits calculated in the analysis may duplicate each other if there is overlap in the underlying values used to quantify losses avoided or value added.
2. Bridgeport has implemented or plans to implement a project in the same area with overlapping benefits.

Table 34 identifies potential double counting along with a description of how analysts managed or removed these duplications.

Table 34. Summary of Double-Counting Approach

Benefit	Potential Duplication	Resolution of Duplication
Resiliency Benefits		
Road Service and Casualties	The primary objective of dry egress is to provide residents with a means to evacuate before and after a flood event. There are two benefits associated with dry egress: continuity of road service, valued through lost time, and avoided casualties, valued using the FAA's WTP for life and injuries. In theory, residents that choose to evacuate would not be exposed to the risk of injury or loss of life. Similarly, residents that choose to shelter in place do not benefit from avoided time lost. Therefore, analysts must take care to identify the appropriate population for each analysis.	Analysts used local evacuation rates to address potential overlapping benefits: casualties were estimated for the population not expected to evacuate, and continuity of road service was estimated for the population expected to evacuate before a storm event.
Relocation	Relocation costs may be a double-counting with shelter needs. The relocation approach assumes that all displaced individuals will require alternative living quarters, thus capturing the costs of individuals that may opt or need to go to a shelter.	The BCR does not include costs associated the shelter needs to avoid any possible duplication. Instead, the BCA reports provides estimated population expecting to require public shelter in the case of an event for the benefit of the reader.
Social Benefits		
Recreation	In the future, Bridgeport may implement projects that improve the quality of Seaside Park. Such improvements may impact park visitation and may duplicate recreation benefits for different park sites.	The BCA calculates recreation benefits by unit of stormwater park elements to ensure that the benefits calculated are specific to RBD project only.
Health	Surveys used to determine consumer surplus values for recreation benefits may inherently include a health benefit component. Thus, recreation consumer surplus values may be duplicative with health benefits related to recreation.	The BCA report describes health benefits of recreation space in a quantitative manner, but analysts did not calculate monetary values to be included in the benefit-cost ratio to avoid any risk of double-counting benefits.

7 BENEFIT COST ANALYSIS RESULTS

The BCA finds the RBD project cost effective in each benefit scenario (**Table 36**), indicating the project is a sound investment of public resources.

*The NPV of the RBD project is **$5.4 million**, and the BCR using a 7 percent discount rate is **1.57**.*

The RBD project is expected to provide a range of resiliency, social, environmental, and economic benefits totaling to **$14.6 million** in today's dollars, compared to an overall investment of **$9.2 million**, both at a 7 percent discount rate (**Table 35** and **Table 1**). ***Resilient redevelopment benefits*** comprise 60 percent of the project's overall benefits, while ***social benefits*** comprise 13 percent of the project's overall benefits (**Figure 2**). The BCA reveals the RBD project will reduce acute and chronic flood impacts to future Marina Village development and residents, as well as provide a range of social, environmental, and economic benefits to the South End.

Table 35. Annual and Present Value Benefits for the Medium Benefit Scenario

Benefit	Annualized Benefit	Present Value (7 Percent Discount Rate)	Present Value (3 Percent Discount Rate)
Resiliency Benefits			
Resilient Redevelopment			
Direct Physical Damages	$ 720,690	$ 9,272,460	$ 17,843,370
Displacement	$ 1,150	$ 14,800	$ 28,470
Mental Stress and Anxiety	-	$ 1,050,280	$ 1,050,280
Lost Productivity	-	$ 653,610	$ 653,610
Dry Egress Value			
Evacuation / Roadway Loss of Service	$ 10,910	$ 149,370	$ 270,120
Casualties	$ 86,690	$ 1,115,390	$ 2,146,390
Value Added Benefits			
Social Value			
Recreation Benefits	$ 135,910	$ 1,910,160	$ 3,929,180
Aesthetic Benefits	$ 5,130	$ 71,660	$ 142,700
Environmental Value			
Ecosystem Goods and Services Benefits	$ 8,830	$ 126,030	$ 279,090
CSO Reduction Benefits	$ 3,300	$ 45,630	$ 85,070
Economic Value			
Economic Revitalization Benefits	$ 5,400	$ 69,480	$ 133,700
Total Project Benefits	**$978,010**	**$14,478,870**	**$26,561,980**

Table 36. Benefit Cost Ratio by Benefit Scenario

Scenario	Low Benefit Cost Ratio	Medium Benefit Cost Ratio	High Benefit Cost Ratio
7% Discount Rate			
RBD Project	1.32	1.57	1.91
3% Discount Rate			
RBD Project	2.16	2.64	3.24

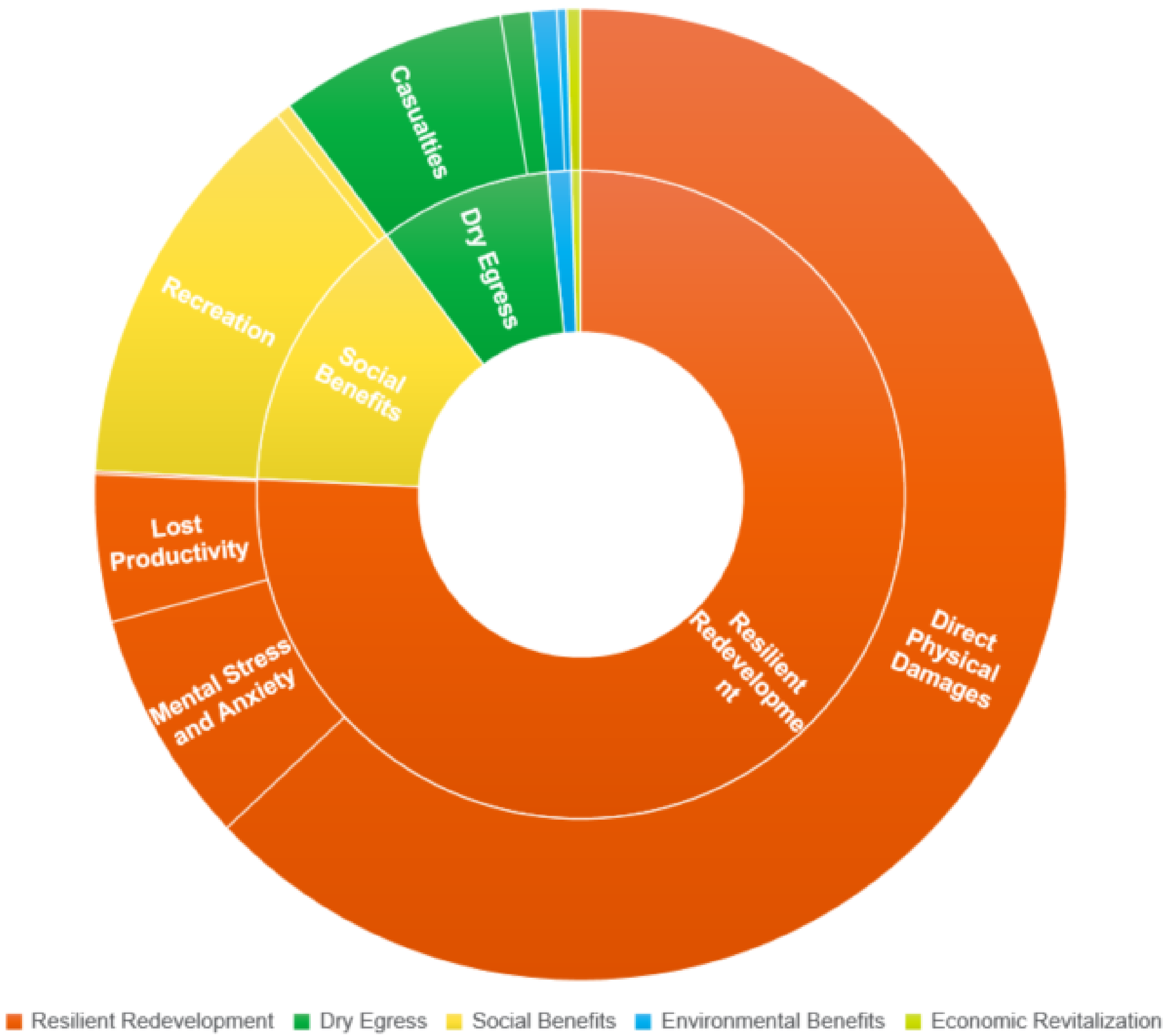


Figure 2. Distribution of RBD Project Benefits, Medium Benefit Scenario

Table 37. Annual and Present Value Benefits for the Low Benefit Scenario

Benefit	Annualized Benefit	Present Value (7 Percent Discount Rate)	Present Value (3 Percent Discount Rate)
Resiliency Benefits			
Resilient Redevelopment			
Direct Physical Damages	$ 673,630	$ 8,667,050	$16,678,350
Displacement	$ 1,150	$ 14,800	$ 28,470
Mental Stress and Anxiety	-	$1,150,430	$1,150,430
Lost Productivity	-	$715,940	$715,940
Dry Egress Value			
Evacuation / Roadway Loss of Service	$ 10,910	$ 149,370	$ 270,120
Casualties	$ 86,690	$ 1,115,390	$ 2,146,390
Value Added Benefits			
Social Value			
Recreation Benefits	$ 8,470	$ 119,240	$ 247,030
Aesthetic Benefits	$ 5,130	$ 71,660	$ 142,700
Environmental Value			
Ecosystem Goods and Services Benefits	$ 8,830	$ 126,030	$ 279,090
CSO Reduction Benefits	$ 3,300	$ 45,630	$ 85,070
Economic Value			
Economic Revitalization Benefits	$ 5,400	$ 69,480	$ 133,700
Total Project Benefits	**$803,510**	**$12,245,030**	**$21,877,300**

Table 38. Annual and Present Value Benefits for the High Benefit Scenario

Benefit	Annualized Benefit	Present Value (7 Percent Discount Rate)	Present Value (3 Percent Discount Rate)
Resiliency Benefits			
Resilient Redevelopment			
Direct Physical Damages	$ 817,070	$ 10,512,500	$ 20,229,640
Displacement	$ 1,150	$ 14,800	$ 28,470
Mental Stress and Anxiety	-	$1,150,430	$1,150,430
Lost Productivity	-	$715,940	$715,940
Dry Egress Value			
Evacuation / Roadway Loss of Service	$ 10,910	$ 149,370	$ 270,120
Casualties	$ 86,690	$ 1,115,390	$ 2,146,390
Value Added Benefits			
Social Value			
Recreation Benefits	$ 263,350	$ 3,701,080	$ 7,611,340
Aesthetic Benefits	$ 5,130	$ 71,660	$ 142,700
Environmental Value			
Ecosystem Goods and Services Benefits	$ 8,830	$ 126,030	$ 279,090
CSO Reduction Benefits	$ 3,300	$ 45,630	$ 85,070
Economic Value			
Economic Revitalization Benefits	$ 5,400	$ 69,480	$ 133,700
Total Project Benefits	**$1,201,830**	**$17,672,320**	**$32,792,900**

8 ECONOMIC IMPACT ANALYSIS

In addition to the benefits of increased resiliency from reduced future disaster loss, project expenditures for construction are expected to stimulate economic activity within Bridgeport and Fairfield County. This economic impact evaluation is accessory to the RBD project; the intent is to evaluate the expected economic benefits generated by project construction in the form of employment, labor income, value added, and sales and revenues (output).

8.1 Project Description

The RBD project includes two main elements: the Johnson Street Extension and a multiuse stormwater park. The Johnson Street Extension will provide dry egress and incorporate green infrastructure, such as bioswales, to divert surface runoff from the combined sewer system and into the multifunctional stormwater park. The 2.5 acre stormwater park will include terraced basins, underground storage features, community gathering space, and recreational features. Flow from the stormwater park will be pumped via a new force main to an existing outfall. Analysts used the cost estimates for the Johnson Street Extension and force main to conduct the economic impact analysis (EIA); detailed cost estimates for the stormwater park were not available at the time of analysis.

8.2 IMPLAN Software and Results

This methodology presents the approach used to model economic impacts for project expenditures. Generally, analysts evaluate the cost of each proposed project element using IMPLAN modeling software to determine the economic impacts that will result from the change in the local economy directly related to project expenditures. IMPLAN software provides economic data and modeling to users for assessing the economic impacts of project implementation in all industry sectors, with the intent of predicting how projects or policies interact with and shape the economy. Analysts used IMPLAN Version 3.1 software, an input-output system that uses a combination with social accounting matrices (SAMs) and economic multipliers to estimate the result of changes or activities in an economic region. SAMs provide a complete picture of the economy and generate multipliers to measure the impacts from one activity for a given sector throughout the entire economy. Analysts used the 2015 Fairfield County Package for the economic impact analysis, which includes the economic profile for each zip code. and **Table 40** below describes the IMPLAN analysis report outputs and types of relationships reported. Each result category presented in **Table 39** is reported in terms of relationships measured, displayed in **Table 40**.

Table 39. Economic Impact Analysis Result Outputs

Analysis Result	Definition
Output	The value of industry production, which varies by industry. For example, the output of the service sector is measured in sales, hospital output is measured in the total service package that a patient receives during their entire length of stay, and output for non-profit organizations is based on the cost of production or the expenses that the organization must incur to operate.
Labor Income	The expected combined income of employment in each industry sector generated by project implementation expenditures. Including wages and benefits for employees and proprietor income.
Value-Added	Measure of the project's contribution to Gross Domestic Product (GDP).
Employment	All jobs (full-time, part-time, and temporary) that are created or lost as a result of an economic activity in the year of the activity.

Table 40. Economic Impact Analysis Relationships Measured

Analysis Result	Definition
Direct Effects	Represents the initial impacts that occur as a result of an economic activity.
Indirect Effects	The impact of direct economic effects on supporting industries, such as those that provide equipment and materials.
Induced Effects	The response to a direct effect that occurs through re-spending of income.

8.3 Approach

Outlined below is the approach to estimate economic impacts of project.

1. **Compare project estimates with IMPLAN industries**

IMPLAN has a total of 440 economic industries, derived from the North American Industry Classification System (NAICS). To run IMPLAN, analysts must choose the economic industry expected to be impacted by a project related activity, and estimate how much that industry will change (in dollars). Evaluating the economic impact of mitigation measures requires analysts to choose economic industries necessary for project design, construction, and maintenance and divide project costs appropriately among those industries. **Table 41** displays the project elements and corresponding economic industries chosen by analysts.

Table 41. Expenditures used in the Economic Impact Analysis

IMPLAN Industry	Planning and Design	Johnson Street Extension	24" RCP	Force Main	Maintenance
30 Stone mining and quarrying	$-	$20,480	$-	$-	$-
31 Sand and gravel mining	$-	$-	$11,040	$-	$-
36 Other nonmetallic materials	$-	$45,080	$-	$-	$-
51 Water, sewage, and other systems	$-	$126,400	$-	$254,240	$-
58 Construction of other new nonresidential structures	$-	$-	$49,600	$-	$-
62 Maintenance and repair construction of nonresidential structures	$-	$42,960	$-	$-	$75,000
64 Maintenance and repair construction of highways, streets, and bridges	$-	$94,520	$-	$-	$-
58 Construction of other new nonresidential structures	$-	$116,880	$-	$106,960	$-
157 Asphalt paving and manufacturing	$-	$163,680	$-	$-	$-
208 Concrete pipe manufacturing	$-	$-	$54,320	$226,800	$-
213 Cut stone and stone product manufacturing	$-	$50,440	$-	$-	$-
326 Street lighting fixtures manufacturing	$-	$64,680	$-	$-	$-
445 Commercial and industrial machinery and equipment rental	$-	$276,560	$172,280	$-	$-
449 Architectural, engineering, and related services	$1,100,000	$-	$-	$-	$-
507 Commercial and industrial machinery and equipment	$-	$35,560	$-	$-	$-

2. Populate IMPLAN model

Analysts created an IMPLAN model and populated the software with appropriate project costs listed in Step 1.

3. Review IMPLAN outputs

Analysts reviewed outputs generated from IMPLAN software for appropriateness. The IMPLAN analysis software evaluates the relationships between employment, labor income, economic output, and value added to GDP three ways: 1) direct impacts, which include industries directly related to mitigation activities; 2) indirect impacts, which include industries that support directly impacted industries; and 3) induced impacts, or benefits created through employee spending.

8.4 Assumptions

Analysts made the below assumptions to run the IMPLAN model accurately.

- Project planning and design will take place from 2016 through 2018. The costs of planning and design are distributed across those three years as described in the project budget.
- Project expenditure inputs are assigned the year of activity completion, IMPLAN outputs are adjusted to 2017 dollars.
- Project construction will occur between 2018 and 2022. Analysts allocated the costs of project construction, including materials, labor, and equipment, equally across those four years to account for temporal differences in project expenditures.
- Analysts applied IMPLAN's Local Purchase Percentage, calculated from the study area's SAM, to all industry sectors. This assumes that a certain percentage of an industry will be purchased locally, discounting commodities or services that are imported from outside of the study area which therefore have no impact on the local economy.

The following caveats apply to the results of the economic impact analysis, and should be considered when evaluating results:

- These results display the expected economic effect of the proposed project on the entirety of Fairfield County.
- The project is in the first stages of planning; the analysis must be considered as preliminary and can be refined as more project details are realized.
- Employment generated by analyzed project expenditures include all full-time, part time, and temporary positions.
- IMPLAN does not account for price elasticities or changes in consumer/industry behavior based on a direct effect, such as changes in spending patterns within sectors not related to project expenditures directly.
- The results presented are those that are associated with the years the project is implemented, and are not projected into the future.

8.5 Results

Analysis results indicate that the Johnson Street Extension and force main, will result in:

- 10 JOBS DIRECTLY RELATED TO THE ACTIVITIES LISTED IN THE **APPROACH**.
- 4 JOBS CREATED IN SUPPORTING INDUSTRIES.
- 5 JOBS CREATED THROUGH EMPLOYEE SPENDING.
- 19 JOBS CREATED TOTAL, WITH $1.8 MILLION IN LABOR INCOME (THIS INCLUDES EMPLOYEE WAGES AND BENEFITS AND PROPRIETOR INCOME).

The top three industries expected to be impacted by project implementation include the ***construction industry, the engineering and architectural services industry, and the water system industry***. As a whole, the project is expected to generate ***$3.7 million in industry production***, creating ***$2.4 million in value added*** (GDP) for Fairfield County.

Figure 3 below offers the results of the economic impact analysis, organized by project activity. These results are presented in percentages to show the contributions that each makes to the whole impact.

Figure 3. Economic Impact Results by Activity, Presented as Percentages

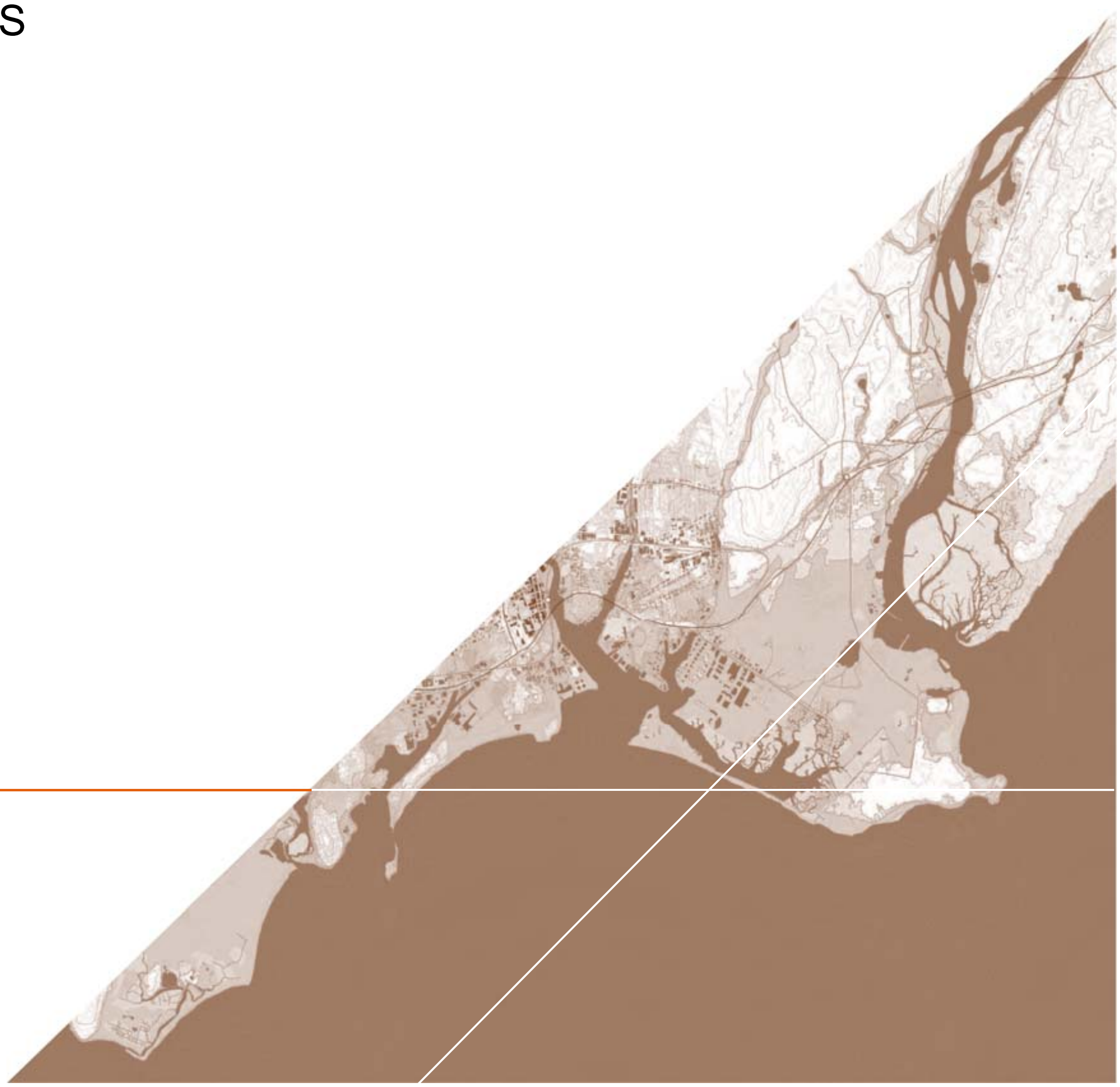
ARCADIS
Design & Consultancy for natural and built assets

RESILIENT BRIDGEPORT

BENEFIT COST ANALYSIS METHODOLOGY REPORT

APPENDICES

April 21, 2017



CONTENTS

APPENDIX A

US Housing and Urban Development (HUD) Crosswalk

Costs and Benefits by Category	BCA Section	Qualitative Description of Effect and Rationale for Including in BCA	Quantitative Assessment (Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)	Current monetized effect (if applicable)	Uncertainty
Life Cycle Costs					
Resilient Bridgeport Selected Project	BCA Methodology Report, Section 2 Rebuild by Design Pilot Project	The RBD project will extend Johnson Street to provide dry egress for future Mariana Village residents out of the FEMA 500-year flood zone, as well as future SLR conditions of 3 feet. The Johnson Street Extension will incorporate green infrastructure, such as rain gardens and bioswales, to divert surface runoff away from the combined sewer system and into a multifunctional stormwater park. Stormwater park components such as terraced basins and underground storage features will retain, delay, and improve the quality of stormwater runoff. Community gather spaces, play equipment and courts, and walkways in the stormwater park will provide space for community programs, environmental education, and passive and active recreation. The park component will also include new flora and fauna.	Engineers compiled a detailed cost estimate based on direct capital costs, as well as operation and maintenance (O&M) costs over the project useful life.	**Present Value of Costs: $9,235,060**	**3** Medium uncertainty because the project design is not yet final.
Resiliency Benefits					
Resilient Development					
Direct Physical Damages – Structure	BCA Methodology Report, Section 3.1.1 Direct Physical Damages – Buildings and Contents	Direct physical damages include the degradation and destruction of property and are quantified through monetary losses. The BCA categorizes property loss as both structural damage (damage that applies to real property) and content damage (damage to personal property or inventory).	A structure inventory was created to gather the appropriate information required for the analysis, such as building square footage, use, and stories, using Bridgeport tax assessment data. Analysts compared flood elevations from the Flood Insurance Study (FIS) to grade elevations to determine a flood depth at each structure. The North Atlantic Coastal Comprehensive Study (NACCS) Depth-Damage Functions (DDFs) consider first floor elevations, therefore analysts use ground elevation rather than first floor elevations when estimating flood depth. Building Replacement Values (BRVs) were calculated using RSMeans. The DDFs from the USACE are applied to estimate structure damages associated with the 10 percent, 2 percent, 1 percent, and 0.2 percent annual chance events. The percent of structural damage is related to 1-foot depth above grade increments, which are multiplied by the replacement value for a portion of the structure defined by the DDFs to produce a physical loss value in dollars. See BCA Summary Report, Table 1 Summary of Resiliency and Added Value Benefits for data sources.	**Annual Benefits: $318,840** **Present Value of Benefits: $4,102,180**	**3** Medium uncertainty; the methodology used to estimate this benefit is approved by more than one federal agency. Further, property appraiser data provided site-specific structure information, and USACE DDFs specific to the study area were used in the analysis. LiDAR was used to determine grade elevations, with site checks in several areas.
Direct Physical Damages to Buildings - Contents	BCA Methodology Report, Section 3.1.1 Direct Physical Damages – Buildings and Contents	Contents damage is damage that applies to personal property as a direct result of flooding. This is calculated as a function of direct physical damages to structures.	Contents loss is a percentage of the BRV based on the contents-to-structure ratio values from USACE data. DDFs are applied to estimate contents damages associated with each return period. The percent of contents damage is related to 1-foot depth increments, which are multiplied by a contents replacement value to produce a physical loss value in dollars. See BCA Summary Report, Table 1 Summary of Resiliency and Added Value Benefits for data sources.	**Annual Benefits: $401,850** **Present Value of Benefits: $5,170,280**	**3** Uncertainties are the same as for Direct Physical Damages to Structures

Costs and Benefits by Category	BCA Section	Qualitative Description of Effect and Rationale for Including in BCA	Quantitative Assessment (Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)	Current monetized effect (if applicable)	Uncertainty
Displacement Costs	BCA Methodology Report, Section 3.1.2 Displacement Costs	Residents of impacted structures may experience displacement costs during the time when a building becomes uninhabitable due to flood damage. Relocation costs are associated with moving a household or a business to a new location and resuming business in that new location. Relocation costs are derived from displacement time, which is derived from DDFs that relate a depth of flooding to an amount of time a structure is not usable.	Analysts identified structures experiencing flood impacts at different flood scenario, and determined the total flooded floor area. Census block level data provided the percent owner occupied for residential structures and Hazus-MH 3.2 provided default owner-occupancies for non-residential uses. Analysts used Zillow and Loopnet to develop location specific rental costs for residential and non-residential structures. Flood depths estimated in the direct physical damage analysis are correlated to USACE displacement DDFs to estimate displacement time for each flood scenario. Analysts processed relocation costs to building occupants based on occupancy type. Analysts applied the probability of each flood scenario to expected impacts to calculate annual benefits. See BCA Summary Report, Table 1 Summary of Resiliency and Added Value Benefits for data sources.	**Annual Benefits: $1,150** **Present Value of Benefits: $14,800**	**3** FEMA Hazus methods and FEMA BCA Reference Guide methods applied. Uncertainty is related to post-disaster behavior of residents and businesses.
Mental Stress and Anxiety	BCA Methodology Report, Section 3.1.3 Mental Stress and Anxiety	Natural disasters threaten or cause loss of health, social, and economic resources, which leads to psychological distress. Research indicates that individuals who experience a high number of stressors and property damage are more likely to experience symptoms of mental illness, Post-Traumatic Stress Disorder (PTSD), and higher levels of stress and anxiety. An increase in mental health issues after a disaster will increase mental health treatment costs.	An increase in mental health issues after a disaster will increase mental health treatment costs. Calculations consider prevalence of mental health issues after a disaster, as well as the number of individuals who will seek treatment. Benefits are based on a national standard cost of treatment per person by type of treatment (mild/moderate or severe). The FEMA standard value was normalized and then applied to the number of residents that would be impacted if the RBD project were not implemented. The result of the analysis is avoided mental health treatment costs due to the implementation of the RBD project. The cost of mental health is estimated for 30 months, the amount of time for which literature has been able to estimate the prevalence of mental health impacts after a disaster. See BCA Summary Report, Table 1 Summary of Resiliency and Added Value Benefits for data sources.	**Annual Benefits: N/A** **Present Value of Benefits: $1,050,280**	**3** Medium uncertainty; the methodology used for calculating this benefit has been approved by at least one federal agency. This method only considers the percent of the population that is expected to seek treatment and is conservatively low for that reason. Further, the percent of the population expected to seek treatment is a national figure, and not locally specific. Costs are also national and not locally specific. Coping tactics, skills, and support systems vary widely within a given population.
Lost Productivity	BCA Methodology Report, Section 3.1.4 Lost Productivity	Work productivity can be lost due to mental stress and anxiety. Lost work productivity can be avoided by the implementation of the RBD project as stress resulting from damage to homes and disruption of life is expected to be mitigated.	The methodology relies on the results of existing studies to determine the dollar amount of monthly productivity loss due to mental health issues. This is multiplied by the number of affected wage earners based on the number of households impacted by a flood event. The total amount of productivity loss is also estimated for 30 months. The total value is treated in the same manner as mental health treatment costs. See BCA Summary Report, Table 1 Summary of Resiliency and Added Value Benefits for data sources.	**Annual Benefits: N/A** **Present Value of Benefits: $653,610**	**3** Medium uncertainty; this method contains the same variables as mental stress and anxiety. Nevertheless, there are multiple international studies to corroborate these results. Impacts may vary based on population affected and nature of disaster.

Costs and Benefits by Category	BCA Section	Qualitative Description of Effect and Rationale for Including in BCA	Quantitative Assessment (Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)	Current monetized effect (if applicable)	Uncertainty
Dry Egress Value					
Transportation	BCA Methodology Report, Section 3.2.1 Loss of Roadway Service	Transportation assets and systems in the South End may flood during both acute and chronic events. Loss of roadway service is a function of the per-hour value of time, detour route, and number of vehicles evacuating. Analysts focused on the residents benefitting from dry egress, those in Marina Village and Seaside Village that are within the FEMA flood zones.	Lost transportation service can be estimated as a function of the lost time to travelers due to disruption to the various transportation networks. The basic economic concept is that personal time has value, regardless of formal employment compensation. Figures are based on FEMA methodologies for BCA. See BCA Summary Report, Table 1 Summary of Resiliency and Added Value Benefits for data sources.	**Annual Benefits: $10,910** **Present Value of Benefits: $149,370**	**3** Medium uncertainty; the methodology used for calculating this benefit has been approved by at least one federal agency. Values are derived from national, as opposed to local figures.
Casualties	BCA Methodology Report, Section 3.2.2 Casualties	Casualties, which include loss of life and injuries, are an unfortunate risk inherent to hazard events. Flood events are considered some of the most frequently occurring natural hazards, contributing to 44 percent of natural hazard-related fatalities worldwide.	After an analysis of both the impacts of Hurricane Sandy and the various methodologies available for calculating number of deaths in flood-related disasters, the selected methodology for estimating fatalities is based on a 2013 study conducted by BRNO University. FEMA standard life safety values were used. It is also assumed that there is a 78 percent evacuation rate. Injuries are based on a post-Sandy CDC study of injuries within a week of flooding due to evacuation and clean-up efforts (roughly 10% of the impacted population). See BCA Summary Report, Table 1 Summary of Resiliency and Added Value Benefits for data sources.	**Annual Benefits:** **Fatalities: $80,210** **Injuries: $6,480** **Present Value of Benefits: $1,115,390**	**3** A standard FEMA value for life was used; however, there are multiple methods for determining the number of possible casualties. In addition, there are many factors post-disaster that could increase or decrease potential casualties, including unpredictable behaviors and population density.
Value Added Benefits					
Social Value					
Recreation	BCA Methodology Report, Section 4.1.1 Recreation Benefits	Open spaces, parks, and the use of these spaces provide recreational benefits. There are several currently accepted methods to value the added recreational benefits of amenities such as those anticipated to be provided by the Project program elements. This BCA used a method that considers residents' willingness to pay for access to recreational uses. Methods under the umbrella of the willingness to pay concept of economic valuation include contingent valuation, hedonic pricing, and value of enjoyment.	Recreation benefits quantify the consumer value of increased outdoor recreation expected as a result of project improvements. Two approaches to value recreation benefits are provided within this methodology. The first method applies FEMA's standard value for recreation benefit per acre to the total amount of new or improved recreation space. The second method estimates an increase in recreation activity based on the type of activities thought to occur at the park using statewide survey data. See BCA Summary Report, Table 1 Summary of Resiliency and Added Value Benefits for data sources.	**Annual Benefits: $135,910** **Present Value of Benefits: $1,910,160**	**3** Medium uncertainty; federal methods and standard values used in the analysis. Uncertainty is related to existing park usage, user habits, and expected increase in park users.

Costs and Benefits by Category	BCA Section	Qualitative Description of Effect and Rationale for Including in BCA	Quantitative Assessment (Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)	Current monetized effect (if applicable)	Uncertainty
Aesthetic	BCA Methodology Report, Section 4.1.2 Aesthetic Benefits	The RBD project will implement flood protection measures that integrate concepts of green infrastructure coupled with the addition of usable park space which will create a more appealing project area to existing and future residents. This attention to aesthetic detail may create a positive effect for residential property and the local economy.	FEMA uses a benefit transfer methodology to obtain an aesthetic value per acre per year of green open space. This value is applied to the area of new park space to value aesthetic benefits. New trees may also increase the aesthetic quality. An annual aesthetic value per public tree was applied to the total number of added trees to generate benefits.	**Annual Benefits: $5,130** **Present Value of Benefits: $71,660**	**3** Medium uncertainty; method to estimate benefits uses a federal methodology. The FEMA method is based on nationally derived figures.
Environmental Value					
Environmental	BCA Methodology Report, Section 4.2.1 Ecosystem Goods and Services	The RBD project proposes to add new natural vegetation that will produce a range of environmental benefits, also known as ecosystem goods and services. Ecosystem goods and services provided by natural vegetation may be quantified to estimate their economic benefit to society. Such benefits can be categorized through measures such as carbon sequestration, air pollutant reduction, energy savings, increase in water quality, and pollination.	Natural capital is the world's stock of natural assets, such as soil, air, water, and all living things that provide a good or service that benefits society. For example, natural capital, such as forests and soils, provide the ecosystem service of filtering water independent of treatment plants. The USDA's Northeast Community Tree Guide (Tree Guide) and FEMA's Final Sustainability Benefits Methodology Report are the sources analysts used to develop environmental benefits for various vegetation types.	**Annual Benefits: $8,830** **Present Value of Benefits: $126,030**	**3** Medium certainty; values used in calculating this benefit are provided by federal and published sources. Local conditions may vary from nationwide standard values.
Combines Sewer Overflow Reduction	BCA Methodology Report, Section 4.2.2 Combines Sewer Overflow Reduction	A significant added benefit of the RBD project is the ability to retain stormwater. The City of Bridgeport currently uses a combined sewer system. When rain events occur, the City's sewer system can become overwhelmed and untreated wastewater can spill into nearby waterways as a relief mechanism to avoid damaging property or treatment plants. The RBD project proposes to implement stormwater management features that will capture flow, preventing it from entering the combined sewer system and contributing to CSO events. This benefit is not captured in ecosystems services benefits, therefore requiring a separate analysis.	The City has developed a Long-Term Control Plan to reduce the frequency of CSO events. The Plan reveals it will cost the City $384,900,000 over 30 years to reduce CSO output by 43 million gallons. Given this information, analysts generated a damage cost for CSO abatement: $0.29 per gallon per year. Analysts modeled CSO reduction and applied the damage cost to the total volume of CSO reduction to estimate water quality benefits.	**Annual Benefits: $3,300** **Present Value of Benefits: $45,630**	**3** Medium certainty; assessment accounts for runoff that will be retained by the stormwater park and green street's bio-retention features. Uncertainty is related to Bridgeport's investment in CSO abatement.
Economic Value					
Economic Revitalization	BCA Methodology Report, Section 4.3 Economic Revitalization	The resilient redevelopment of Marina Village includes added commercial space that will generate economic revitalization benefits.	Economic revitalization benefits can be measured through anticipated added economic output and employment compensation. Commercial output per square foot and employment compensation per square foot are sourced from FEMA's Hazus-MH 3.2 software.	**Annual Benefits: $5,400** **Present Value of Benefits: $69,480**	3 Medium certainty; national values used in calculating this benefit are provided by Federally published sources.

Costs and Benefits by Category	BCA Section	Qualitative Description of Effect and Rationale for Including in BCA	Quantitative Assessment (Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)	Current monetized effect (if applicable)	Uncertainty
Qualitative Benefits					
Health Benefits of Recreation	BCA Summary Report, 4.1 Health Benefits	Several studies have found that physical improvements and increased access to parks can increase both the number of users in the park and the frequency of exercise. There is strong evidence from the Centers for Disease Control and Prevention which demonstrates that access to parks and/or recreation areas results in more exercise taking place at that location. The addition of a public park at the center of the project area has the potential to increase residents' health and physical fitness. It has also been shown that outdoor recreation increases mental health and overall wellbeing.	Population data was used to determine the percentage of adults, seniors, and children. Then the percentage of population in each age group that met physical fitness guidelines was determined. This percentage was used to then determine the increase in the number of residents meeting fitness guidelines for each age category. The increase in population using the physical fitness guidelines was used to determine the healthcare cost savings. The outcome is the avoided health care costs for each age group due to increased physical activity.	Health benefits are considered to duplicate recreation benefits; therefore, the BCA does not place a monetary value on benefits.	**3** Medium uncertainty; federal sources provided the majority of data used. Benefits are based on a conceptualized scenario for project programming, based on public outreach and feasibility.
Emergency Response and Recovery Efforts	BCA Summary Report, 4.2 Emergency Response and Recovery Efforts	During and after both Hurricane Irene and Superstorm Sandy, the South End experienced major flooding that impeded roadway travel in the area due to a significant number of flooded streets. Although no lives were lost due to the flooding situation, floods associated with future coastal storms and low-frequency rainfall events could prevent emergency response vehicles, such as police vehicles, ambulances, and firefighting equipment from reaching vulnerable populations in time.	The addition of a dry egress corridor on Johnson Street will allow residents to evacuate safely, if necessary, during a hazard event. Additionally, mitigating flood risk in the project area will serve to reduce emergency response times and give adequate access to first responders that typically address fallen trees, downed power lines, or other disaster related impacts.	-	**3** Medium uncertainty; this reduction in the need for and cost of emergency services cannot be quantified at this time due to a lack of data from previous flood events.
Affordable Housing	BCA Summary Report, 4.3 Affordable Housing	The project area contains a high concentration of low-income populations, and focuses on the site of the future Marina Village mixed-income housing redevelopment. Given that over half of Marina Village is in the floodplain, dry egress during a 500-year flood event is required for new development. The RBD project would extend Johnson Street from Columbia to Iranistan at an elevation of 15 feet (the FEMA effective Flood Insurance Rate Maps 500-year stillwater elevation of 11.3 feet NAVD88 plus 3 feet to account for SLR), which would provide the Marina Village redevelopment a dry egress corridor, and subsequently allow the new mixed income housing development to be constructed.	The availability of affordable housing in a neighborhood is directly related to the economic resilience of that neighborhood. Studies indicate that the construction of approximately 100 affordable housing units through the Low-Income Housing Tax Credit program can support as many as 30 new jobs in the local economy. Therefore, the availability of housing not only attracts employers to the area, but could also increase the amount of disposable income residents are able to reinvest in the local economy.	-	**4** High uncertainty; the methodology used for capturing the monetary benefits of affordable housing availability is not yet standardized and therefore relies on a heavier amount of uncertainty. BCA analysts felt that due to this uncertainty, it should not be incorporated into the overall BCR
Workforce Benefits	BCA Summary Report, 4.4 Workforce Benefits	The South End has some of the highest unemployment and lowest median household income in Connecticut. There is a distinct lack of economic development in the neighborhood, with very few businesses or employment opportunities for the community. As a result, unemployment in the South End is approximately 30%, higher than 6 times the national average, and almost half of residents are below the poverty level.	The RBD project provides opportunity for economic revitalization to the South End, and with it, job creating economic investment. The redevelopment of Marina Village will include a community center with job-training and education programs. These amenities will attract new residents to the neighborhood, creating a larger potential consumer base. Additionally, when the RBD project is completed and the frequency of flooding is reduced, there will be less risk to businesses of flood-related closures, further incentivizing investment in the neighborhood.	-	**4** It is uncertain to what extent the addition of new jobs will benefit the community. As such, analysts felt that quantifying this value would not rely on a defensible methodology.

Costs and Benefits by Category	BCA Section	Qualitative Description of Effect and Rationale for Including in BCA	Quantitative Assessment (Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)	Current monetized effect (if applicable)	Uncertainty
Historic Preservation	BCA Summary Report, 4.5 Historic Preservation	The Marina Park Historic District is almost entirely within the project area, and contains 14 buildings of historic significance along Park Avenue, all of which are listed on the National Register of Historic Places. Seaside Village is also listed on the National Register of Historic Places, and is immediately adjacent to the project area. It is a housing community that was constructed during World War I and consists of about 200 single-family dwellings. In addition to the Marina Park Historic District and Seaside Village, there are 3 other historic districts in the South End that would be indirectly affected by the RBD project. They are: the Barnum/Palliser Historic District, Seaside Park, and the William D. Bishop Cottage Development Historic District.	The South End includes several important buildings and neighborhoods with rich histories that would benefit from the implementation of the RBD project. The primary purpose of the RBD project is to provide a level of flood protection to citizens of the South End. The historic structures and districts within the vicinity of the project would therefore benefit from this protection.	-	**3** It is uncertain to what extent the historic structures would benefit from the implementation of the RBD project. Additionally, it is difficult to quantify the value of historic structures as there may be hidden value not easily teased out (donations to tour the site, surrounding property value increases, etc.)
Economic Impact Analysis	BCA Summary Report, 4.6 Economic Impact Analysis	Resiliency projects and infrastructure investments have additional economic benefits beyond losses avoided. Implementing such projects often benefit the local and regional economy by providing employment opportunities, increasing economic output (sales and revenues), and contributing to Gross Domestic Product (GDP).	Analysts evaluated the economic impacts of the RBD project using IMPLAN input-output economic modeling software. The IMPLAN software evaluates the relationships between employment, labor income, economic output, and value added to GDP in three ways: 1) direct impacts, which include industries directly related to project implementation; 2) indirect impacts for industries that support those which are directly impacted; and 3), induced impacts, or benefits created through employee spending.	**Present Value of Benefits: $2,442,500**	**3** The software estimates such impacts through multipliers and social accounting matrices; thus, the economic benefits of project implementation cannot be counted toward the Project's BCR. Nevertheless, it is important to identify the employment and economic benefits of resiliency projects to the Bridgeport economy.

APPENDIX B

Benefit Cost Analysis Crosswalk

BCA Narrative Requirements	Location
A description of the process undertaken to prepare the BCA.	
If prepared by a professional technical writer or grant writer in a consulting or contract capacity, please explain how the grantee staff was involved, particularly in preparing or evaluating benefits and costs.	Explanation of the BCA development is provided in the BCA Summary Report, Section 1.2 Benefit Cost Analysis Process Overview, page 1-5.
A description of the proposed, funded project including functionally- or geographically- related elements and estimated useful life.	
What are the key project objectives?	Key project objectives are provided in the BCA Summary Report, Section 1.1.2 Project Objectives, page 1-2.
How is the project specifically designed to address the community's recovery needs and current and future risks and vulnerabilities?	The BCA Summary Report, Section 1.1.4 Project Description, page 1-4 provides detail regarding the community's needs and how these needs will be addressed.
If applicable, what are the geographic boundaries of the project (including any related activities) and/or the area it is designed to serve?	The geographic boundaries are described in the BCA Summary Report, Section 1.1.1 Project Location, page 1-2.
What are the main components of the project plan and how do they interact? What links or supports them?	The main project components and links are described in the BCA Summary Report, Section 1.1.4 Project Description, page 1-4.
Describe how any anticipated changes to local policies, including, but not limited to local zoning/land use or building codes, will address the community's recovery need and/or risks and vulnerabilities, including economic effects.	It is anticipated the installation of this project will encourage the implementation of updated local policies, building codes, and zoning regulations. Refer to the BCA Methodology Report, Section 2 Rebuild by Design Pilot Project, page 2-1.
What is the timeline for completion and/or term of the full proposed project and each component, if applicable?	The major milestones of the RBD project and an understanding of the timeline can be found in the BCA Methodology Report, Section 2.1 Project Timeline, page 2-2.
What is the estimated useful life of the project?	Estimated useful life of the project is provided in the BCA Summary Report, Section 1.1.4.1 Project Useful Life, page 1-5.
Are alternative discount rates used in addition to the 7% base-case discount rate? If so, provide a justification based on the nature of the project as described above.	Discount rate descriptions and explanations are included in BCA Methodology Report, Section 5.2 Discount Rates, page 5-1.
Full project cost, including federal, State, local, and private funding; expected operations and maintenance costs; and other functionally-related costs.	
Full project cost, including federal, State, local, and private funding; expected operations and maintenance costs; and other functionally-related costs.	Project costs, included operations and maintenance, over the life of the project are provided in the BCA Summary Report, Section 3.2 Costs, page 3-2.
A description of the current situation and the problem to be solved (including anticipated changes over the analysis period).	
What are the existing flood, wind, fire, earthquake, climate change or other risks and vulnerabilities in your project area?	The major risks to the project area are described in the BCA Summary Report, Section 2 Risk Context, page 2-1.
What risks is the project designed to reduce?	Descriptions of specific risks to be reduced by the RBD project are included in the BCA Summary Report, Sections 2 Risk Context, page 2-1. A full project description is provided in the BCA Summary Report, Section 1.1.4 Project Description, page 1-4.
What are the existing social conditions/challenges in your area and what populations are vulnerable to the disaster impacts and risks identified above? Are any of these vulnerable populations disproportionately lower income or minority?	Existing social conditions/challenges are discussed in the BCA Summary Report, Section 2.3 Existing Social and Economic Conditions, page 2-3.
How do trends in land-use, housing development and affordability, and/or employment affect disaster recovery or vulnerability to the risks identified above?	Existing social conditions/challenges are discussed in the BCA Summary Report, Section 2.3 Existing Social and Economic Conditions, page 2-3.
A description of the risks to your community if the project and any land use, zoning or building code changes are not implemented, including costs that might be avoided if a disaster similar to Hurricane Sandy struck again.	
What would realistically happen now, in 5 years, in 20 and 50 years if this project is not implemented?	Predictions of the 5-, 20-, and 50-year outcomes are included in the BCA Summary Report, Section 6 No Action Alternative, page 6-1.
What would be the impact on the community as a whole and any vulnerable lower income populations identified above, in particular, if the RBD project is not implemented?	Impacts of inaction are described in the BCA Summary Report, Section 6 No Action Alternative, page 6-1.
For RBD projects with multiple components, are there additive impacts or benefits that will not be realized if this project is not done?	Impacts of inaction are described in the BCA Summary Report, Section 6 No Action Alternative, page 6-1.
Are there any areas of concentrated poverty that will remain adversely affected if the RBD project is not implemented?	Social impacts of inaction are discussed in the BCA Summary Report, Section 6 No Action Alternative, page 6-1.
Estimate the costs that might be avoided if a disaster similar to Hurricane Sandy occurred in the same area, accounting for how development may proceed differently depending on whether the RBD project is implemented.	Cost estimates of inaction are given in the BCA Summary Report, Section 6 No Action Alternative, page 6-2.

A list of the benefits and costs of the RBD project and the rationale for including each, using categories provided.	
Costs	
Lifecycle costs/Project/Investment costs	BCA Summary Report, Section 3.2 Costs, page 3-2. See BCA Methodology Report, Appendix D for detailed cost estimates.
Operations and maintenance costs	
Resiliency Value	
Reduction of expected property damages due to future/repeat disasters	Estimated project resiliency benefits are given in the BCA Summary Report, Section 3.1 Benefits, page 3-1. Full methodologies of these benefits are described in the BCA Methodology Report, Section 3 Resiliency Benefits, page 3-1. Qualitative benefits are also described in the BCA Summary Report, Section 4 Qualitative Benefits, page 4-1.
Reduction of expected casualties from future/repeat disasters	
Value of reduced displacement caused by future/repeat disasters	
Reduced vulnerability of energy and water infrastructure to large- scale outages	
Value of protection from disruptive non-disaster events, such as nuisance flooding	
Environmental Value	
Ecosystem and bio diversity effects	Estimated project environmental benefits are given in the BCA Summary Report, Section 3.1 Benefits, page 3-1. Full methodologies of these benefits are described in the BCA Methodology Report, Section 4.2 Environmental Benefits, page 4-7. Qualitative benefits are also described in the BCA Summary Report, Section 4 Qualitative Benefits, page 4-1.
Reduced energy use	
Noise levels	
Climate change– Reduced Greenhouse Gas emissions	
Air Quality–Reduced criteria pollutants (nitrogen dioxide (NO2), ozone (03), sulfur dioxide (SO2) and particulate matter of aerodynamic diameter of the micrometers or fewer (PM-10)	
Water quality– reduced stormwater runoff	
Social Value	
Reductions in human suffering (lives lost, illness from exposure to environmental contamination, asthma and cancer rates in low-income and minority populations living in areas with greater environmental risk)	Estimated project social benefits are given in the BCA Summary Report, Section 3.1 Benefits, page 3-1. Social benefit methodologies are described in the BCA Methodology Report, Section 4.1 Social Benefits, page 4-3. Qualitative benefits are also described in the BCA Summary Report, Section 4 Qualitative Benefits, page 4-1.
Benefit to low- and moderate-income persons and/or households	
Improved living environment (such as elimination of slum and blight conditions, improved community identity and social cohesion, improved recreational value, greater access to cultural, historic, improved recreational value, greater access to cultural, historic, archaeological sites and landscapes, equal access to resilient community assets)	
Greater housing affordability	
Economic Revitalization Benefits	
Direct effects on local or regional economy (e.g., tourism revenue) net of opportunity costs	Estimated economic benefits are given in the BCA Summary Report, Section 3.1 Benefits, page 3-1. Methodologies are described in the BCA Methodology Report, Section 4.3 Economic Revitalization, page 4-10. Qualitative benefits are also described in the BCA Summary Report, Section 4 Qualitative Benefits, page 4-1.
A description of risks to ongoing benefits from the proposed project	
What are the key risks and uncertainties that may affect the RBD project and how do those risks affect the positive and negative effects of the project? Especially risks resulting from climate change and the cost of loss of function or service provided by the project, if applicable.	Risks to the project are described in the BCA Summary Report, Section 7.1 Risks to Project Benefits, page 7-1.
How well can the RBD project be adapted in case any of these risks occur?	Project adaptability is discussed in the BCA Summary Report, Section 7.1 Risks to Project Benefits, page 7-1.
An assessment of challenges faced with implementing the RBD project	
Are there any political or stakeholder risks that could affect the project's implementation schedule?	Potential challenges to project implementation are discussed in detail in the BCA Summary Report, Section 7.2 Potential Challenges to Project Implementation, page 7-1.
What are the technical risks to this project	
What are the procedural (legal) risks to this project?	
Can the grantee demonstrate broad community support for the project? Are there any political and/or stakeholder issues? Have environmental groups serving low-income and minority populations been included in project planning and alternative development?	

APPENDIX C

Depth Damage Functions

Resilient Bridgeport Benefit Cost Analysis Methodology Report, Appendix C: Depth Damage Functions
BCA Structure Depth Damage Functions

Description		DDF No.	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	-0.5	0	0.5	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1A1 Apartments - 1 Story, No Basement, Inundation Damage	Min	1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%	10.0%	16.0%	23.0%	39.0%	45.5%	52.0%	55.5%	59.0%	56.4%	64.0%	71.6%	79.1%	86.7%	94.3%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
1A1 Apartments - 1 Story, No Basement, Inundation Damage	Most Likely	2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.0%	16.0%	25.0%	35.0%	43.0%	51.5%	60.0%	64.0%	68.0%	64.5%	72.2%	80.0%	87.7%	95.4%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
1A1 Apartments - 1 Story, No Basement, Inundation Damage	Max	3	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	14.0%	22.0%	38.0%	45.0%	60.0%	67.5%	75.0%	80.0%	85.0%	81.8%	91.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
1A-1 Apartments - 1 Story, No Basement, Wave Damage	Min	4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.5%	5.0%	25.0%	37.5%	43.8%	50.0%	42.30%	51.76%	61.22%	70.68%	80.14%	89.60%	99.06%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
1A-1 Apartments - 1 Story, No Basement, Wave Damage	Most Likely	5	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	12.5%	25.0%	37.5%	90.0%	95.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
1A-1 Apartments - 1 Story, No Basement, Wave Damage	Max	6	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	10.0%	21.3%	32.5%	65.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
1A-1 Apartments - 1 Story, No Basement, Wave Damage - Extended Foundation Wall	Min	7	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.8%	7.5%	25.0%	47.5%	61.3%	75.0%	82.5%	90.0%	82.0%	94.8%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
1A-1 Apartments - 1 Story, No Basement, Wave Damage - Extended Foundation Wall	Most Likely	8	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.0%	20.0%	42.5%	60.0%	80.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
1A-1 Apartments - 1 Story, No Basement, Wave Damage - Extended Foundation Wall	Max	9	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	13.8%	27.5%	55.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
1A-3 Apartments - 3 Story, No Basement, Inundation Damage	Min	10	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	7.0%	10.0%	18.0%	19.0%	20.0%	27.5%	35.0%	35.0%	35.0%	35.0%	36%	40%	43%	47%	50%	54%	58%	61%	65%	68%
1A-3 Apartments - 3 Story, No Basement, Inundation Damage	Most Likely	11	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	8.0%	20.0%	28.0%	28.0%	33.0%	38.0%	42.0%	46.0%	47.3%	48.7%	50.0%	52%	56%	60%	64%	68%	72%	77%	81%	85%	89%
1A-3 Apartments - 3 Story, No Basement, Inundation Damage	Max	12	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.0%	12.0%	25.0%	29.0%	30.0%	37.0%	44.0%	47.0%	50.0%	53.3%	56.7%	60.0%										
2 Commerical, Engineered, Inundation Damage	Min	13	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	12.0%	18.0%	28.0%	30.5%	33.0%	38.0%	43.0%	44.7%	46.3%	48.0%										
2 Commerical, Engineered, Inundation Damage	Most Likely	14	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	10.0%	20.0%	30.0%	35.0%	37.5%	40.0%	46.5%	53.0%	54.7%	56.3%	58.0%										
2 Commerical, Engineered, Inundation Damage	Max	15	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.0%	17.0%	27.0%	36.0%	43.0%	45.5%	48.0%	54.0%	60.0%	63.0%	66.0%	69.0%										
2 Commerical, Engineered, Wave Damage	Min	16	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.5%	5.0%	13.0%	25.0%	32.5%	40.0%	44.0%	48.0%	50.3%	52.7%	55.0%										
2 Commerical, Engineered, Wave Damage	Most Likely	17	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.5%	9.0%	20.0%	33.0%	44.0%	55.0%	60.0%	65.0%	70.7%	76.3%	82.0%										
2 Commerical, Engineered, Wave Damage	Max	18	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	1.0%	10.5%	20.0%	30.0%	50.0%	60.0%	70.0%	75.5%	81.0%	84.0%	87.0%	90.0%										
3 Commerical, Non/Pre-Engineered, Inundation Damage	Min	19	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	10.0%	15.0%	20.0%	24.0%	28.0%	31.5%	35.0%	36.7%	38.3%	40.0%										
3 Commerical, Non/Pre-Engineered, Inundation Damage	Most Likely	20	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	12.0%	20.0%	28.0%	35.0%	40.0%	45.0%	50.0%	55.0%	56.7%	58.3%	60.0%										
3 Commerical, Non/Pre-Engineered, Inundation Damage	Max	21	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.0%	15.0%	20.0%	30.0%	42.0%	55.0%	60.0%	65.0%	70.0%	75.0%	76.0%	77.0%	78.0%										
3 Commerical, Non/Pre-Engineered, Wave Damage	Min	22	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.3%	2.5%	9.0%	25.0%	35.0%	45.0%	47.5%	50.0%	55.0%	60.0%	65.0%										
3 Commerical, Non/Pre-Engineered, Wave Damage	Most Likely	23	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.3%	12.5%	30.0%	49.0%	62.0%	75.0%	87.5%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
3 Commerical, Non/Pre-Engineered, Wave Damage	Max	24	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	12.3%	24.5%	50.0%	80.0%	87.5%	95.0%	97.5%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
4A - Urban High Rise, Inundation Damage	Min	25	0.0%	0.0%	0.0%	0.2%	0.3%	0.5%	1.1%	1.8%	2.6%	3.5%	3.5%	5.5%	6.8%	8.0%	8.8%	9.5%	9.9%	10.3%	10.9%	11.5%	11.8%	12.2%	12.5%										
4A - Urban High Rise, Inundation Damage	Most Likely	26	0.0%	0.0%	0.0%	2.2%	4.3%	6.5%	7.8%	9.0%	11.0%	13.0%	13.3%	13.8%	14.3%	15.5%	17.5%	19.0%	20.3%	21.5%	22.0%	22.5%	22.8%	23.2%	23.5%										
4A - Urban High Rise, Inundation Damage	Max	27	0.0%	0.0%	0.0%	3.3%	6.7%	10.0%	11.3%	12.5%	14.3%	16.0%	17.8%	18.5%	19.3%	20.0%	22.5%	24.0%	24.5%	25.0%	25.3%	25.5%	25.8%	26.2%	26.5%										
4B - Beach High Rise, Inundation Damage	Min	28	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	2.0%	3.5%	4.5%	5.0%	5.5%	6.0%	6.5%	6.8%	7.2%	7.5%										
4B - Beach High Rise, Inundation Damage	Most Likely	29	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.3%	4.5%	7.0%	7.8%	9.6%	11.5%	12.1%	12.8%	14.0%	15.3%	16.5%										
4B - Beach High Rise, Inundation Damage	Max	30	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.3%	7.5%	12.0%	14.0%	14.5%	15.0%	16.1%	17.3%	18.2%	19.1%	20.0%										
4B - Beach High Rise, Wave Damage	Min	31	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%	1.8%	2.5%	3.3%	3.9%	4.5%	4.8%	5.0%	5.0%	5.0%	5.0%										
4B - Beach High Rise, Wave Damage	Most Likely	32	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	1.5%	3.3%	5.0%	7.5%	11.0%	12.5%	14.0%	15.0%	16.0%	17.2%	18.3%	19.5%										
4B - Beach High Rise, Wave Damage	Max	33	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.3%	2.5%	6.3%	10.0%	13.5%	17.0%	19.3%	21.5%	24.3%	27.0%	28.3%	29.7%	31.0%										
5A Single Story Residence, No Basement, Inundation Damage	Min	34	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.0%	10.0%	16.0%	20.0%	25.0%	30.0%	36.0%	42.0%	46.3%	50.7%	55.0%										
5A Single Story Residence, No Basement, Inundation Damage	Most Likely	35	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	10.0%	18.0%	28.0%	33.0%	37.5%	42.0%	48.5%	55.0%	58.3%	61.7%	65.0%										
5A Single Story Residence, No Basement, Inundation Damage	Max	36	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	10.0%	20.0%	30.0%	40.0%	45.0%	52.5%	60.0%	77.0%	94.0%	96.0%	98.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
5A Single Story Residence, No Basement, Wave Damage	Min	37	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.0%	20.0%	30.0%	40.0%	55.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%										
5A Single Story Residence, No Basement, Wave Damage	Most Likely	38	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	15.0%	30.0%	50.0%	90.0%	95.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
5A Single Story Residence, No Basement, Wave Damage	Max	39	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.0%	21.3%	32.5%	65.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
5A Single Story Residence, No Basement, Wave Damage- Extended Foundation Wall	Min	40	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.5%	5.0%	10.0%	15.0%	30.0%	50.0%	65.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%										
5A Single Story Residence, No Basement, Wave Damage- Extended Foundation Wall	Most Likely	41	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	7.5%	10.0%	25.0%	40.0%	70.0%	90.0%	95.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
5A Single Story Residence, No Basement, Wave Damage- Extended Foundation Wall	Max	42	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.0%	15.0%	20.0%	39.0%	58.0%	94.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
5B Two-Story Residence, No Basement, Inundation Damage	Min	43	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	9.0%	15.0%	20.0%	22.5%	25.0%	32.5%	40.0%	43.3%	46.7%	50.0%										
5B Two-Story Residence, No Basement, Inundation Damage	Most Likely	44	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	5.0%	10.0%	15.0%	20.0%	25.0%	27.5%	30.0%	40.0%	50.0%	53.3%	56.7%	60.0%										
5B Two-Story Residence, No Basement, Inundation Damage	Max	45	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	3.0%	8.0%	10.0%	20.0%	25.0%	30.0%	35.0%	40.0%	47.5%	55.0%	60.0%	65.0%	70.0%										
5B Two-Story Residence, No Basement, Wave Damage	Min	46	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.5%	5.0%	7.5%	10.0%	30.0%	40.0%	50.0%	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%										
5B Two-Story Residence, No Basement, Wave Damage	Most Likely	47	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.0%	15.0%	20.0%	28.0%	36.0%	50.0%	86.0%	93.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
5B Two-Story Residence, No Basement, Wave Damage	Max	48	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	15.0%	20.0%	25.0%	37.5%	50.0%	60.0%	94.0%	97.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
6A Single Story Residence, With Basement, Inundation Damage	Min	49	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	1.0%	2.0%	3.0%	4.0%	5.0%	10.0%	15.0%	25.0%	30.0%	40.0%	50.0%	57.0%	64.0%	71.0%	78.0%	85.0%										
6A Single Story Residence, With Basement, Inundation Damage	Most Likely	50	0.0%	0.0%	1.0%	1.7%	2.3%	3.0%	4.0%	5.0%	7.5%	10.0%	12.0%	18.0%	30.0%	30.0%	35.0%	40.0%	55.0%	70.0%	80.0%	90.0%	91.7%	93.3%	95.0%										
6A Single Story Residence, With Basement, Inundation Damage	Max	51	0.0%	0.0%	2.0%	4.7%	7.3%	10.0%	12.5%	15.0%	16.5%	18.0%	21.0%	30.0%	35.0%	43.0%	50.0%	55.0%	69.5%	84.0%	89.0%	94.0%	96.0%	98.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
6A Single Story Residence, With Basement, Wave Damage	Min	52	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.0%	7.0%	10.0%	12.5%	15.0%	48.0%	60.0%	77.0%	94.0%	94.0%	94.0%	94.0%	94.0%	94.0%										
6A Single Story Residence, With Basement, Wave Damage	Most Likely	53	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.0%	10.0%	15.0%	20.0%	27.5%	35.0%	60.0%	88.0%	94.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
6A Single Story Residence, With Basement, Wave Damage	Max	54	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	15.0%	24.5%	34.0%	44.0%	54.0%	75.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
6B Two-Story Residence, With Basement, Inundation Damage	Min	55	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	1.0%	2.0%	3.0%	4.0%	5.0%	7.0%	15.0%	17.0%	27.0%	33.5%	40.0%	45.0%	50.0%	54.0%	58.0%	62.0%										
6B Two-Story Residence, With Basement, Inundation Damage	Most Likely	56	0.0%	0.0%	0.0%	1.0%	2.0%	3.0%	5.0%	7.0%	8.5%	10.0%	12.0%	15.0%	20.0%	25.0%	30.0%	35.0%	42.5%	50.0%	55.0%	60.0%	63.3%	66.7%	70.0%										
6B Two-Story Residence, With Basement, Inundation Damage	Max	57	0.0%	0.0%	3.0%	4.7%	6.3%	8.0%	9.0%	10.0%	12.5%	15.0%	17.0%	20.0%	30.0%	30.0%	35.0%	40.0%	47.5%	55.0%	60.0%	65.0%	70.0%	75.0%	80.0%										
6B Two-Story Residence, With Basement, Wave Damage	Min	58	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.0%	7.0%	10.0%	12.5%	15.0%	35.0%	60.0%	65.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%										
6B Two-Story Residence, With Basement, Wave Damage	Most Likely	59	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	10.0%	15.0%	20.0%	27.5%	35.0%	60.0%	80.0%	90.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
6B Two-Story Residence, With Basement, Wave Damage	Max	60	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	18.0%	26.0%	34.0%	44.0%	54.0%	80.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
7A Building on Open Pile Foundation, Inundation Damage	Min	61	0.0%	0.0%	0.0%	0.3%	0.7%	1.0%	1.5%	2.0%	2.0%	2.0%	6.0%	7.0%	12.0%	30.0%	35.0%	40.0%	45.0%	50.0%	55.0%	60.0%	67.3%	74.7%	82.0%										
7A Building on Open Pile Foundation, Inundation Damage	Most Likely	62	0.0%	0.0%	0.0%	0.7%	1.3%	2.0%	3.0%	4.0%	8.0%	12.0%	16.0%	20.0%	28.0%	35.0%	40.0%	60.0%	65.0%	70.0%	75.0%	80.0%	86.7%	93.3%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
7A Building on Open Pile Foundation, Inundation Damage	Max	63	0.0%	0.0%	2.0%	4.7%	7.3%	10.0%	11.0%	12.0%	16.0%	20.0%	25.0%	32.0%	35.0%	55.0%	70.0%	80.0%	90.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
7A Building on Open Pile Foundation, Wave Damage	Min	64	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.5%	5.0%	12.5%	20.0%	30.0%	40.0%	80.0%	90.0%	95.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
7A Building on Open Pile Foundation, Wave Damage	Most Likely	65	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	4.0%	7.0%	10.0%	30.0%	50.0%	60.0%	70.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
7A Building on Open Pile Foundation, Wave Damage	Max	66	0.0%	0.0%	0.0%	0.7%	1.3%	2.0%	3.5%	5.0%	17.5%	30.0%	52.5%	75.0%	87.5%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
7B Building on Pile Foundation with Enclosures, Inundation Damage	Min	67	0.0%	0.0%	0.0%	0.3%	0.7%	1.0%	1.5%	2.0%	2.0%	2.0%	6.0%	7.0%	12.0%	30.0%	35.0%	40.0%	45.0%	50.0%	55.0%	60.0%	67.3%	74.7%	82.0%										
7B Building on Pile Foundation with Enclosures, Inundation Damage	Most Likely	68	0.0%	0.0%	0.0%	0.7%	1.3%	2.0%	3.0%	4.0%	8.0%	12.0%	16.0%	20.0%	28.0%	35.0%	40.0%	60.0%	65.0%	70.0%	75.0%	80.0%	86.7%	93.3%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
7B Building on Pile Foundation with Enclosures, Inundation Damage	Max	69	0.0%	0.0%	2.0%	4.7%	7.3%	10.0%	11.0%	12.0%	16.0%	20.0%	25.0%	32.0%	35.0%	55.0%	70.0%	80.0%	90.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
7B Building on Pile Foundation with Enclosures, Wave Damage	Min	70	0.0%	0.0%	0.0%	0.7%	1.3%	2.0%	2.0%	2.0%	11.0%	20.0%	22.5%	25.0%	42.5%	60.0%	85.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
7B Building on Pile Foundation with Enclosures, Wave Damage	Most Likely	71	0.0%	0.0%	0.0%	2.0%	4.0%	6.0%	10.0%	14.0%	27.0%	40.0%	50.0%	60.0%	72.5%	85.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
7B Building on Pile Foundation with Enclosures, Wave Damage	Max	72	0.0%	0.0%	0.0%	3.3%	6.7%	10.0%	15.0%	20.0%	40.0%	60.0%	67.5%	75.0%	87.5%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Resilient Bridgeport Benefit Cost Analysis Methodology Report, Appendix C: Depth Damage Functions
BCA Content Depth Damage Functions

Description		DDF No.	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	-0.5	0	0.5	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1A1 Apartments - 1 Story, No Basement, Inundation Damage	Min	1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.00%	10.00%	16.00%	23.00%	39.00%	45.50%	52.00%	55.50%	59.00%	59.00%	59.00%	59.00%										
1A1 Apartments - 1 Story, No Basement, Inundation Damage	Most Likely	2	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	10.00%	16.00%	25.00%	35.00%	43.00%	51.50%	60.00%	64.00%	68.00%	68.00%	68.00%	68.00%										
1A1 Apartments - 1 Story, No Basement, Inundation Damage	Max	3	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	14.00%	22.00%	38.00%	45.00%	60.00%	67.50%	75.00%	80.00%	85.00%	85.00%	85.00%	85.00%										
1A-1 Apartments - 1 Story, No Basement, Wave Damage	Min	4	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	8.75%	17.50%	30.00%	50.00%	60.75%	71.50%	71.50%	71.50%	71.50%	71.50%	71.50%										
1A-1 Apartments - 1 Story, No Basement, Wave Damage	Most Likely	5	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.75%	3.50%	16.75%	30.00%	50.00%	90.00%	95.00%	100.00%	100.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
1A-1 Apartments - 1 Story, No Basement, Wave Damage	Max	6	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	10.00%	23.75%	37.50%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
1A-1 Apartments - 1 Story, No Basement, Wave Damage - Extended Foundation Wall	Min	7	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.75%	7.50%	25.00%	47.50%	61.25%	75.00%	82.50%	90.00%	90.00%	90.00%	90.00%										
1A-1 Apartments - 1 Story, No Basement, Wave Damage - Extended Foundation Wall	Most Likely	8	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	10.00%	20.00%	42.50%	60.00%	80.00%	100.00%	100.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
1A-1 Apartments - 1 Story, No Basement, Wave Damage - Extended Foundation Wall	Max	9	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	13.75%	27.50%	55.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
1A-3 Apartments - 3 Story, No Basement, Inundation Damage	Min	10	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.00%	5.00%	8.00%	15.00%	20.00%	22.50%	25.00%	27.50%	30.00%	32.3%	34.7%	37%										
1A-3 Apartments - 3 Story, No Basement, Inundation Damage	Most Likely	11	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.00%	10.00%	15.00%	20.00%	25.00%	27.50%	30.00%	32.50%	35.00%	38.3%	41.7%	45%										
1A-3 Apartments - 3 Story, No Basement, Inundation Damage	Max	12	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	8.00%	15.00%	20.00%	25.00%	30.00%	31.00%	32.00%	36.00%	40.00%	43.3%	46.7%	50%										
2 Commerical, Engineered, Inundation Damage - Perishable	Min	13	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	17.00%	28.00%	37.00%	40.00%	43.00%	46.50%	50.00%	50.0%	50.0%	50%										
2 Commerical, Engineered, Inundation Damage - Perishable	Most Likely	14	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	18.00%	35.00%	39.00%	43.00%	45.00%	47.00%	58.50%	70.00%	71.7%	73.3%	75%										
2 Commerical, Engineered, Inundation Damage - Perishable	Max	15	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	8.00%	28.00%	50.00%	58.00%	65.00%	65.00%	65.00%	77.50%	90.00%	90.0%	90.0%	90%										
2 Commerical, Engineered, Inundation Damage - Non Perishable	Min	16	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	4.00%	10.00%	22.00%	27.00%	30.00%	33.00%	38.50%	44.00%	45.3%	46.7%	48%										
2 Commerical, Engineered, Inundation Damage - Non Perishable	Most Likely	17	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.00%	10.00%	13.00%	28.00%	37.00%	40.50%	44.00%	47.00%	50.00%	51.7%	53.3%	55%										
2 Commerical, Engineered, Inundation Damage - Non Perishable	Max	18	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	15.00%	22.00%	35.00%	44.00%	47.00%	50.00%	52.50%	55.00%	60.0%	65.0%	70%										
2 Commerical, Engineered, Wave Damage - Perishable	Min	19	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	10.00%	23.00%	33.00%	38.00%	43.00%	46.50%	50.00%	50.0%	50.0%	50%										
2 Commerical, Engineered, Wave Damage - Perishable	Most Likely	20	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.50%	3.00%	10.50%	18.00%	30.00%	41.00%	58.00%	75.00%	85.00%	95.00%	95.0%	95.0%	95%										
2 Commerical, Engineered, Wave Damage - Perishable	Max	21	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	4.00%	8.00%	18.00%	28.00%	45.00%	70.00%	85.00%	100.00%	100.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
2 Commerical, Engineered, Wave Damage - Non -Perishable	Min	22	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	4.50%	9.00%	11.00%	23.00%	29.00%	35.00%	42.50%	50.00%	50.0%	50.0%	50%										
2 Commerical, Engineered, Wave Damage - Non -Perishable	Most Likely	23	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.00%	2.00%	7.00%	12.00%	23.00%	36.00%	47.00%	58.00%	61.50%	65.00%	69.0%	73.0%	77%										
2 Commerical, Engineered, Wave Damage - Non -Perishable	Max	24	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.50%	5.00%	14.00%	23.00%	29.00%	55.00%	77.50%	100.00%	100.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
3 Commerical, Non/Pre-Engineered, Inundation Damage - Perishable	Min	25	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	9.00%	15.00%	23.00%	26.50%	30.00%	32.50%	35.00%	37.0%	39.0%	41%										
3 Commerical, Non/Pre-Engineered, Inundation Damage - Perishable	Most Likely	26	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.00%	15.00%	30.00%	42.00%	64.00%	67.50%	71.00%	75.50%	80.00%	82.3%	84.7%	87%										
3 Commerical, Non/Pre-Engineered, Inundation Damage - Perishable	Max	27	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	10.00%	35.00%	54.00%	65.00%	84.00%	89.50%	95.00%	97.00%	99.00%	99.3%	99.7%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
3 Commerical, Non/Pre-Engineered, Inundation Damage - Non-Perishable	Min	28	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.00%	7.00%	13.00%	20.00%	25.00%	30.00%	35.00%	40.00%	41.7%	43.3%	45%										
3 Commerical, Non/Pre-Engineered, Inundation Damage - Non-Perishable	Most Likely	29	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.00%	8.00%	12.00%	18.00%	25.00%	32.00%	39.00%	44.50%	50.00%	53.3%	56.7%	60%										
3 Commerical, Non/Pre-Engineered, Inundation Damage - Non-Perishable	Max	30	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	4.00%	18.00%	28.00%	38.00%	49.00%	56.50%	64.00%	68.00%	72.00%	78.0%	84.0%	90%										
3 Commerical, Non/Pre-Engineered, Wave Damage - Perishable	Min	31	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	10.00%	20.00%	32.50%	41.25%	50.00%	60.00%	70.00%	73.3%	76.7%	80%										
3 Commerical, Non/Pre-Engineered, Wave Damage - Perishable	Most Likely	32	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.25%	2.50%	11.25%	20.00%	40.00%	60.00%	77.50%	95.00%	97.50%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
3 Commerical, Non/Pre-Engineered, Wave Damage - Perishable	Max	33	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.75%	7.50%	21.25%	35.00%	61.00%	95.00%	97.50%	100.00%	100.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
3 Commerical, Non/Pre-Engineered, Wave Damage - Non-Perishable	Min	34	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.75%	7.50%	12.50%	29.00%	34.50%	40.00%	52.50%	65.00%	69.2%	73.3%	78%										
3 Commerical, Non/Pre-Engineered, Wave Damage - Non-Perishable	Most Likely	35	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.25%	2.50%	12.25%	22.00%	27.50%	45.00%	57.50%	70.00%	85.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
3 Commerical, Non/Pre-Engineered, Wave Damage - Non-Perishable	Max	36	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.25%	6.50%	18.25%	30.00%	45.00%	90.00%	95.00%	100.00%	100.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
4A - Urban High Rise, Inundation Damage	Min	37	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.50%	2.60%	4.00%	5.50%	6.00%	6.50%	7.25%	8.00%	8.3%	8.7%	9.00%										
4A - Urban High Rise, Inundation Damage	Most Likely	38	0.00%	0.00%	0.00%	0.1%	0.2%	0.25%	0.25%	0.25%	0.38%	0.50%	1.50%	4.00%	5.00%	5.00%	7.00%	7.50%	8.75%	10.00%	10.50%	11.00%	11.3%	11.7%	12.00%										
4A - Urban High Rise, Inundation Damage	Max	39	0.00%	0.00%	0.00%	0.2%	0.3%	0.50%	0.88%	1.25%	1.88%	2.50%	3.50%	5.00%	6.00%	8.00%	11.00%	13.50%	14.75%	16.00%	18.00%	20.00%	20.0%	20.0%	20.00%										
4B - Beach High Rise, Inundation Damage	Min	40	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.50%	1.00%	1.50%	2.00%	2.00%	2.00%	2.00%	2.00%	2.2%	2.3%	2.5%										
4B - Beach High Rise, Inundation Damage	Most Likely	41	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.00%	4.00%	4.50%	5.50%	6.25%	7.00%	7.75%	8.50%	8.7%	8.8%	9.0%										
4B - Beach High Rise, Inundation Damage	Max	42	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.50%	5.00%	5.50%	6.50%	8.00%	8.75%	9.50%	9.75%	10.00%	10.0%	10.0%	10.0%										
4B - Beach High Rise, Wave Damage	Min	43	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.63%	1.25%	1.75%	2.00%	2.00%	2.00%	2.00%	2.00%	2.5%	3.0%	3.5%										
4B - Beach High Rise, Wave Damage	Most Likely	44	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.63%	1.25%	1.88%	2.50%	5.00%	6.00%	7.00%	8.00%	8.00%	8.00%	8.3%	8.7%	9.0%										
4B - Beach High Rise, Wave Damage	Max	45	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.00%	2.00%	3.50%	5.00%	6.00%	9.00%	9.50%	10.00%	10.00%	10.00%	10.3%	10.7%	11.0%										
5A Single Story Residence, No Basement, Inundation Damage	Min	46	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	18.00%	34.00%	60.00%	70.00%	80.00%	90.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
5A Single Story Residence, No Basement, Inundation Damage	Most Likely	47	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	20.00%	40.00%	60.00%	80.00%	85.00%	90.00%	95.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
5A Single Story Residence, No Basement, Inundation Damage	Max	48	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	30.00%	60.00%	84.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
5A Single Story Residence, No Basement, Wave Damage	Min	49	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	7.50%	15.00%	35.00%	50.00%	55.00%	60.00%	60.00%	60.00%	60.00%	60.00%	60.00%										
5A Single Story Residence, No Basement, Wave Damage	Most Likely	50	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	20.00%	40.00%	60.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
5A Single Story Residence, No Basement, Wave Damage	Max	51	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	25.00%	50.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
5A Single Story Residence, No Basement, Wave Damage- Extended Foundation Wall	Min	52	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.50%	5.00%	8.50%	12.00%	40.00%	50.00%	62.50%	75.00%	75.00%	75.00%	75.00%	75.00%	75.00%										
5A Single Story Residence, No Basement, Wave Damage- Extended Foundation Wall	Most Likely	53	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	10.00%	20.00%	30.00%	60.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
5A Single Story Residence, No Basement, Wave Damage- Extended Foundation Wall	Max	54	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	15.00%	25.00%	42.50%	60.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
5B Two-Story Residence, No Basement, Inundation Damage	Min	55	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	15.00%	25.00%	32.00%	36.00%	40.00%	45.00%	50.00%	53.3%	56.7%	60%										
5B Two-Story Residence, No Basement, Inundation Damage	Most Likely	68	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	12.00%	25.00%	35.00%	45.00%	50.00%	55.00%	62.50%	70.00%	73.3%	76.7%	80%										
5B Two-Story Residence, No Basement, Inundation Damage	Max	57	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.00%	8.00%	20.00%	30.00%	40.00%	60.00%	70.00%	80.00%	90.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
5B Two-Story Residence, No Basement, Wave Damage	Min	58	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.50%	5.00%	10.00%	15.00%	30.00%	40.00%	57.50%	75.00%	75.00%	75.00%	75.00%	75.00%	75.00%										
5B Two-Story Residence, No Basement, Wave Damage	Most Likely	59	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	12.50%	20.00%	27.50%	35.00%	45.00%	94.00%	97.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
5B Two-Story Residence, No Basement, Wave Damage	Max	60	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	12.00%	18.50%	25.00%	32.50%	40.00%	70.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
6A Single Story Residence, With Basement, Inundation Damage	Min	61	0.00%	0.00%	0.00%	1.0%	2.0%	3.00%	4.00%	5.00%	5.00%	5.00%	5.00%	10.00%	15.00%	30.00%	52.00%	66.00%	73.00%	80.00%	90.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
6A Single Story Residence, With Basement, Inundation Damage	Most Likely	62	0.00%	0.00%	0.00%	1.0%	2.0%	3.00%	4.00%	5.00%	10.00%	15.00%	15.00%	15.00%	30.00%	45.00%	64.00%	80.00%	90.00%	100.00%	100.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
6A Single Story Residence, With Basement, Inundation Damage	Max	63	0.00%	0.00%	5.00%	8.0%	11.0%	14.00%	19.50%	25.00%	27.50%	30.00%	40.00%	48.00%	60.00%	80.00%	90.00%	97.00%	98.50%	100.00%	100.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
6A Single Story Residence, With Basement, Wave Damage	Min	64	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	10.00%	15.00%	20.00%	50.00%	60.00%	80.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
6A Single Story Residence, With Basement, Wave Damage	Most Likely	65	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	15.00%	25.00%	35.00%	42.50%	50.00%	80.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
6A Single Story Residence, With Basement, Wave Damage	Max	66	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	28.00%	36.00%	44.00%	59.00%	74.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
6B Two-Story Residence, With Basement, Inundation Damage	Min	67	0.00%	0.00%	0.00%	0.7%	1.3%	2.00%	3.50%	5.00%	5.00%	5.00%	5.00%	10.00%	15.00%	20.00%	30.00%	40.00%	45.00%	50.00%	55.00%	60.00%	64.0%	68.0%	72%										
6B Two-Story Residence, With Basement, Inundation Damage	Most Likely	56	0.00%	0.00%	0.00%	1.0%	2.0%	3.00%	4.00%	5.00%	10.00%	15.00%	15.00%	20.00%	30.00%	35.00%	40.00%	50.00%	55.00%	60.00%	65.00%	70.00%	76.7%	83.3%	90%										
6B Two-Story Residence, With Basement, Inundation Damage	Max	69	0.00%	0.00%	2.00%	4.7%	7.3%	10.00%	17.50%	25.00%	25.00%	25.00%	28.00%	34.00%	40.00%	50.00%	60.00%	70.00%	71.00%	72.00%	81.00%	90.00%	93.3%	96.7%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
6B Two-Story Residence, With Basement, Wave Damage	Min	70	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%	10.00%	17.50%	25.00%	50.00%	60.00%	72.50%	85.00%	85.00%	85.00%	85.00%	85.00%	85.00%										
6B Two-Story Residence, With Basement, Wave Damage	Most Likely	71	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	12.00%	23.50%	35.00%	45.00%	55.00%	75.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
6B Two-Story Residence, With Basement, Wave Damage	Max	72	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	10.00%	25.00%	34.50%	44.00%	62.00%	80.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
7A Building on Open Pile Foundation, Inundation Damage	Min	73	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.00%	5.00%	15.00%	30.00%	50.00%	60.00%	77.00%	94.00%	97.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
7A Building on Open Pile Foundation, Inundation Damage	Most Likely	74	0.00%	0.00%	0.00%	0.3%	0.7%	1.00%	1.00%	1.00%	1.00%	1.00%	5.00%	10.00%	25.00%	40.00%	50.00%	80.00%	89.00%	98.00%	99.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
7A Building on Open Pile Foundation, Inundation Damage	Max	75	0.00%	0.00%	0.00%	0.3%	0.7%	1.00%	1.00%	1.00%	3.00%	5.00%	10.00%	17.00%	30.00%	50.00%	75.00%	90.00%	95.00%	100.00%	100.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
7A Building on Open Pile Foundation, Wave Damage	Min	76	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.50%	3.00%	4.00%	5.00%	12.50%	20.00%	30.00%	40.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
7A Building on Open Pile Foundation, Wave Damage	Most Likely	77	0.00%	0.00%	0.00%	1.7%	3.3%	5.00%	5.00%	5.00%	12.50%	20.00%	35.00%	50.00%	62.50%	75.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

BCA Content Depth Damage Functions

Description		DDF No.	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	-0.5	0	0.5
7A Building on Open Pile Foundation, Wave Damage	Max	78	0.00%	0.00%	0.00%	2.7%	5.3%	8.00%	9.00%	10.00%	25.00%	40.00%	57.50%	75.00%	87.50%
7B Building on Pile Foundation with Enclosures, Inundation Damage	Min	79	0.00%	0.00%	0.00%	0.3%	0.7%	1.00%	1.00%	1.00%	1.50%	2.00%	5.00%	5.00%	15.00%
7B Building on Pile Foundation with Enclosures, Inundation Damage	Most Likely	80	0.00%	0.00%	0.00%	1.3%	2.7%	4.00%	5.50%	7.00%	9.00%	11.00%	20.00%	20.00%	30.00%
7B Building on Pile Foundation with Enclosures, Inundation Damage	Max	81	0.00%	0.00%	0.00%	2.7%	5.3%	8.00%	9.00%	10.00%	15.00%	20.00%	40.00%	50.00%	65.00%
7B Building on Pile Foundation with Enclosures, Wave Damage	Min	82	0.00%	0.00%	0.00%	0.7%	1.3%	2.00%	3.50%	5.00%	6.50%	8.00%	16.50%	25.00%	32.50%
7B Building on Pile Foundation with Enclosures, Wave Damage	Most Likely	83	0.00%	0.00%	0.00%	1.7%	3.3%	5.00%	7.50%	10.00%	25.00%	40.00%	45.00%	50.00%	62.50%
7B Building on Pile Foundation with Enclosures, Wave Damage	Max	84	0.00%	0.00%	5.00%	6.7%	8.3%	10.00%	15.00%	20.00%	40.00%	60.00%	67.50%	75.00%	87.50%

Description		DDF No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
7A Building on Open Pile Foundation, Wave Damage	Max	78	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
7B Building on Pile Foundation with Enclosures, Inundation Damage	Min	79	35.00%	60.00%	70.00%	80.00%	90.00%	95.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
7B Building on Pile Foundation with Enclosures, Inundation Damage	Most Likely	80	40.00%	75.00%	85.00%	92.50%	100.00%	100.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
7B Building on Pile Foundation with Enclosures, Inundation Damage	Max	81	75.00%	80.00%	90.00%	95.00%	100.00%	100.00%	100.00%	100.0%	100.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
7B Building on Pile Foundation with Enclosures, Wave Damage	Min	82	40.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
7B Building on Pile Foundation with Enclosures, Wave Damage	Most Likely	83	75.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
7B Building on Pile Foundation with Enclosures, Wave Damage	Max	84	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

BCA Displacement Depth Damage Functions

Description		DDF No.	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1A1 Apartments - 1 Story, No Basement, Inundation Damage	Min	1	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
1A1 Apartments - 1 Story, No Basement, Inundation Damage	Most Likely	2	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
1A1 Apartments - 1 Story, No Basement, Inundation Damage	Max	3	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
1A-1 Apartments - 1 Story, No Basement, Wave Damage	Min	4	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
1A-1 Apartments - 1 Story, No Basement, Wave Damage	Most Likely	5	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
1A-1 Apartments - 1 Story, No Basement, Wave Damage	Max	6	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
1A-1 Apartments - 1 Story, No Basement, Wave Damage - Extended Foundation Wall	Min	7	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
1A-1 Apartments - 1 Story, No Basement, Wave Damage - Extended Foundation Wall	Most Likely	8	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
1A-1 Apartments - 1 Story, No Basement, Wave Damage - Extended Foundation Wall	Max	9	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
1A-3 Apartments - 3 Story, No Basement, Inundation Damage	Min	10	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
1A-3 Apartments - 3 Story, No Basement, Inundation Damage	Most Likely	11	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
1A-3 Apartments - 3 Story, No Basement, Inundation Damage	Max	12	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
2 Commerical, Engineered, Inundation Damage - Perishable	Min	13	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
2 Commerical, Engineered, Inundation Damage - Perishable	Most Likely	14	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
2 Commerical, Engineered, Inundation Damage - Perishable	Max	15	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
2 Commerical, Engineered, Inundation Damage - Non Perishable	Min	16	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
2 Commerical, Engineered, Inundation Damage - Non Perishable	Most Likely	17	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
2 Commerical, Engineered, Inundation Damage - Non Perishable	Max	18	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
2 Commerical, Engineered, Wave Damage - Perishable	Min	19	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
2 Commerical, Engineered, Wave Damage - Perishable	Most Likely	20	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
2 Commerical, Engineered, Wave Damage - Perishable	Max	21	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
2 Commerical, Engineered, Wave Damage - Non -Perishable	Min	22	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
2 Commerical, Engineered, Wave Damage - Non -Perishable	Most Likely	23	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
2 Commerical, Engineered, Wave Damage - Non -Perishable	Max	24	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
3 Commerical, Non/Pre-Engineered, Inundation Damage - Perishable	Min	25	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
3 Commerical, Non/Pre-Engineered, Inundation Damage - Perishable	Most Likely	26	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
3 Commerical, Non/Pre-Engineered, Inundation Damage - Perishable	Max	27	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
3 Commerical, Non/Pre-Engineered, Inundation Damage - Non-Perishable	Min	28	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
3 Commerical, Non/Pre-Engineered, Inundation Damage - Non-Perishable	Most Likely	29	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
3 Commerical, Non/Pre-Engineered, Inundation Damage - Non-Perishable	Max	30	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
3 Commerical, Non/Pre-Engineered, Wave Damage - Perishable	Min	31	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
3 Commerical, Non/Pre-Engineered, Wave Damage - Perishable	Most Likely	32	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
3 Commerical, Non/Pre-Engineered, Wave Damage - Perishable	Max	33	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
3 Commerical, Non/Pre-Engineered, Wave Damage - Non-Perishable	Min	34	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
3 Commerical, Non/Pre-Engineered, Wave Damage - Non-Perishable	Most Likely	35	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
3 Commerical, Non/Pre-Engineered, Wave Damage - Non-Perishable	Max	36	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
4A - Urban High Rise, Inundation Damage	Min	37	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
4A - Urban High Rise, Inundation Damage	Most Likely	38	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
4A - Urban High Rise, Inundation Damage	Max	39	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
4B - Beach High Rise, Inundation Damage	Min	40	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
4B - Beach High Rise, Inundation Damage	Most Likely	41	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
4B - Beach High Rise, Inundation Damage	Max	42	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
4B - Beach High Rise, Wave Damage	Min	43	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
4B - Beach High Rise, Wave Damage	Most Likely	44	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
4B - Beach High Rise, Wave Damage	Max	45	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	450	450	450	450	450
5A Single Story Residence, No Basement, Inundation Damage	Min	46	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
5A Single Story Residence, No Basement, Inundation Damage	Most Likely	47	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
5A Single Story Residence, No Basement, Inundation Damage	Max	48	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
5A Single Story Residence, No Basement, Wave Damage	Min	49	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
5A Single Story Residence, No Basement, Wave Damage	Most Likely	50	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
5A Single Story Residence, No Basement, Wave Damage	Max	51	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
5A Single Story Residence, No Basement, Wave Damage- Extended Foundation Wall	Min	52	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
5A Single Story Residence, No Basement, Wave Damage- Extended Foundation Wall	Most Likely	53	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
5A Single Story Residence, No Basement, Wave Damage- Extended Foundation Wall	Max	54	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
5B Two-Story Residence, No Basement, Inundation Damage	Min	55	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
5B Two-Story Residence, No Basement, Inundation Damage	Most Likely	68	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
5B Two-Story Residence, No Basement, Inundation Damage	Max	57	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
5B Two-Story Residence, No Basement, Wave Damage	Min	58	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
5B Two-Story Residence, No Basement, Wave Damage	Most Likely	59	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
5B Two-Story Residence, No Basement, Wave Damage	Max	60	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
6A Single Story Residence, With Basement, Inundation Damage	Min	61	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
6A Single Story Residence, With Basement, Inundation Damage	Most Likely	62	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
6A Single Story Residence, With Basement, Inundation Damage	Max	63	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720

BCA Displacement Depth Damage Functions

Description		DDF No.	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
6A Single Story Residence, With Basement, Wave Damage	Min	64	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
6A Single Story Residence, With Basement, Wave Damage	Most Likely	65	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
6A Single Story Residence, With Basement, Wave Damage	Max	66	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
6B Two-Story Residence, With Basement, Inundation Damage	Min	67	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
6B Two-Story Residence, With Basement, Inundation Damage	Most Likely	56	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
6B Two-Story Residence, With Basement, Inundation Damage	Max	69	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
6B Two-Story Residence, With Basement, Wave Damage	Min	70	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
6B Two-Story Residence, With Basement, Wave Damage	Most Likely	71	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
6B Two-Story Residence, With Basement, Wave Damage	Max	72	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
7A Building on Open Pile Foundation, Inundation Damage	Min	73	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
7A Building on Open Pile Foundation, Inundation Damage	Most Likely	74	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
7A Building on Open Pile Foundation, Inundation Damage	Max	75	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
7A Building on Open Pile Foundation, Wave Damage	Min	76	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
7A Building on Open Pile Foundation, Wave Damage	Most Likely	77	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
7A Building on Open Pile Foundation, Wave Damage	Max	78	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
7B Building on Pile Foundation with Enclosures, Inundation Damage	Min	79	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
7B Building on Pile Foundation with Enclosures, Inundation Damage	Most Likely	80	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
7B Building on Pile Foundation with Enclosures, Inundation Damage	Max	81	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
7B Building on Pile Foundation with Enclosures, Wave Damage	Min	82	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
7B Building on Pile Foundation with Enclosures, Wave Damage	Most Likely	83	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720
7B Building on Pile Foundation with Enclosures, Wave Damage	Max	84	0	0	0	0	0	0	0	0	0	0	0	45	90	135	180	225	270	315	360	405	450	495	540	585	630	675	720	720	720	720	720

APPENDIX D

Rebuild by Design Pilot Project Cost Estimates

Rebuild By Design Project

Bridgeport, CT

Cost Estimate

Summary of All Project Costs
Date: March 17, 2017
Compiled by: SMC
Checked by: RCS

Description	Cost	Cost per LF
Johnson Street Extension	$ 599,700	$ 2,670
24" RCP	$ 166,100	$ 240
16" Force Main	$ 177,600	$ 200

Cost of Work	**$ 943,400.00**	**$ 3,110.00**
Design Contingency (35%)	$ 330,190.00	$ 1,088.50
General Requirements (20%)	$ 188,680.00	$ 622.00
Overhead and Profit (15%)	$ 141,510.00	$ 466.50
Escalation (3%)	$ 28,302.00	$ 93.30
Mobilization	$ 50,000.00	$ -
Maintenance of Traffic	$ 87,500.00	$ -
Pump	$ 2,100,000.00	$ -
Total	**$ 3,869,582.00**	**$ 5,380.30**

Assumptions

- Assumes no contaminated materials disposal
- Assumes normal daytime work hours
- Assumes no temporary security fencing or lighting required
- Assumes adjacent electrical supply for pump station with tap in to system at the pump.
    - No electrical work to connect to power source off site.
- Assumes no unknown buried utilities or relocation of existing utilities

Rebuild By Design Project

Bridgeport, CT

Cost Estimate

Project Component: Johnson Street Extension
Date: March 17, 2017
Compiled by: SMC
Checked by: RCS

JOHNSON STREET EXTENSION						
Description	**Unit**	**Qty**	**Unit Cost**	**Adjusted Unit Cost**	**Cost**	**Cost per LF**
		Rounded Subtotal =			**$ 348,900**	**$ 390**
Earthwork - fill	CY	10759.00	$ 2.32	$ 2.54	$ 27,307.20	$ 30.34
Earthwork - grading	SY	4400.00	$ 0.72	$ 0.79	$ 3,465.79	$ 3.85
Earthwork - hauling	LCY	8868.33	$ 5.96	$ 6.52	$ 57,823.66	$ 64.25
Base Material	CY	733.33	$ 5.92	$ 6.48	$ 4,749.42	$ 5.28
Asphalt Pavement	SY	1100.00	$ 75.00	$ 75.00	$ 82,500.00	$ 91.67
Concrete Formwork - Sidewalk	LF	4480.00	$ 2.77	$ 3.03	$ 13,576.10	$ 15.08
Curb - straight (including forms)	LF	900.00	$ 10.62	$ 11.62	$ 10,456.45	$ 11.62
Curb - radius (including forms)	LF	188.50	$ 17.40	$ 19.04	$ 3,588.13	$ 3.99
Sidewalk	SF	14400.00	$ 2.35	$ 2.57	$ 37,020.96	$ 41.13
Curb Ramps	EA	4.00	$ 5,000.00	$ 5,470.00	$ 21,880.00	$ 24.31
Driveways	SF	600.00	$ 4.85	$ 5.31	$ 3,183.54	$ 3.54
Inlets	EA	8.00	$ 3,000.00	$ 3,000.00	$ 24,000.00	$ 26.67
Electrical Service Extension	LF	900.00	$ 25.00	$ 25.00	$ 22,500.00	$ 25.00
Street Lighting - Pole	EA	10.00	$ 1,861.00	$ 2,035.93	$ 20,359.34	$ 22.62
Street Lighting - Bracket Arm	EA	10.00	$ 238.00	$ 260.37	$ 2,603.72	$ 2.89
Street Lighting - Luminaire	EA	10.00	$ 1,018.00	$ 1,113.69	$ 11,136.92	$ 12.37
Pavement Markings	LF	4600.00	$ 0.53	$ 0.58	$ 2,667.17	$ 2.96

COLUMBIA STREET AND INTERSECTION						
Description	**Unit**	**Qty**	**Unit Cost**	**Adjusted Unit Cost**	**Cost**	**Cost per LF**
		Rounded Subtotal =			**$ 250,800**	**$ 2,280**
Earthwork - fill	CY	483.00	$ 2.32	$ 2.54	$ 1,225.89	$ 11.14
Earthwork - grading	SY	140030.00	$ 0.72	$ 0.79	$ 110,298.83	$ 1,002.72
Earthwork - hauling	LCY	529.85	$ 5.96	$ 6.52	$ 3,454.76	$ 31.41
Base Material	CY	1265.00	$ 5.92	$ 6.48	$ 8,192.75	$ 74.48
Asphalt Pavement	SY	281.11	$ 75.00	$ 75.00	$ 21,083.33	$ 191.67
Concrete Formwork - Sidewalk	LF	578.00	$ 2.77	$ 3.03	$ 1,751.56	$ 15.92
Curb - straight (including forms)	LF	220.00	$ 10.62	$ 11.62	$ 2,556.02	$ 23.24
Sidewalk	SF	1540.00	$ 2.35	$ 2.57	$ 3,959.19	$ 35.99
Driveways	SF	400.00	$ 4.85	$ 5.31	$ 2,122.36	$ 19.29
Inlets	EA	3.00	$ 3,000.00	$ 3,000.00	$ 9,000.00	$ 81.82
Hydrants and water utilities	LS	1.00	$ 80,000.00	$ 80,000.00	$ 80,000.00	$ 727.27
Street Lighting - Pole	EA	2.00	$ 1,861.00	$ 2,035.93	$ 4,071.87	$ 37.02
Street Lighting - Bracket Arm	EA	2.00	$ 238.00	$ 260.37	$ 520.74	$ 4.73
Street Lighting - Luminaire	EA	2.00	$ 1,018.00	$ 1,113.69	$ 2,227.38	$ 20.25
Pavement Markings	LF	440.00	$ 0.53	$ 0.58	$ 255.12	$ 2.32

Cost of Work		**$ 599,538.22**	**$ 2,666.85**
Design Contigency	35.00%	$ 209,838.38	$ 933.40
General Requirements	20.00%	$ 119,907.64	$ 533.37
Overhead and Profit	15.00%	$ 89,930.73	$ 400.03
Escalation	3.00%	$ 17,986.15	$ 80.01
Total		**$ 1,037,201.13**	**$ 4,613.65**

Rebuild By Design Project

Bridgeport, CT

Cost Estimate

Project Component: 24" RCP Installation
Date: March 17, 2017
Compiled by: SMC
Checked by: RCS

24" RCP INSTALLATION						
Description	**Unit**	**Qty**	**Unit Cost**	**Adjusted Unit Cost**	**Cost**	**Cost per LF**
		Rounded Subtotal =			**$ 166,100**	**$ 240**
Excavation	CY	2333.33	$ 6.12	$ 6.70	$ 15,622.32	$ 22.32
Trench Shoring	SF	12600.00	$ 7.91	$ 8.65	$ 109,034.60	$ 155.76
24" RCP	LF	700.00	$ 44.90	$ 49.12	$ 34,384.42	$ 49.12
Fill and Compact	CY	2251.88	$ 2.84	$ 3.11	$ 6,996.52	$ 10.00

Cost of Work		**$ 166,037.86**	**$ 237.20**
Design Contigency	35.00%	$ 58,113.25	$ 83.02
General Requirements	20.00%	$ 33,207.57	$ 47.44
Overhead and Profit	15.00%	$ 24,905.68	$ 35.58
Escalation	3.00%	$ 4,981.14	$ 7.12
Total		**$ 287,245.50**	**$ 410.35**

Rebuild By Design Project

Bridgeport, CT

Cost Estimate

Project Component: 16" Force Main Installation
Date: March 17, 2017
Compiled by: SMC
Checked by: RCS

16" FORCE MAIN INSTALLATION						
Description	**Unit**	**Qty**	**Unit Cost**	**Adjusted Unit Cost**	**Cost**	**Cost per LF**
			Rounded Subtotal =		**$ 177,600**	**$ 200**
16" Force Main	LF	900.00	$ 85.39	$ 93.42	$ 84,074.99	$ 93.42
Valves and fittings for force main	LS	1.00	$ 75,000.00	$ 75,000.00	$ 75,000.00	$ 83.33
Sidewalk	SF	7200.00	$ 2.35	$ 2.57	$ 18,510.48	$ 20.57

Cost of Work		**$ 177,585.47**	**$ 197.32**
Design Contigency	35.00%	$ 62,154.92	$ 69.06
General Requirements	20.00%	$ 35,517.09	$ 39.46
Overhead and Profit	15.00%	$ 26,637.82	$ 29.60
Escalation	3.00%	$ 5,327.56	$ 5.92
Total		**$ 307,222.87**	**$ 341.36**

APPENDIX E

Occupancy Mapping

Land Use Code	Description	Hazus Occupancy Code	DDF Category	Occ Mapping	Stories Analysis	BRV	CSRV	CRV	BMRV	% Own Occ	1 Time Disruption Cost	None	Slight	Moderate	Extensive	Complete	Rent/SF/Year	DDF ID	HazusOcc	Output/SF/Day
101	Single Family	RES1	Urban High Rise	101H	10	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	26	RES1	0
101	Single Family	RES1	Residential 1-Story, No Basement	101L	1	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	35	RES1	0
101	Single Family	RES1	Residential 2-Story, No Basement	101M	2	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	44	RES1	0
102	Two Family	RES3A	Urban High Rise	102H	10	$107.23	0.69	$73.99	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	26	RES3A	0
102	Two Family	RES3A	Residential 1-Story, No Basement	102L	1	$107.23	0.69	$73.99	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	35	RES3A	0
102	Two Family	RES3A	Residential 2-Story, No Basement	102M	2	$107.23	0.69	$73.99	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	44	RES3A	0
103	Three Family	RES3B	Urban High Rise	103H	10	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	26	RES3B	0
103	Three Family	RES3B	Apartment 1-Story, No Basement	103L	1	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	2	RES3B	0
103	Three Family	RES3B	Apartment 3-Story, No Basement	103M	3	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	11	RES3B	0
104	Four Family	RES3B	Urban High Rise	104H	10	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	26	RES3B	0
104	Four Family	RES3B	Apartment 1-Story, No Basement	104L	1	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	2	RES3B	0
104	Four Family	RES3B	Apartment 3-Story, No Basement	104M	3	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	11	RES3B	0
105	Five Family	RES3C	Urban High Rise	105H	10	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	26	RES3C	0
105	Five Family	RES3C	Apartment 1-Story, No Basement	105L	1	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	2	RES3C	0
105	Five Family	RES3C	Apartment 3-Story, No Basement	105M	3	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	11	RES3C	0
106	Six Family	RES3C	Urban High Rise	106H	10	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	26	RES3C	0
106	Six Family	RES3C	Apartment 1-Story, No Basement	106L	1	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	2	RES3C	0
106	Six Family	RES3C	Apartment 3-Story, No Basement	106M	3	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	11	RES3C	0
107	SFR W/Acc. Apt	RES1	Residential 2-Story, No Basement	107M	2	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	44	RES1	0
108	Condominium	RES1	Urban High Rise	108H	10	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	26	RES1	0
108	Condominium	RES1	Apartment 1-Story, No Basement	108L	1	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	2	RES1	0
108	Condominium	RES1	Apartment 3-Story, No Basement	108M	3	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	11	RES1	0
112	Res. Waterfront	RES1	Residential 1-Story, No Basement	112L	1	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	35	RES1	0
112	Res. Waterfront	RES1	Residential 2-Story, No Basement	112M	2	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	44	RES1	0
200	Com Mld 94	COM1	Urban High Rise	200H	10	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	26	COM1	0.54
200	Com Mld 94	COM1	Commercial Engineered	200L	2	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	14	COM1	0.54
200	Com Mld 94	COM1	Commercial Engineered	200M	2	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	14	COM1	0.54
202	Comm WF Mdl 95	COM1	Commercial Engineered	202M	2	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	14	COM1	0.54
203	Acc Comm Lnd	COM1	Urban High Rise	203H	10	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	26	COM1	0.54
203	Acc Comm Lnd	COM1	Commercial Engineered	203L	2	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	26	COM1	0.54
203	Acc Comm Lnd	COM1	Commercial Engineered	203M	2	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	14	COM1	0.54
205	Comm Condo	COM1	Commercial Engineered	205L	2	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	14	COM1	0.54
206	Comm WF Mdl 96	COM1	Commercial Engineered	206L	2	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	14	COM1	0.54
215	Retail Strip/Plaza	COM1	Urban High Rise	215H	10	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	26	COM1	0.54
215	Retail Strip/Plaza	COM1	Commercial Engineered	215L	2	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	14	COM1	0.54
215	Retail Strip/Plaza	COM1	Commercial Engineered	215M	2	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	14	COM1	0.54
217	Retail	COM1	Urban High Rise	217H	10	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	26	COM1	0.54
217	Retail	COM1	Commercial Engineered	217L	2	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	14	COM1	0.54
217	Retail	COM1	Commercial Engineered	217M	2	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	14	COM1	0.54
218	Office	COM4	Urban High Rise	218H	10	$183.48	0.54	$99.08	$44.91	55%	1.12	0.5	0.1	0.1	0.2	0.3	$10.05	26	COM4	1.2
218	Office	COM4	Commercial Engineered	218M	2	$183.48	0.54	$99.08	$44.91	55%	1.12	0.5	0.1	0.1	0.2	0.3	$10.05	14	COM4	1.2
220	Professional Office	COM4	Urban High Rise	220H	10	$183.48	0.54	$99.08	$44.91	55%	1.12	0.5	0.1	0.1	0.2	0.3	$10.05	26	COM4	1.2
221	Fast Food	COM8	Commercial Engineered	221L	2	$233.01	1.7	$396.13	$40.33	55%	0	0.5	0.1	1	1	1	$10.05	26	COM8	1.29
221	Fast Food	COM8	Urban High Rise	221H	10	$233.01	1.7	$396.13	$40.33	55%	0	0.5	0.1	1	1	1	$10.05	26	COM8	1.29
222	Marina/Yacht Club	COM8	Commercial Engineered	222L	2	$233.01	1.7	$396.13	$40.33	55%	0	0.5	0.1	1	1	1	$10.05	14	COM8	1.29
222	Marina/Yacht Club	COM8	Commercial Engineered	222M	2	$233.01	1.7	$396.13	$40.33	55%	0	0.5	0.1	1	1	1	$10.05	14	COM8	1.29
225	Com Garage Shop	COM3	Urban High Rise	225H	10	$148.21	2.36	$349.78	$38.91	55%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	26	COM3	0.83
225	Com Garage Shop	COM3	Commercial Engineered	225L	2	$148.21	2.36	$349.78	$38.91	55%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	14	COM3	0.83
225	Com Garage Shop	COM3	Commercial Engineered	225M	2	$148.21	2.36	$349.78	$38.91	55%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	14	COM3	0.83
228	Funeral Home	COM4	Urban High Rise	228H	10	$183.48	0.54	$99.08	$44.91	55%	1.12	0.5	0.1	0.1	0.2	0.3	$10.05	26	COM4	1.2
229	Nursing Home	RES6	Urban High Rise	229H	10	$224.80	0.69	$155.11	$37.74	0%	0.97	0	0	0.5	1	1	$13.13	26	RES6	1.03
229	Nursing Home	RES6	Commercial Engineered	229M	2	$224.80	0.69	$155.11	$37.74	0%	0.97	0	0	0.5	1	1	$13.13	26	RES6	1.03
230	Restaurant/Bar	COM8	Urban High Rise	230H	10	$233.01	1.7	$396.13	$40.33	55%	0	0.5	0.1	1	1	1	$10.05	26	COM8	1.29
230	Restaurant/Bar	COM8	Commercial Engineered	230L	2	$233.01	1.7	$396.13	$40.33	55%	0	0.5	0.1	1	1	1	$10.05	14	COM8	1.29
230	Restaurant/Bar	COM8	Commercial Engineered	230M	2	$233.01	1.7	$396.13	$40.33	55%	0	0.5	0.1	1	1	1	$10.05	14	COM8	1.29
231	Bank	COM5	Urban High Rise	231H	10	$276.60	0.54	$149.36	$38.59	75%	1.12	0.5	0.1	0.05	0.03	0.03	$10.05	26	COM5	3.9
232	Theatre	COM9	Commercial Engineered	232L	2	$195.78	0.54	$105.72	$0.00	45%	0	0.5	0.1	1	1	1	$10.05	14	COM9	1.23
237	Hotel/Motel	RES4	Urban High Rise	237H	10	$192.14	0.69	$132.57	$40.99	0%	0.97	0	0	0.5	1	1	$13.13	26	RES4	0.62
245	Gas Mart	COM1	Urban High Rise	245H	10	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	26	COM1	0.54
278	Res Style Com	COM1	Urban High Rise	278H	10	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	26	COM1	0.54
278	Res Style Com	COM1	Commercial Engineered	278M	2	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	14	COM1	0.54
279	Telephone Bldg	COM4	Urban High Rise	279H	10	$183.48	0.54	$99.08	$44.91	55%	1.12	0.5	0.1	0.1	0.2	0.3	$10.05	26	COM4	1.2
280	Mix Use Comm	COM1	Urban High Rise	280H	10	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	26	COM1	0.54
280	Mix Use Comm	COM1	Commercial Engineered	280M	2	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	14	COM1	0.54
282	Office/Retail	COM1	Urban High Rise	282H	10	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	26	COM1	0.54
282	Office/Retail	COM1	Commercial Engineered	282M	2	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	14	COM1	0.54
286	Assisted Living	RES6	Urban High Rise	286H	10	$224.80	0.69	$155.11	$37.74	0%	0.97	0	0	0.5	1	1	$13.13	26	RES6	1.03
292	Self Storage	IND2	Urban High Rise	292H	10	$123.23	2.07	$255.09	$33.14	75%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	26	IND2	2.08

Land Use Code	Description	Hazus Occupancy Code	DDF Category	Occ Mapping	Stories Analysis	BRV	CSRV	CRV	BMRV	% Own Occ	1 Time Disruption Cost	None	Slight	Moderate	Extensive	Complete	Rent/SF/Year	DDF ID	HazusOcc	Output/SF/Day
292	Self Storage	IND2	Commercial Non-Engineered	292L	1	$123.23	2.07	$255.09	$33.14	75%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	20	IND2	2.08
296	Com MDL 96	COM1	Urban High Rise	296H	10	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	26	COM1	0.54
296	Com MDL 96	COM1	Commercial Engineered	296L	2	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	14	COM1	0.54
299	Vac Comm Lnd	COM1	Urban High Rise	299H	10	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	26	COM1	0.54
299	Vac Comm Lnd	COM1	Commercial Engineered	299L	2	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	14	COM1	0.54
299	Vac Comm Lnd	COM1	Commercial Engineered	299M	2	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	14	COM1	0.54
300	Industrial Mdl 96	IND1	Urban High Rise	300H	10	$140.17	2.07	$290.16	$36.13	75%	0	0.5	0.5	1	1	1	$10.05	26	IND1	2.08
300	Industrial Mdl 96	IND1	Commercial Non-Engineered	300L	1	$140.17	2.07	$290.16	$36.13	75%	0	0.5	0.5	1	1	1	$10.05	20	IND1	2.08
300	Industrial Mdl 96	IND1	Commercial Non-Engineered	300M	1	$140.17	2.07	$290.16	$36.13	75%	0	0.5	0.5	1	1	1	$10.05	20	IND1	2.08
303	Acc Ind Lnd	IND2	Commercial Non-Engineered	303M	1	$123.23	2.07	$255.09	$33.14	75%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	20	IND2	2.08
306	Ind WF Mdl 96	IND2	Commercial Non-Engineered	306L	1	$123.23	2.07	$255.09	$33.14	75%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	20	IND2	2.08
306	Ind WF Mdl 96	IND2	Commercial Non-Engineered	306M	1	$123.23	2.07	$255.09	$33.14	75%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	20	IND2	2.08
325	Ind Garage/Shop	COM3	Urban High Rise	325H	10	$148.21	2.36	$349.78	$38.91	55%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	26	COM3	0.83
325	Ind Garage/Shop	COM3	Commercial Non-Engineered	325L	1	$148.21	2.36	$349.78	$38.91	55%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	20	COM3	0.83
340	Ind/Whs Mdl 96	IND2	Urban High Rise	340H	10	$123.23	2.07	$255.09	$33.14	75%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	26	IND2	2.08
340	Ind/Whs Mdl 96	IND2	Commercial Non-Engineered	340L	1	$123.23	2.07	$255.09	$33.14	75%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	20	IND2	2.08
340	Ind/Whs Mdl 96	IND2	Commercial Non-Engineered	340M	1	$123.23	2.07	$255.09	$33.14	75%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	20	IND2	2.08
341	R+D/Indo	IND1	Urban High Rise	341H	10	$140.17	2.07	$290.16	$36.13	75%	0	0.5	0.5	1	1	1	$10.05	26	IND1	2.08
341	R+D/Indo	IND1	Commercial Non-Engineered	341L	1	$140.17	2.07	$290.16	$36.13	75%	0	0.5	0.5	1	1	1	$10.05	20	IND1	2.08
341	R+D/Indo	IND1	Commercial Non-Engineered	341M	1	$140.17	2.07	$290.16	$36.13	75%	0	0.5	0.5	1	1	1	$10.05	20	IND1	2.08
342	Mill Building	IND2	Urban High Rise	342H	10	$123.23	2.07	$255.09	$33.14	75%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	26	IND2	2.08
342	Mill Building	IND2	Commercial Engineered	342M	2	$123.23	2.07	$255.09	$33.14	75%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	14	IND2	2.08
343	Manufacturing	IND1	Urban High Rise	343H	10	$140.17	2.07	$290.16	$36.13	75%	0	0.5	0.5	1	1	1	$10.05	26	IND1	2.08
343	Manufacturing	IND1	Commercial Engineered	343L	2	$140.17	2.07	$290.16	$36.13	75%	0	0.5	0.5	1	1	1	$10.05	14	IND1	2.08
343	Manufacturing	IND1	Commercial Engineered	343M	2	$140.17	2.07	$290.16	$36.13	75%	0	0.5	0.5	1	1	1	$10.05	14	IND1	2.08
394	Com/Ind Mdl 94	IND2	Urban High Rise	394H	10	$123.23	2.07	$255.09	$33.14	75%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	26	IND2	2.08
394	Com/Ind Mdl 94	IND2	Commercial Engineered	394M	2	$123.23	2.07	$255.09	$33.14	75%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	14	IND2	2.08
396	Com/Ind Mdl 96	IND2	Urban High Rise	396H	10	$123.23	2.07	$255.09	$33.14	75%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	26	IND2	2.08
396	Com/Ind Mdl 96	IND2	Commercial Engineered	396L	2	$123.23	2.07	$255.09	$33.14	75%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	14	IND2	2.08
396	Com/Ind Mdl 96	IND2	Commercial Engineered	396M	2	$123.23	2.07	$255.09	$33.14	75%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	14	IND2	2.08
400	Pub Utility	GOV1	Urban High Rise	400H	10	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	26	GOV1	0.83
400	Pub Utility	GOV1	Commercial Engineered	400L	2	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	14	GOV1	0.83
400	Pub Utility	GOV1	Commercial Engineered	400M	2	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	14	GOV1	0.83
800	Apartment Mdl 03	RES3D	Urban High Rise	800H	10	$197.06	0.69	$135.97	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	26	RES3D	0
800	Apartment Mdl 03	RES3D	Apartment 1-Story, No Basement	800L	1	$197.06	0.69	$135.97	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	2	RES3D	0
800	Apartment Mdl 03	RES3D	Apartment 3-Story, No Basement	800M	3	$197.06	0.69	$135.97	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	11	RES3D	0
801	Subsidized Apts	RES3D	Urban High Rise	801H	10	$197.06	0.69	$135.97	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	26	RES3D	0
801	Subsidized Apts	RES3D	Commercial Engineered	801M	2	$197.06	0.69	$135.97	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	14	RES3D	0
814	Comm Apts	RES3E	Urban High Rise	814H	10	$191.07	0.69	$131.84	$41.94	35%	0.97	0	0	0.5	1	1	$13.13	26	RES3E	0
814	Comm Apts	RES3E	Apartment 1-Story, No Basement	814L	1	$191.07	0.69	$131.84	$41.94	35%	0.97	0	0	0.5	1	1	$13.13	2	RES3E	0
814	Comm Apts	RES3E	Apartment 3-Story, No Basement	814M	3	$191.07	0.69	$131.84	$41.94	35%	0.97	0	0	0.5	1	1	$13.13	11	RES3E	0
861	Rooming House	RES4	Urban High Rise	861H	10	$192.14	0.69	$132.57	$40.99	0%	0.97	0	0	0.5	1	1	$13.13	26	RES4	0.62
861	Rooming House	RES4	Apartment 1-Story, No Basement	861L	1	$192.14	0.69	$132.57	$40.99	0%	0.97	0	0	0.5	1	1	$13.13	2	RES4	0.62
861	Rooming House	RES4	Apartment 3-Story, No Basement	861M	3	$192.14	0.69	$132.57	$40.99	0%	0.97	0	0	0.5	1	1	$13.13	11	RES4	0.62
862	Co-op	RES3B	Urban High Rise	862H	10	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	26	RES3B	0
862	Co-op	RES3B	Apartment 1-Story, No Basement	862L	1	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	2	RES3B	0
862	Co-op	RES3B	Apartment 3-Story, No Basement	862M	3	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	11	RES3B	0
863	Co-op	RES3B	Urban High Rise	863H	10	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	26	RES3B	0
863	Co-op	RES3B	Apartment 1-Story, No Basement	863L	1	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	2	RES3B	0
863	Co-op	RES3B	Apartment 3-Story, No Basement	863M	3	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	11	RES3B	0
901	USGovComBldg 94	GOV1	Urban High Rise	901H	10	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	26	GOV1	0.83
908	US Courthouse	GOV1	Urban High Rise	908H	10	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	26	GOV1	0.83
909	State Courthouse	GOV1	Urban High Rise	909H	10	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	26	GOV1	0.83
910	State Com Bldg 96	GOV1	Urban High Rise	910H	10	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	26	GOV1	0.83
911	State Com Bldg 94	GOV1	Urban High Rise	911H	10	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	26	GOV1	0.83
911	State Com Bldg 94	GOV1	Commercial Engineered	911L	2	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	14	GOV1	0.83
911	State Com Bldg 94	GOV1	Commercial Engineered	911M	2	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	14	GOV1	0.83
922	Mun Com Bldg Mdl 94	GOV1	Urban High Rise	922H	10	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	26	GOV1	0.83

Land Use Code	Description	Hazus Occupancy Code	DDF Category	Occ Mapping	Stories Analysis	BRV	CSRV	CRV	BMRV	% Own Occ	1 Time Disruption Cost	None	Slight	Moderate	Extensive	Complete	Rent/SF/Year	DDF ID	HazusOcc	Output/SF/Day
922	Mun Com Bldg Mdl 94	GOV1	Commercial Engineered	922L	2	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	14	GOV1	0.83
922	Mun Com Bldg Mdl 94	GOV1	Commercial Engineered	922M	2	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	14	GOV1	0.83
923	Mun Com Bldg Mdl 96	GOV1	Urban High Rise	923H	10	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	26	GOV1	0.83
923	Mun Com Bldg Mdl 96	GOV1	Commercial Engineered	923M	2	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	14	GOV1	0.83
924	Mun Res Bldg Mdl 01	GOV1	Urban High Rise	924H	10	$197.06	0.69	$135.97	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	26	GOV1	0.83
924	Mun Res Bldg Mdl 01	GOV1	Commercial Engineered	924M	2	$197.06	0.69	$135.97	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	26	GOV1	0.83
928	Fire Dept	GOV2	Urban High Rise	928H	10	$262.05	1.5	$393.07	$35.32	95%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	26	GOV2	0.95
928	Fire Dept	GOV2	Commercial Engineered	928L	2	$262.05	1.5	$393.07	$35.32	95%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	14	GOV2	0.95
929	Police Dept	GOV2	Urban High Rise	929H	10	$262.05	1.5	$393.07	$35.32	95%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	26	GOV2	0.95
930	Garage/ Shop	COM3	Commercial Engineered	930M	2	$148.21	2.36	$349.78	$38.91	55%	1.12	0.5	0.1	0.2	0.3	0.4	$10.05	14	COM3	0.83
933	Public School	GOV1	Commercial Engineered	933M	2	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	14	GOV1	0.83
934	Public School Mdl 94	GOV1	Urban High Rise	934H	10	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	26	GOV1	0.83
934	Public School Mdl 94	GOV1	Commercial Engineered	934M	2	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	14	GOV1	0.83
935	Library	GOV1	Urban High Rise	935H	10	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	26	GOV1	0.83
935	Library	GOV1	Commercial Engineered	935L	2	$157.02	0.55	$86.36	$35.43	70%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	14	GOV1	0.83
937	Mun Recr Bldg	COM8	Urban High Rise	937H	10	$233.01	1.7	$396.13	$40.33	55%	0	0.5	0.1	1	1	1	$10.05	26	COM8	1.29
937	Mun Recr Bldg	COM8	Commercial Non-Engineered	937L	1	$233.01	1.7	$396.13	$40.33	55%	0	0.5	0.1	1	1	1	$10.05	20	COM8	1.29
937	Mun Recr Bldg	COM8	Commercial Non-Engineered	937M	1	$233.01	1.7	$396.13	$40.33	55%	0	0.5	0.1	1	1	1	$10.05	20	COM8	1.29
941	Hsng Auth 1 Family	RES1	Urban High Rise	941H	10	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	26	RES1	0
941	Hsng Auth 1 Family	RES1	Residential 1-Story, No Basement	941L	1	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	35	RES1	0
941	Hsng Auth 1 Family	RES1	Residential 2-Story, No Basement	941M	2	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	44	RES1	0
942	Hsng Auth 2 Family	RES3A	Urban High Rise	942H	10	$107.23	0.69	$73.99	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	26	RES3A	0
942	Hsng Auth 2 Family	RES3A	Residential 2-Story, No Basement	942M	2	$107.23	0.69	$73.99	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	44	RES3A	0
943	Hsng Auth 3 Family	RES3B	Urban High Rise	943H	10	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	26	RES3B	0
943	Hsng Auth 3 Family	RES3B	Residential 2-Story, No Basement	943M	2	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	26	RES3B	0
944	Hsng Auth 4 Family	RES3B	Residential 2-Story, No Basement	944M	2	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	26	RES3B	0
944	Hsng Auth 4 Family	RES3B	Urban High Rise	944H	10	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	26	RES3B	0
947	Hsng Auth Apts Mdl 03	RES3C	Urban High Rise	947H	10	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	26	RES3C	0
948	Hsng Auth Apts Mdl 94	RES3C	Urban High Rise	948H	10	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	26	RES3C	0
948	Hsng Auth Apts Mdl 94	RES3C	6B Two-Story Residence, With Basement, Inundation Damage	948L	2	$130.34	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	56	RES3C	0
948	Hsng Auth Apts Mdl 94	RES3C	6B Two-Story Residence, With Basement, Inundation Damage	948M	2	$130.34	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	56	RES3C	0
950	Hospital	COM6	Commercial Engineered	950M	2	$394.26	0.54	$212.90	$40.60	95%	1.61	0.5	0.1	0.5	0.5	0.5	$10.05	14	COM6	1.03
955	Religious Mdl 96	REL1	Urban High Rise	955H	10	$197.03	0.55	$108.36	$39.79	90%	1.12	1	0.2	0.05	0.03	0.03	$10.05	26	REL1	2.06
955	Religious Mdl 96	REL1	Commercial Engineered	955L	2	$197.03	0.55	$108.36	$39.79	90%	1.12	1	0.2	0.05	0.03	0.03	$10.05	14	REL1	2.06
955	Religious Mdl 96	REL1	Commercial Engineered	955M	2	$197.03	0.55	$108.36	$39.79	90%	1.12	1	0.2	0.05	0.03	0.03	$10.05	14	REL1	2.06
957	Religious Hse	RES1	Urban High Rise	957H	10	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	26	RES1	0
957	Religious Hse	RES1	Residential 1-Story, No Basement	957L	1	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	35	RES1	0
957	Religious Hse	RES1	Residential 2-Story, No Basement	957M	2	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	44	RES1	0
958	Religious Mdl 94	REL1	Urban High Rise	958H	10	$197.03	0.55	$108.36	$39.79	90%	1.12	1	0.2	0.05	0.03	0.03	$10.05	26	REL1	2.06
958	Religious Mdl 94	REL1	Commercial Engineered	958L	2	$197.03	0.55	$108.36	$39.79	90%	1.12	1	0.2	0.05	0.03	0.03	$10.05	14	REL1	2.06
958	Religious Mdl 94	REL1	Commercial Engineered	958M	2	$197.03	0.55	$108.36	$39.79	90%	1.12	1	0.2	0.05	0.03	0.03	$10.05	14	REL1	2.06
959	Religious School	EDU1	Urban High Rise	959H	10	$210.99	1	$210.99	$39.02	95%	1.12	0.5	0.1	0.02	0.05	0.05	$10.05	26	EDU1	0
959	Religious School	EDU1	Commercial Engineered	959L	2	$210.99	1	$210.99	$39.02	95%	1.12	0.5	0.1	0.02	0.05	0.05	$10.05	14	EDU1	0
959	Religious School	EDU1	Commercial Engineered	959M	2	$210.99	1	$210.99	$39.02	95%	1.12	0.5	0.1	0.02	0.05	0.05	$10.05	14	EDU1	0
961	Pvt School	EDU1	Urban High Rise	961H	10	$210.99	1	$210.99	$39.02	95%	1.12	0.5	0.1	0.02	0.05	0.05	$10.05	26	EDU1	0
961	Pvt School	EDU1	Commercial Engineered	961L	2	$210.99	1	$210.99	$39.02	95%	1.12	0.5	0.1	0.02	0.05	0.05	$10.05	14	EDU1	0
961	Pvt School	EDU1	Commercial Engineered	961M	2	$210.99	1	$210.99	$39.02	95%	1.12	0.5	0.1	0.02	0.05	0.05	$10.05	14	EDU1	0
962	Pvt School Res	RES5	Urban High Rise	962H	10	$220.99	0.69	$152.49	$41.44	0%	0.97	0	0	0.5	1	1	$13.13	26	RES5	0
962	Pvt School Res	RES5	Apartment 1-Story, No Basement	962L	1	$220.99	0.69	$152.49	$41.44	0%	0.97	0	0	0.5	1	1	$13.13	2	RES5	0
962	Pvt School Res	RES5	Apartment 3-Story, No Basement	962M	3	$220.99	0.69	$152.49	$41.44	0%	0.97	0	0	0.5	1	1	$13.13	11	RES5	0
963	Pvt College Classrm	EDU2	Urban High Rise	963H	10	$185.28	1	$185.28	$41.42	90%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	26	EDU2	0
963	Pvt College Classrm	EDU2	Commercial Engineered	963M	2	$185.28	1	$185.28	$41.42	90%	1.12	0.5	0.1	0.02	0.03	0.03	$10.05	14	EDU2	0
964	Pvt College Offices	COM4	Urban High Rise	964H	10	$183.48	0.54	$99.08	$44.91	55%	1.12	0.5	0.1	0.1	0.2	0.3	$10.05	26	COM4	1.2
964	Pvt College Offices	COM4	Commercial Engineered	964M	2	$183.48	0.54	$99.08	$44.91	55%	1.12	0.5	0.1	0.1	0.2	0.3	$10.05	14	COM4	1.2
965	Pvt College Dorms	RES5	Urban High Rise	965H	10	$220.99	0.69	$152.49	$41.44	0%	0.97	0	0	0.5	1	1	$13.13	26	RES5	0
965	Pvt College Dorms	RES5	Apartment 1-Story, No Basement	965L	1	$220.99	0.69	$152.49	$41.44	0%	0.97	0	0	0.5	1	1	$13.13	2	RES5	0
965	Pvt College Dorms	RES5	Apartment 3-Story, No Basement	965M	3	$220.99	0.69	$152.49	$41.44	0%	0.97	0	0	0.5	1	1	$13.13	11	RES5	0
966	Pvt College Res	RES5	Urban High Rise	966H	10	$220.99	0.69	$152.49	$41.44	0%	0.97	0	0	0.5	1	1	$13.13	26	RES5	0
966	Pvt College Res	RES5	Apartment 1-Story, No Basement	966L	1	$220.99	0.69	$152.49	$41.44	0%	0.97	0	0	0.5	1	1	$13.13	2	RES5	0
966	Pvt College Res	RES5	Apartment 3-Story, No Basement	966M	3	$220.99	0.69	$152.49	$41.44	0%	0.97	0	0	0.5	1	1	$13.13	11	RES5	0
967	Pvt College Rec Fac	COM8	Urban High Rise	967H	10	$233.01	1.7	$396.13	$40.33	55%	0	0.5	0.1	1	1	1	$10.05	26	COM8	1.29
967	Pvt College Rec Fac	COM8	Commercial Engineered	967L	2	$233.01	1.7	$396.13	$40.33	55%	0	0.5	0.1	1	1	1	$10.05	14	COM8	1.29
967	Pvt College Rec Fac	COM8	Commercial Engineered	967M	2	$233.01	1.7	$396.13	$40.33	55%	0	0.5	0.1	1	1	1	$10.05	14	COM8	1.29
977	Charitable Bldg	RES1	Urban High Rise	977H	10	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	26	RES1	0
977	Charitable Bldg	RES1	Residential 1-Story, No Basement	977L	1	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	35	RES1	0
977	Charitable Bldg	RES1	Residential 2-Story, No Basement	977M	2	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	44	RES1	0
979	Charitable Bldg	RES1	Urban High Rise	979H	10	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	26	RES1	0
979	Charitable Bldg	RES1	Residential 2-Story, No Basement	979M	2	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	26	RES1	0
981	Non-Profit Bldg	COM1	Urban High Rise	981H	10	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	26	COM1	0.54
982	Non-Profit Res	RES1	Urban High Rise	982H	10	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	26	RES1	0

Structure Mapping and Coding

Land Use Code	Description	Hazus Occupancy Code	DDF Category	Occ Mapping	Stories Analysis	BRV	CSRV	CRV	BMRV	% Own Occ	1 Time Disruption Cost	None	Slight	Moderate	Extensive	Complete	Rent/SF/Year	DDF ID	HazusOcc	Output/SF/Day
982	Non-Profit Res	RES1	Commercial Engineered	982M	2	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	14	RES1	0
983	Charitable Bldg Res	RES1	Urban High Rise	983H	10	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	26	RES1	0
983	Charitable Bldg Res	RES1	Residential 1-Story, No Basement	983L	1	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	35	RES1	0
983	Charitable Bldg Res	RES1	Residential 2-Story, No Basement	983M	2	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	44	RES1	0
985	Hsng Auth Condo	RES3C	Urban High Rise	985H	10	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	26	RES3C	0
985	Hsng Auth Condo	RES3C	Apartment 1-Story, No Basement	985L	1	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	2	RES3C	0
985	Hsng Auth Condo	RES3C	Apartment 3-Story, No Basement	985M	3	$206.99	0.69	$142.82	$41.89	35%	0.97	0	0	0.5	1	1	$13.13	11	RES3C	0
993	Exempt Bldg Res	RES1	Urban High Rise	993H	10	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	26	RES1	0
993	Exempt Bldg Res	RES1	Residential 1-Story, No Basement	993L	1	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	35	RES1	0
993	Exempt Bldg Res	RES1	Residential 2-Story, No Basement	993M	2	$130.34	0.69	$89.93	$19.19	75%	0.97	0	0	0.5	1	1	$13.13	44	RES1	0
995	Condo Main	COM1	Urban High Rise	995H	10	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	26	COM1	0.54
995	Condo Main	COM1	Commercial Engineered	995M	2	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	14	COM1	0.54
200I	Com MDL 96	COM1	Urban High Rise	200IH	10	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	26	COM1	0.54
200I	Com MDL 96	COM1	Commercial Engineered	200IM	2	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	26	COM1	0.54
200R	Com Res Mdl	COM1	Urban High Rise	200RH	10	$127.17	1.19	$151.33	$29.27	55%	1.29	0.5	0.1	0.1	0.3	0.4	$10.05	26	COM1	0.54
300C	Industrial Mdl 94	IND1	Urban High Rise	300CH	10	$140.17	2.07	$290.16	$36.13	75%	0	0.5	0.5	1	1	1	$10.05	26	IND1	2.08
300C	Industrial Mdl 96	IND1	Commercial Non-Engineered	300CL	1	$140.17	2.07	$290.16	$36.13	75%	0	0.5	0.5	1	1	1	$10.05	20	IND1	2.08

APPENDIX F

Additional Benefit Cost Analysis Resources

Federal Emergency Management Agency Value for Ecosystem Services of Green Open Space

Ecosystem Service	Study Name	Year	Authors Name	Study Location	Valuation Method	Value per Acre per year (2011)	Value per Square Foot per year (2011)	Value per Acre per year (2015)	Value per Square Foot per year (2015)
Regulating									
Climate Regulation	Ontario's wealth, Canada's future: Appreciating the value of the Greenbelt's eco-services / Economic Valuation ofSoil Functions Phase 1: Literature Review and Method Development	2008 / 2006	Wilson, S.J. / Harris, D., Crabtree, B., Newell-Price, P.	Ontario, Canada and Global Estimates	Avoided Cost	$13.19	$0.000	$13.99	$0.00
Water Retention/Flood Hazard Reduction	The Economic Benefits of Seattle's Park and Recreation System / The Economic Benefits and Fiscal Impact of Parks and Open Space in Nassau and Suffolk Counties, New York	2011 / 2010	Trust for Public Land	Seattle and two counties in New York State	Avoided Cost	$293.02	$0.007	$310.87	$0.01
Air Quality	Ontario's wealth, Canada's future: Appreciating the value of the Greenbelt's eco-services / Estimating Cost Effectiveness of Residential Yard Trees for Improving Air Quality in Sacramento, California / The Economic Benefits of Seattle's Park and Recreation System	2006 / 1998 / 2011	Wilson. S.J. / McPherson, E.G., Scott, K.I., Simpson, J.R. / Trust for Public Land	Southern Ontario / Urban Sacramento / Urban Seattle	Avoided Cost	$204.47	$0.005	$216.92	$0.00
Supporting									
Pollination	Economic and Environmental Benefits of Biodiversity	1997	Pimentel D., Wilson, C., McCullum, C., Huang, R., Dwen, P., Flack, J., Tran, Q., Saltman, T., Cliff, B.	National Average	Market Price	$290.08	$0.007	$307.75	$0.01
Erosion Control	Environmental and Economic Costs of Soil Erosion and Conservation Benefits	1995	Pimentel, D., Harvey, C., Resosudarmo, P., Sinclair, K., Kurz, D., McNair, M., Crist, S., Shpritz, L., Fitton, L., Saffouri, R., Blair, R.	U.S. National Estimates	Avoided Cost	$64.88	$0.001	$68.83	$0.00
Cultural									

Ecosystem Service	Study Name	Year	Authors Name	Study Location	Valuation Method	Value per Acre per year (2011)	Value per Square Foot per year (2011)	Value per Acre per year (2015)	Value per Square Foot per year (2015)
Recreation/Tourism	Measuring Amenity Benefits from Farmland: Hedonic Pricing vs. Contingent Valuation / Using Contingent Valuation to Estimate a Neighborhood's Willingness to Pay to Preserve Undeveloped Rural Land	1997 / 1997	Ready, R.C., Berger, M.C. / Breffle, W.S., Morey, E.R., Lodder, T.S.	Kentucky Farmland (average of all counties) and Boulder, Colorado	Contingent Valuation and Hedonic Pricing	$5,365.26	$0.123	$5,692.01	$0.13
Aesthetic Values	Economic Valuation of Riparian Buffer and Open Space in a Suburban Watershed / The Impact of Open Spaces on Property Values in Portland, Oregon	2006 / 2000	Qiu, Z., Prato, T., Boehm, G. ./ Bolitzer, B., Netusil, N.R.	Rural and Urban Missouri (North of St. Louis) / Urban Portland, Oregon	Hedonic Pricing	$1,622.37	$0.037	$1,721.17	$0.04
Total						**$7,853.27**	**$0.180**	**$8,331.54**	**$0.19**

Federal Emergency Management Agency Value for Relocation, Displacement, and Business Interruption

14.2.8 Relocation Expenses

Relocation expenses in the HAZUS Flood Model are estimated in a manner consistent with the current earthquake model. In the HAZUS99 & HAZUS-MH earthquake model, relocation expenses represent disruption costs to building owners for selected occupancies. These include all occupancies except entertainment (COM8), theatres (COM9), parking facilities (COM10) and heavy industry (IND1). Expenses include "… disruption costs that include the cost of shifting and transferring, and the rental of temporary space". These costs are assumed to be incurred once the building reaches a damage threshold of 10% (beyond damage state "slight" in the earthquake model). Below that threshold, it is assumed unlikely that the occupants will not need to relocate. Relocation losses will be estimated as follows:

$$\text{REL}_i = \sum_j \text{ If } \%\text{DAM-BL}_{i,j} > 10\%\text{: } \text{Fa}_{i,j} * \begin{bmatrix} (1-\%OO_i)*(DC_i)+ \\ \%OO_i*(DC_i + RENT_i * RT_{i,j}) \end{bmatrix} \quad (14\text{-}6)$$

where:

REL_i	=	relocation costs for occupancy class i (i = 1-13 and 18-28)
$\text{Fa}_{i,j}$	=	floor area of occupancy group i and depth j (in square feet)
$\%\text{DAM-BL}_{i,j}$	=	percent building damage for occupancy i and water depth j (from depth-damage function), ***if greater than 10%.***
Dc_i	=	disruption costs for occupancy i (\$/ft^2, column 6 in Table 14.9)
$\text{RT}_{i,j}$	=	recovery time (in days) for occupancy i and water depth j (See Table 14.11 for preliminary flood restoration time estimates)
$\%\text{OO}_i$	=	percent owner occupied for occupancy i (HAZUS99 Technical Manual Table 15.14, reprinted here as Table 14.10)
RENT_i	=	rental cost (\$/ft^2/day) for occupancy i (column 5 in Table 14.9)

It should be noted that the default values for rental costs and disruption costs provided in Table 14.9, have been updated from the original development year of 1994 to the year 2006 baseline using CPI scaling, as discussed in Section 14.3.7.

Table 14.10 Rental Costs and Disruption Costs

No.	Label	Occupancy Class	Rental Cost (2006)		Disruption Costs (2006)
			($/ft^2/month)	($/ft^2/day)	($/ft^2)
Residential					
1	RES1	Single-family Dwelling	0.68	0.02	0.82
2	RES2	Mobile Home	0.48	0.02	0.82
3	RES3A	Multi-family Dwelling; Duplex	0.61	0.02	0.82
4	RES3B	Multi-family Dwelling;	0.61	0.02	0.82
5	RES3C	Multi-family Dwelling; 5 - 9 units	0.61	0.02	0.82
6	RES3D	Multi-family Dwelling; 10 - 19 units	0.61	0.02	0.82
7	RES3E	Multi-family Dwelling; 20 - 49 units	0.61	0.02	0.82
8	RES3F	Multi-family Dwelling; 50+ units	0.61	0.02	0.82
9	RES4	Temporary Lodging	2.04	0.07	0.82
10	RES5	Institutional Dormitory	0.41	0.01	0.82
11	RES6	Nursing Home	0.75	0.03	0.82
Commercial					
12	COM1	Retail Trade	1.16	0.04	1.09
13	COM2	Wholesale Trade	0.48	0.02	0.95
14	COM3	Personal and Repair Services	1.36	0.05	0.95
15	COM4	Professional/Technical/ Business	1.36	0.05	0.95
16	COM5	Banks	1.70	0.06	0.95
17	COM6	Hospital	1.36	0.05	1.36
18	COM7	Medial Office/Clinic	1.36	0.05	1.36
19	COM8	Entertainment & Recreation	1.70	0.06	0.00
20	COM9	Theaters	1.70	0.06	0.00
21	COM10	Parking	0.34	0.01	0.00
Industrial					
22	IND1	Heavy	0.20	0.01	0.00
23	IND2	Light	0.27	0.01	0.95
24	IND3	Food/Drugs/Chemicals	0.27	0.01	0.95
25	IND4	Metals/Minerals Processing	0.20	0.01	0.95
26	IND5	High Technology	0.34	0.01	0.95
27	IND6	Construction	0.14	0.00	0.95
Agriculture					
28	AGR1	Agriculture	0.68	0.02	0.68
Religion/Non-Profit					
29	REL1	Church/Membership Organization	1.02	0.03	0.95
Government					
30	GOV1	General Services	1.36	0.05	0.95
31	GOV2	Emergency Response	1.36	0.05	0.95
Education					
32	EDU1	Schools/Libraries	1.02	0.03	0.95
33	EDU2	Colleges/Universities	1.36	0.05	0.95

Table 14.11 Percent Owned Occupied
(ref: NIBS/FEMA HAZUS Technical Manual, Table 15.14)

No.	Label	Occupancy Class	Percent Owner Occupied
Residential			
1	RES1	Single-family Dwelling	75
2	RES2	Mobile Home	85
3	RES3	Multi-family Dwelling	35
4	RES4	Temporary Lodging	0
5	RES5	Institutional Dormitory	0
6	RES6	Nursing Home	0
Commercial			
7	COM1	Retail Trade	55
8	COM2	Wholesale Trade	55
9	COM3	Personal and Repair Services	55
10	COM4	Professional/Technical/ Business Services	55
11	COM5	Banks	75
12	COM6	Hospital	95
13	COM7	Medial Office/Clinic	65
14	COM8	Entertainment & Recreation	55
15	COM9	Theaters	45
16	COM10	Parking	25
Industrial			
17	IND1	Heavy	75
18	IND2	Light	75
19	IND3	Food/Drugs/Chemicals	75
20	IND4	Metals/Minerals Processing	75
21	IND5	High Technology	55
22	IND6	Construction	85
Agriculture			
23	AGR1	Agriculture	95
Religion/Non-Profit			
24	REL1	Church/Membership Organization	90
Government			
25	GOV1	General Services	70
26	GOV2	Emergency Response	95
Education			
27	EDU1	Schools/Libraries	95
28	EDU2	Colleges/Universities	90

14.2.9 Loss of Income

Income-related losses are time-dependent; the losses will depend on the amount of time required to restore business operations. Restoration times include time for physical restoration of the damage to the building, as well as time for clean-up, time required for inspections, permits and the approval process, as well as delays due to contractor availability.

Earthquake damage restoration and flood damage restoration differ in a variety of ways, including:

- Damage due to flooding is likely to be widespread throughout the inundated area; earthquakes will cause differing degrees of damage to structures located within the same area.

- In an earthquake, inventory that does not break can be picked up and sold. Flooded-damaged inventory is usually a total loss.

- An earthquake-damaged business may be able to re-open quickly with undamaged inventory in a new location (e.g., alternate space, parking lot) in parallel with clean up. A flood-damaged business is less likely to re-open during clean up, in particular, re-opening may depend on resupply of inventory.

Because flood damage is fundamentally different than earthquake damage, a flood-specific restoration time model has been developed. The project team has developed draft estimates of required restoration time by occupancy, assumed to vary with flood depth. Here, flood depths are generally examined in increments of four feet, to coincide with likely physical repair strategies. For example, once inundation has exceeded the finished floor and damaged the lower portion of the wall, a sheet of 4x8 dry wall will be laid horizontally to replace the damaged wallboard. The proposed restoration model is provided in Table 14.11 on the following page, and includes restoration time required for physical building restoration, as well as additional time required for clean-up, permitting, contractor availability, and potential hazardous materials issues. (This table corresponds to the existing HAZUS earthquake Table 15.11, Building Recovery Time).

It should be noted that restoration times increase with depth, until the building has reached the 50% damage threshold, beyond which the building is considered a total loss. Once a building reaches 50% damage, it is assumed that the building will be demolished and re-built. For structures, outside the 100-year floodplain, reconstruction can be accomplished at the same site, and will require 18 months; 12 months for physical construction, plus 6 months for damage determination, permits, approvals, etc. If the structure is located within the 100-year floodplain, reconstruction to the original configuration at the same location will not be allowed, and the building is a potential buy-out candidate. Associated political considerations are assumed to add an additional 6-month delay to the reconstruction process, bringing the total time estimate to 24 months.

Future model development will include an assessment as to whether Interruption time multipliers (reduction factors), similar to those used in the earthquake model (Table 15.12 – Building and Service Interruption Time Modifiers), are applicable to flood. For consideration in this process, the project team has reviewed the list of occupancies to determine the dominant restoration element, provided in Table 14.12.

Table 14.12 Flood Restoration Time by Occupancy

Occupancy	Depth	Location	Physical Restoration Time (Months)	Add-ons				Max Total Time	Notes
				Dry-out & Clean up	Insp., permits, Ord., approval	Contr. Avail.	Hazmat Delay		
RES1 (No Base)	0' – 4'		3 to 6	1	2	3		12	
	4' – 8'		6 to 9	1	2	3		15	
	8'+	Outside 100-yr	12	1	2	3		18	Total loss, requires replacement
	8'+	Inside 100-yr	18	1	2	3		24	Total loss, subject to buy-out review/political process
RES1 (W/Base)	(-8') – (-4')		3 to 6	1	2	3		9	No sub-floor repair required
	(-4') – 0'		6 to 9	1	2	3		15	
	0' – 6'		9 to 12	1	2	3		18	
	6'+	Outside 100-yr	12	1	2	3		18	Total loss, requires replacement
	6'+	Inside 100-yr	18	1	2	3		24	Total loss, subject to buy-out review/political process
RES2	0' TO 1'		3 to 6	1	2	3		12	
	1'+	Outside 100-yr	12	1	2	3		18	Total loss, requires replacement
	1'+	Inside 100-yr	18	1	2	3		24	Total loss, subject to buy-out review/political process
RES3 (SM)	0' – 4'		3 to 6	1	2	3		12	Same as RES1
	4' – 8'		6 to 9	1	2	3		15	
	8'+	Outside 100-yr	12	1	2	3		18	
	8'+	Inside 100-yr	18	1	2	3		24	

Table 14.12 Flood Restoration Time by Occupancy (Continued)

Occupancy	Depth	Location	Physical Restoration Time (Months)	Add-ons				Max Total Time	Notes
				Dry-out & Clean up	Insp., permits, Ord., approval	Contr. Avail.	Hazmat Delay		
RES3 (MED) 5-9 & 10-19 units	0' – 4'		5 to 8	1	2	3		14	(RES1*1.2) + 1 Month based on 3-5 units per floor
	4' – 8'		8 to 12	1	2	3		18	
	8' – 12'		12	1	2	3		18	Note: available apt models reach 5-% damage ~ 12'
	12'+	Outside 100-yr	12	1	2	3		18	Total loss, requires replacement
	12'+	Inside 100-yr	18	1	2	3		24	Total loss, subject to buy-out review/political process
RES3 (LRG) 20-49 & 50+ units	0' – 4'		5 to 8	1	2	3		14	(RES1*1.2) + 1 Month based on 3-5 units per floor
	4' – 8'		8 to 12	1	2	3		18	(RES1*1.2) + 1 Month based on 3-5 units per floor
	8'+		12	1	2	3		18	Note: available apt models reach 5-% damage ~ 12'
	12'+	Outside 100-yr	12	1	2	3		18	Total loss, requires replacement
	12'+	Inside 100 yr	18	1	2	3		24	Total loss, subject to buy-out review/political process
RES4	0' – 4'		5 to 8	1	2	3		14	Use RES3 (LRG)
	4' – 8'		8 to 12	1	2	3		18	
	8'+		12	1	2	3		18	
	12'+	Outside 100-yr	12	1	2	3		18	Total loss, requires replacement
	12'+	Inside 100 yr	18	1	2	3		24	Total loss, subject to buy-out review/political process

Table 14.12 Flood Restoration Time by Occupancy (Continued)

Occupancy	Depth	Location	Physical Restoration Time (Months)	Add-ons				Max Total Time	Notes
				Dry-out & Clean up	Insp., permits, Ord., approval	Contr. Avail.	Hazmat Delay		
RES5 RES6 EDU1 EDU2	0' – 4'		6 to 10	1	2	3		16	Repairs may require less work (fewer partitions & finishes), but have more politics or funding issues. Use RES3 (LRG) but increase 1.2 factor to 1.5
	4' – 8'		10 to 15	1	2	3		21	
	8' – 12'		19	1	2	3		25	
	12'+	Outside 100-yr	12	1	2	3		18	Total loss, requires replacement
	12'+	Inside 100-yr	18	1	2	3		24	Total loss, subject to buy-out review/political process
COM1 COM2 COM8 COM9 REL1	0' – 4'		7 to 13	1	2	3		19	Use RES3*2.0 – Longer clean up, but no wood sub-floor, perimeter wall, linoleum. Inventory damaged/destroyed, restoration depends on resupply, damage widespread in inundation area, insurance is a factor.
	4' – 8'		13 to 19	1	2	3		25	
	8'+		25	1	2	3		31	
	12'+	Outside 100-yr	12	1	2	3		18	Total loss, requires replacement
	12'+	Inside 100 yr	18	1	2	3		24	Total loss, subject to buy-out review/political process
COM3	0' – 4'		3 to 6	1	2	3		12	On average, same as RES1 without a basement.
	4' – 8'		6 to 9	1	2	3		15	
	8'+	Outside 100-yr	12	1	2	3		18	Total loss, requires replacement
	8'+	Inside 100 yr	18	1	2	3		24	Total loss, subject to buy-out review/political process

Table 14.12 Flood Restoration Time by Occupancy (Continued)

Occupancy	Depth	Location	Physical Restoration Time (Months)	Add-ons				Max Total Time	Notes
				Dry-out & Clean up	Insp., permits, Ord., approval	Contr. Avail.	Hazmat Delay		
COM4 COM5 COM7 GOV1 GOV2	0' – 4'		6 to 10	1	2	3		16	Use RES3 (LRG)*1.5 (same as RES5 & RES6)
	4' – 8'		10 to 15	1	2	3		21	
	8' – 12'		19	1	2	3		25	
	12'+	Outside 100-yr	12	1	2	3		18	Total loss, requires replacement
	12'+	Inside 100-yr	18	1	2	3		24	Total loss, subject to buy-out review/political process
COM6 (assume w/base)	(-8') - (-4')		6	1	2	3		16	Hospitals are highly regulated, have equipment issues. This model represents full repair/restoration, but certain repairs will be prioritized to allow selected operations to begin sooner.
	(-4') – 0'		12	1	2	3		21	
	0' – 4'		18	1	2	3		18	
	4' – 8'		24	1	2	3		24	
COM10	Any > 0'			1				1	Parking lot restoration is not dependent on flood depth, only clean up.
IND1	Any > 0'		1 to 3	1	2		1	7	For heavy industrial, clean up is the primary issue, especially for equipment. Relocation is unlikely. Hazmat is a potential for this occupancy class.
IND2 IND6	Any > 0'		1 to 2	1	2			5	Like heavy industrial except no equipment issues. Totally content issues.
IND3	0' – 4'		6 to 10	1	2	3	1	17	Like laboratories, perimeter walls. Hazmat a potential issue. Use RES3*1.5 + Hazmat delay. Similar to RES5, RES6, COM4, COM5, COM7.
	4' – 8'		10 to 15	1	2	3	1	22	
	8' – 12'		19	1	2	3	1	26	
	12'+	Outside 100-yr	12	1	2	3		18	Total loss, requires replacement
	12'+	Inside 100-yr	18	1	2	3		24	Total loss, subject to buy-out review/political process

Table 14.12 Flood Restoration Time by Occupancy (Continued)

Occupancy	Depth	Location	Physical Restoration Time (Months)	Add-ons				Max Total Time	Notes
				Dry-out & Clean up	Insp., permits, Ord., approval	Contr. Avail.	Hazmat Delay		
IND4	0' – 4'		6 to 10	1	2	3	2	18	Like IND3, but use a 2-month delay for hazmat.
	4' – 8'		10 to 15	1	2	3	2	27	
	8' – 12'		19	1	2	3	2	26	
	12'+	Outside 100-yr	12	1	2	3		18	Total loss, requires replacement
	12'+	Inside 100-yr	18	1	2	3		24	Total loss, subject to buy-out review/political process
IND5	0' – 4'		7 to 13	1	2	3	2	21	Use RES3*2 + 2-month Hazmat delay. (Similar to COM1, COM2, COM8, COM9.
	4' – 8'		13 to 19	1	2	3	2	27	
	8' – 12'		25	1	2	3	2	33	
	12'+	Outside 100-yr	12	1	2	3	2	20	Total loss, requires replacement
	12'+	Inside 100-yr	18	1	2	3	2	26	Total loss, subject to buy-out review/political process
AGR1	Any > 0'		1 to 2	1	2		2	7	Like IND2 with 2-month hazmat delay,

Table 14.13 Elements Dominating Building and Service Interruption for Floods

Label	Occupancy Class	Element Dominating Restoration
Residential		
RES1	Single Family Dwelling	Building (+ Utilities)
RES2	Mobile Home	Building (+ Utilities)
RES3	Multi Family Dwelling	Building (+ Utilities)
RES4	Temporary Lodging	Building (+ Utilities)
RES5	Institutional Dormitory	Building (+ Utilities)
RES6	Nursing Home	Building (+ Utilities)
Commercial		
COM1	Retail Trade	Inventory
COM2	Wholesale Trade	Inventory
COM3	Personal and Repair Services	Inventory/Equipment
COM4	Professional/Technical/ Business Services	Building (+ Utilities)
COM5	Banks/Financial Institutions	Building (+ Utilities)
COM6	Hospital	Building (+ Utilities)/Equipment
COM7	Medical Office/Clinic	Building (+ Utilities)
COM8	Entertainment & Recreation	Building (+ Utilities)/Contents
COM9	Theaters	Building (+ Utilities)/Contents
COM10	Parking	-----
Industrial		
IND1	Heavy	Equipment
IND2	Light	Inventory
IND3	Food/Drugs/Chemicals	Inventory/Equipment
IND4	Metals/Minerals Processing	Equipment
IND5	High Technology	Inventory/Equipment
IND6	Construction	Building (+ Utilities)
Agriculture		
AGR1	Agriculture	Inventory/Equipment
Religion/Non-Profit		
REL1	Church/Membership Organization	Building (+ Utilities)
Government		
GOV1	General Services	Building (+ Utilities)
GOV2	Emergency Response	Building (+ Utilities)
Education		
EDU1	Schools/Libraries	Building (+ Utilities)
EDU2	Colleges/Universities	Building (+ Utilities)

Table 15.10: Building Recovery Time (Time in Days)

No.	Label	Occupancy Class	Recovery Time				
			Structural Damage State				
			None	Slight	Moderate	Extensive	Complete
		Residential					
1	RES1	Single Family Dwelling	0	5	120	360	720
2	RES2	Mobile Home	0	5	20	120	240
3-8	RES3a-f	Multi Family Dwelling	0	10	120	480	960
9	RES4	Temporary Lodging	0	10	90	360	480
10	RES5	Institutional Dormitory	0	10	90	360	480
11	RES6	Nursing Home	0	10	120	480	960
		Commercial					
12	COM1	Retail Trade	0	10	90	270	360
13	COM2	Wholesale Trade	0	10	90	270	360
14	COM3	Personal and Repair Services	0	10	90	270	360
15	COM4	Professional/Technical/ Business Services	0	20	90	360	480
16	COM5	Banks/Financial Institutions	0	20	90	180	360
17	COM6	Hospital	0	20	135	540	720
18	COM7	Medical Office/Clinic	0	20	135	270	540
19	COM8	Entertainment & Recreation	0	20	90	180	360
20	COM9	Theaters	0	20	90	180	360
21	COM10	Parking	0	5	60	180	360
		Industrial					
22	IND1	Heavy	0	10	90	240	360
23	IND2	Light	0	10	90	240	360
24	IND3	Food/Drugs/Chemicals	0	10	90	240	360
25	IND4	Metals/Minerals Processing	0	10	90	240	360
26	IND5	High Technology	0	20	135	360	540
27	IND6	Construction	0	10	60	160	320
		Agriculture					
28	AGR1	Agriculture	0	2	20	60	120
		Religion/Non-Profit					
29	REL1	Church/Membership Organization	0	5	120	480	960
		Government					
30	GOV1	General Services	0	10	90	360	480
31	GOV2	Emergency Response	0	10	60	270	360
		Education					
32	EDU1	Schools/Libraries	0	10	90	360	480
33	EDU2	Colleges/Universities	0	10	120	480	960

Repair times differ for similar damage states depending on building occupancy: thus simpler and smaller buildings will take less time to repair than more complex, heavily serviced or larger buildings. It has also been noted that large well-financed corporations can sometimes accelerate the repair time compared to normal construction procedures.

However, establishment of a more realistic repair time does not translate directly into business or service interruption. For some businesses, building repair time is largely irrelevant, because these businesses can rent alternative space or use spare industrial/commercial capacity elsewhere. These factors are reflected in Table 15.11, which provides multipliers to be applied to the values in Table 15.10 to arrive at estimates of business interruption for economic purposes. The factors in Tables 15.9, 15.10, and 15.11 are judgmentally derived, using ATC-13, Table 9.11 as a starting point.

The times resulting from the application of the Table 15.11 multipliers to the times shown in Table 15.10 represent median values for the probability of business or service interruption. For none and slight damage the time loss is assumed to be short, with cleanup by staff, but work can resume while slight repairs are done. For most commercial and industrial businesses that suffer moderate or extensive damage, the business interruption time is shown as short on the assumption that these concerns will find alternate ways of continuing their activities. The values in Table15.11 also reflect the fact that a proportion of business will suffer longer outages or even fail completely. Church and Membership Organizations generally quickly find temporary accommodation, and government offices also resume operating almost at once. It is assumed that hospitals and medical offices can continue operating, perhaps with some temporary rearrangement and departmental relocation if necessary, after moderate damage, but with extensive damage their loss of function time is also assumed to be equal to the total time for repair.

For other businesses and facilities, the interruption time is assumed to be equal to, or approaching, the total time for repair. This applies to residential, entertainment, theaters, parking, and religious facilities whose revenue or continued service, is dependent on the existence and continued operation of the facility.

The modifiers from Table 15.11 are multiplied by extended building construction times as follows:

$$LOF_{ds} = BCT_{ds} * MOD_{ds} \qquad (15\text{-}13)$$

where:

LOF_{ds} loss of function for damage state ds

BCT_{ds} building construction and clean up time for damage state ds (See Table 15.10)

MOD_{ds} construction time modifiers for damage state ds (See Table 15.11)

The median value applies to a large inventory of facilities. Thus, at moderate damage, some marginal businesses may close, while others will open after a day's cleanup. Even with extensive damage, some businesses will accelerate repair, while a number will also close or be demolished. For example, one might reasonably assume that a URM building that suffers moderate damage is more likely to be demolished than a newer building that suffers moderate, or even, extensive damage. If the URM building is an historic structure its likelihood of survival and repair will probably increase. There will also be a small number of extreme cases: the slightly damaged building that becomes derelict, or the extensively damaged building that continues to function for years, with temporary shoring, until an expensive repair is financed and executed.

Table 15.11: Building and Service Interruption Time Multipliers

No.	Label	Occupancy Class	Construction Time Structural Damage State				
			None	Slight	Moderate	Extensive	Complete
		Residential					
1	RES1	Single Family Dwelling	0	0	0.5	1.0	1.0
2	RES2	Mobile Home	0	0	0.5	1.0	1.0
3-8	RES3a-f	Multi Family Dwelling	0	0	0.5	1.0	1.0
9	RES4	Temporary Lodging	0	0	0.5	1.0	1.0
10	RES5	Institutional Dormitory	0	0	0.5	1.0	1.0
11	RES6	Nursing Home	0	0	0.5	1.0	1.0
		Commercial					
12	COM1	Retail Trade	0.5	0.1	0.1	0.3	0.4
13	COM2	Wholesale Trade	0.5	0.1	0.2	0.3	0.4
14	COM3	Personal and Repair Services	0.5	0.1	0.2	0.3	0.4
15	COM4	Professional/Technical/ Business Services	0.5	0.1	0.1	0.2	0.3
16	COM5	Banks/Financial Institutions	0.5	0.1	0.05	0.03	0.03
17	COM6	Hospital	0.5	0.1	0.5	0.5	0.5
18	COM7	Medical Office/Clinic	0.5	0.1	0.5	0.5	0.5
19	COM8	Entertainment & Recreation	0.5	0.1	1.0	1.0	1.0
20	COM9	Theaters	0.5	0.1	1.0	1.0	1.0
21	COM10	Parking	0.1	0.1	1.0	1.0	1.0
		Industrial					
22	IND1	Heavy	0.5	0.5	1.0	1.0	1.0
23	IND2	Light	0.5	0.1	0.2	0.3	0.4
24	IND3	Food/Drugs/Chemicals	0.5	0.2	0.2	0.3	0.4
25	IND4	Metals/Minerals Processing	0.5	0.2	0.2	0.3	0.4
26	IND5	High Technology	0.5	0.2	0.2	0.3	0.4
27	IND6	Construction	0.5	0.1	0.2	0.3	0.4
		Agriculture					
28	AGR1	Agriculture	0	0	0.05	0.1	0.2
		Religion/Non-Profit					
29	REL1	Church/Membership Organization	1	0.2	0.05	0.03	0.03
		Government					
30	GOV1	General Services	0.5	0.1	0.02	0.03	0.03
31	GOV2	Emergency Response	0.5	0.1	0.02	0.03	0.03
		Education					
32	EDU1	Schools/Libraries	0.5	0.1	0.02	0.05	0.05
33	EDU2	Colleges/Universities	0.5	0.1	0.02	0.03	0.03

15.2.5 Relocation Expenses

Relocation costs may be incurred when the level of building damage is such that the building or portions of the building are unusable while repairs are being made. While relocation costs may include a number of expenses, in this model, only the following

Fannie Mae Estimated Useful Life Tables

**INSTRUCTIONS FOR PERFORMING A
MULTIFAMILY PROPERTY CONDITION ASSESSMENT
(Version 2.0)**

APPENDIX F

ESTIMATED USEFUL LIFE TABLES

These Estimated Useful Life Tables for multifamily property systems and components are intended to represent standardized average estimated useful life ("EUL") values and are not intended to replace the professional judgment of the PCA Consultant in determining the Effective Age and Remaining Useful Life of the systems and components at the Property. The PCA Consultant should consider preventive maintenance practices, as well as environment, geographic, resident, and other factors when determining Effective Age and Remaining Useful Life of the systems and components of a multifamily Property. In addition to providing guidance on EUL values typically considered capital expenditure items, the EUL tables may include items that are typically considered general maintenance and repair items to be handled by in-house maintenance staff.

Estimated Useful Life (EUL) Tables

FLATWORK, PARKING AREAS AND WALKWAYS	Multifamily / Coop	Seniors	Students
Asphalt pavement	25	25	25
Asphalt seal coat	5	5	5
Concrete pavement	50	50	50
Curbing, asphalt	25	25	25
Curbing, concrete	50	50	50
Parking, stall striping	5	5	5
Parking, gravel surfaced	15	15	15
Security gate (site ingress/egress) - rolling gate / lift arm	10	10	10
Sidewalk, asphalt	25	25	25
Sidewalk, brick paver	30	30	30
Sidewalk, concrete	50	50	50

SITE LIGHTING	Multifamily / Coop	Seniors	Student
Building mounted exterior lighting	10	10	10
Building mounted High Intensity Discharge (HID) lighting	10	20	10
Lighting (pole mounted)	25	25	25

SITE FENCING AND RETAINING WALLS	Multifamily / Coop	Seniors	Students
Bulkhead (barrier) / partition wall /embankment	10	20	10
Fencing, chain-link (4' height)	40	40	40
Fencing, concrete masonry unit (CMU)	30	30	30
Fencing, dumpster enclosure (wood)	12	15	10
Fencing, PVC (6' height)	25	25	25
Fencing, Tennis Court (10' height)-Chain link	40	40	40
Fencing, wood privacy (6' height)	15	20	10
Fencing, wrought iron (4-6' height and decorative)	50	50	50
Retaining walls, 80 lb block type	50	50	50
Retaining walls, concrete masonry unit (CMU) with brick face	40	40	40
Retaining walls, timber (railroad tie)	25	25	25

STRUCTURAL FRAME AND BUILDING ENVELOPE			
BUILDING STRUCTURES	**Multifamily / Coop**	**Seniors**	**Students**
Carports	40	40	40
Canopy, concrete	50	50	50
Canopy, wood / metal	40	40	40
Garages	50	50	50
Storage Sheds	30	30	30
Penthouse (mechanical room)	50	50	50

FOUNDATIONS	**Multifamily / Coop**	**Seniors**	**Students**
Foundations	50+	50+	50+
Waterproofing (foundations)	50+	50+	50+

FRAMING	**Multifamily / Coop**	**Seniors**	**Students**
Brick or block	40	40	40
Precast concrete panel (tilt-up)	40	40	40
Wood floor frame	50+	50+	50+

BUILDING ENVELOPE / CLADDING / EXTERIOR WALL FINISHES	**Multifamily / Coop**	**Seniors**	**Students**
Aluminum Siding	40	40	40
Brownstone	40	40	40
Brick or Stone Veneer	50+	50+	50+
Cement-board siding (Hardi-plank)/ Cementitious (mfgr) siding	45	45	45
Exterior Insulation Finishing Systems (EIFS)	20	20	20
Glass block	40	40	40
Granite block	40	40	40
Insulation, wall	50+	50+	50+
Metal/ glass curtain wall	30	30	30
Painting, Exterior	5-10	5-10	5-10
Pre-cast concrete panel	45	45	45
Stucco systems	50+	50+	50+
Vinyl siding	25	25	25
Wood shingle/ clapboard/ plywood, stucco, composite wood	20	20	20

ROOF SYSTEMS	Multifamily / Coop	Seniors	Students
Asphalt shingle (3-tab)	20	20	20
Built-up roof - Ethylene Propylene Diene Monomer (EPDM) / Thermoplastic Polyolefin (TPO)	20	20	20
Metal	40	40	40
Parapet wall	50+	50+	50+
Caps, copings (aluminum/ terra-cotta) - Parapet	25	25	25
Roof drainage exterior (gutter/ downspout)	10	10	10
Roof drainage interior (drain covers)	30	30	30
Roof railing	25	25	25
Roof structure	50+	50+	50+
Roof hatch	30	30	30
Roof skylight	30	30	30
Slab	50+	50+	50+
Slate, clay, concrete tile	40	40	40
Soffits (wood/ stucco)	20	20	20
Soffits (aluminum or vinyl)	25	25	25
Wood shingles (cedar shake)	25	25	25

DOORS AND WINDOWS	Multifamily / Coop	Seniors	Students
Exterior common door, aluminum and glass	30	30	30
Exterior common door, solid core wood or metal clad	25	25	25
Exterior unit door, solid wood/ metal clad	25	30	20
Residential Sliding Glass Doors	25	30	20
Residential French Glass Doors	25	30	20
Ceilings, open or exterior	30	30	30
Service door (roof)	25	30	20
Storm/ screen doors	7	10	5
Storm/ screen windows	10	15	7
Windows (frames and glazing), vinyl or aluminum	30	30	30

APPURTENANCES:	Multifamily / Coop	Seniors	Students
Chimney	40	40	40
Exterior stairs, wood	15	20	15
Exterior stairs, metal pan- concrete filled	30	30	30
Exterior stairs, concrete	50	50	50
Fire Escapes	40	40	40
Porches, concrete	50	50	50
Wood Decks	20	20	20

AMENITIES	Multifamily / Coop	Senior	Student
Basketball court	25	25	25
Mail kiosk	10	15	10
Mail facility, interior	20	25	20
Pool deck	15	15	15
Pool/ spa plaster liner	8	8	8
Tennis court / basketball court surface (paint markings)	5	7	5
Tennis court Surface (acrylic emulsion)	10	12	10
Tot-lot (playground equipment)	10	15	10
Tot-lot, uncompressed ground cover	2+	3+	2+

MECHANICAL/ELECTRIC/ PLUMBING SYSTEMS

WATER DISTRIBUTION AND DOMESTIC HOT WATER SYSTEMS	**Multifamily / Coop**	**Seniors**	**Students**
Feedwater only (hydronic)	10	10	10
Condensate and feedwater (steam)	Included in boiler	Included in boiler	Included in boiler
Cooling Tower	25	25	25
DHW Circulating Pumps	by size	by size	by size
Domestic Hot Water (DHW) - supply / return	30	30	30
Tank only, dedicated fuel	10	10	10
Exchanger in storage tank	15	15	15
Exchanger in boiler	15	15	15
External tankless	15	15	15
Instantaneous (tankless type)	10	10	10
Domestic Hot Water Storage Tanks, Small (up to 150 gallons)	15	15	15
Domestic Hot Water Storage Tanks, Large (over 150 gallons)	15	15	15
Domestic Cold Water Pumps	15	15	15
Heating Water Circulating Pumps	by size	by size	by size
Heating Water Controller	15	15	15
Hot and Cold Water Distribution	50	50	50
Solar Hot Water	20	20	20
Water Softening and Filtration	15	15	15

SANITARY WASTE AND VENT	Multifamily / Coop	Seniors	Students
Purchased Steam Supply Station	50+	50+	50+
Sanitary Waste and Vent System	50+	50+	50+
Sewage Ejectors	50	50	50

SUMP PUMP	Multifamily / Coop	Seniors	Students
Residential Sump Pump	7	7	7
Commercial Sump Pump	15	15	15

HEATING/COOLING SYSTEM AND CONTROLS	Multifamily / Coop	Senior	Student
Pad/ roof condenser	20	20	20
A/C window unit or through wall	10	10	10
Evaporative Cooler	15	15	15
Fan coil unit, electric	20	20	20
Fan coil unit, hydronic	30	30	30
Furnace (electric heat with A/C)	20	20	20
Furnace (electric heat with A/C)	20	20	20
Furnace (gas heat with A/C)	20	20	20
Packaged terminal air conditioner (PTAC)	15	15	15
Packaged HVAC (roof top units)	20	20	20
Heat pump condensing component	20	20	20
Heater, electric baseboard	25	25	25
Heater, wall mounted electric or gas	20	20	20
Hydronic heat/ electric A/C	20	20	20
Line Dryers	15	15	15
Master TV System	10	10	10
Motorized Valves	12	12	12
Outdoor Temperature Sensor	10	10	10
Pneumatic lines and Controls	30	30	30

BUILDING HEATING WATER TEMPERATURE CONTROLS	Multifamily / Coop	Seniors	Students
Chilled Water Distribution	50+	50+	50+
Chilling Plant	15	15	15
Cooling Tower	25	25	25
Fuel Oil Storage	25	25	25
Fuel Transfer System	25	25	25
Gas Distribution	50+	50+	50+
Heat Sensors	15	15	15
Heat Exchanger	35	35	35
Heating Risers and Distribution	50+	50+	50+

VENTILATION SYSTEMS	Multifamily / Coop	Seniors	Students
Combustion Air, Duct with fixed louvers	30	30	30
Combustion Air, Motor louver and duct	25	25	25
Flue Exhaust	w/boiler	w/boiler	w/boiler
Free Standing Chimney	50+	50+	50+

ELECTRICAL SYSTEMS	Multifamily / Coop	Seniors	Students
Common area	15	15	15
Buzzer/Intercom, central panel	20	20	20
Central Unit Exhaust, roof mounted	15	15	15
Compactors	15	15	15
Dumpsters	10	10	10
Electrical distribution center	40	40	40
Electric main	40	40	40
Emergency Generator	25	25	25
Gas lines	40	40	40
Gas main	40	40	40
Heating supply/ return	40	40	40
Power distribution	40	40	40
Transformer	30	30	30

BOILER ROOM EQUIPMENT	Multifamily / Coop	Seniors	Students
Blowdown and Water Treatment	25	25	25
Boiler Room Pipe Insulation	Included in boiler	Included in boiler	Included in boiler
Boiler Room Piping	Included in boiler	Included in boiler	Included in boiler
Boiler Room Valves	15	15	15
Boiler Temperature Controls	Included in boiler	Included in boiler	Included in boiler

VERTICAL TRANSPORTATION - ELEVATORS	Multifamily / Coop	Senior	Student
Electrical Switchgear	50+	50+	50+
Electrical Wiring	30	30	30
Elevator, Controller, dispatcher	15	20	10
Elevator, Cab	15	20	10
Elevator, Machinery	30	30	30
Elevator, Shaft-way Doors	20	20	20
Elevator, Shaft-way Hoist rails, cables, traveling	25	25	25
Elevator, Shaft-way Hydraulic piston and leveling	25	25	25
BOILERS	**Multifamily / Coop**	**Seniors**	**Students**
Oil-fired, sectional	22	22	22
Gas/ dual fuel, sectional	25	25	25
Oil/ gas/ dual fired, low MBH	30	30	30
Oil/ gas/ dual fired, high MBH	40	40	40
Gas fired atmospheric	25	25	25
Electric	20	20	20

FIRE SAFETY AND FIRE PROTECTION SYSTEMS	Multifamily / Coop	Senior	Student
Call station	10	15	10
Emergency Generator	25	25	25
Emergency Lights	8	10	5
Fire Extinguisher	10	15	5
Fire Pumps	20	20	20
Fire Suppression	50+	50+	50+
Smoke and Fire Detection System, central panel	15	15	15

INTERIOR ELEMENTS (COMMON AREA / DWELLING UNIT)			
INTERIOR / COMMON AREA FINISHES	**Multifamily / Coop**	**Seniors**	**Students**
Common area doors, interior (solid wood/ metal clad)	20	20	20
Common area floors, ceramic / quarry tile, terrazzo	50+	50+	50+
Common area floors, wood (strip or parquet)	30	30	30
Common area floors, resilient tile or sheet	15	15	15
Common area floors, carpet	5	5	5
Common area floors, concrete	50+	50+	50+
Common area railing	20	20	20
Common area ceiling, concrete	50+	50+	50+
Common area ceiling, acoustic tile (drop ceiling), drywall / plaster	10	10	10
Common area countertop and sink	20	20	20
Common area, refrigerator	10	10	10
Common area dishwasher	15	15	10
Common area disposal	5	7	3
Common area kitchen cabinets, wood	15	20	10
Common area walls	15	25	10
Interior railings	20	25	15
Interior lighting	15	20	10
Public bathroom accessories	7	12	5
Public bathroom fixtures	15	20	10

DWELLING FIRE, SAFETY AND SECURITY	Multifamily / Coop	Seniors	Students
Unit Smoke/Fire Detectors *	5	5	5
Unit Carbon Monoxide Detectors *	5	5	5
Unit Buzzer/Intercom	20	20	20

*Tested annually, batteries changed annually.

DWELLING UNIT CEILINGS	Multifamily / Coop	Seniors	Students
Concrete	50+	50+	50+
Acoustic Tile / Drywall / Plaster	10	15	10

DWELLING UNIT FIXTURES	Multifamily / Coop	Senior	Student
Bathroom: Vanity	10	15	10
Bathroom: Fixtures / Faucets	15-20	20+	15-20
Bathroom: Fiberglass Bath / Shower	20	25	18
Bathroom: Toilet	50+	50+	40
Bathroom: Toilet Tank Components	5	5	5
Bathroom: Vent / Exhaust	10	10	10
Interior Doors	15	30	10
Kitchen: Cabinets (wood construction)	20	25	15
Kitchen: Cabinets (particle board)	15	20+	13
Kitchen: Dishwasher	5-10	10-12	5-8
Kitchen: Microwave	10	12	8
Kitchen: Range	15	25	15
Kitchen: Range-hood	10	20	10
Kitchen: Refrigerator	10	20	10
Window covering	3	5	1+

DWELLING UNIT FLOORS	Multifamily / Coop	Senior	Student
Ceramic / Tile / Terrazzo	20	25	20
Wood (strip/ parquet)	15	20	20
Resilient Flooring	10	15	7
Carpet	7	10	3+
Concrete	50+	50+	50+

DWELLING UNIT HVAC AND MECHANICAL EQUIPMENT	Multifamily / Coop	Senior	Student
A/C window unit or through wall	10	10	10
Evaporative cooler	15	15	15
Fan coil unit, electric	20	20	20
Fan coil unit, hydronic	30	30	30
Furnace (electric heat with A/C)	20	20	20
Furnace (gas heat with A/C)	20	20	20
Packaged terminal air conditioner (PTAC)	15	15	15
Packaged HVAC (roof top unit)	15	15	15
Heat pump condensing component	15	15	15
Heater, electric baseboard	25	25	25
Heater, wall mounted electric or gas	20	20	20
Hydronic heat/ electric AC	20	20	20
Unit Electric Panel	50+	50+	50+
Unit Level Boiler	25	25	25
Unit Level Domestic Hot Water	10	15	10
Unit Level Hot Air Furnace	25	25	25
Unit Radiation - Steam/ Hydronic (baseboard or freestanding)	30	30	30
Unit Wiring	30	30	30

Attachment C – Potential Permits or Requirements for Resilient Bridgeport

Potential Permits or Requirements For Resilient Bridgeport - RBD Project						*April 2017*
Level	**Permit or Requirement***	**Description of Permit or Requirement**	**Permit or Requirement Trigger**	**Related Project Component**	**Application Method**	**Average Processing Times (when provided by Agency)****
Federal	FEMA Letter of Map Revision	A Conditional Letter of Map Revision (CLOMR) is FEMA's comment on a proposed project that would, upon construction, affect the hydrologic or hydraulic characteristics of a flooding source and thus result in the modification of the existing regulatory floodway, the effective Base Flood Elevations (BFEs), or the Special Flood Hazard Area (SFHA). The letter does not revise an effective NFIP map, it indicates whether the project, if built as proposed, would be recognized by FEMA.	Development in the floodplain identified in and consulted during the NEPA process. FEMA comments on the effects that a proposed project would have on the FIRM.	Johnson Street Extension	Conditional Letter of Map Revision CLOMR	90 days -Does not revise FIRM map. Letter of Map Revision (LOMR) request when project completed.
Federal	New England District of the U.S. Army Corps of Engineers (USACE), Pre-Construction Notification for General Permit (GP) 6	Permit for activities in water of the U.S. under USACE jurisdiction.	Construction, dredge, or fill below the Mean High Water Line for the Cedar Creek outfall. This would trigger a 401 Water Quality Certification.	Cedar Creek	Pre-construction notification for GP-6 or Individual Permit	Impacts would be based on design details and extent of impacts to waters under jurisdiction of USACE.
State	Connecticut Department of Energy and Environmental Protection (DEEP) Inland Water Resources Division (IWRD) Flood Management Certification	This program, administered by the Bureau of Water Protection and Land Reuse's IWRD, requires approval of a certification for all State actions in or affecting floodplains or natural or man-made storm drainage facilities. DEEP determines if consistent with state standards and criteria for preventing flood hazards to human life, health or property and with the provisions of the NFIP and municipal floodplain regulations; does not adversely affect fish populations or fish passage; and does not promote intensive use and development of flood prone areas.	Any state agency proposing an activity within or affecting a floodplain or that impacts natural or man-made storm drainage facilities.	Johnson Street Extension	Permit Application Form For Inland Water Resources Division Activities	60 days
State		Modification of the City of Bridgeport MS4 Permit (requirements being evaluated)	Discharge permit associated with the reactivation of the Little Regulator stormwater outfall to Cedar Creek.	Cedar Creek	TBD	TBD

*Not all permits may be necessary depending on the design.
** Time provided by corresponding agency website. Actual time may vary depending on design detail and agency review times.

Level	Permit or Requirement*	Description of Permit or Requirement	Permit or Requirement Trigger	Related Project Component	Application Method	Average Processing Times (when provided by Agency)**
State	DEEP IWRD General Permit Registration Form for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities	This general permit applies to all discharges of stormwater and dewatering wastewater from construction activities which result from the disturbance of one or more total acres of land area on a site regardless of project phasing.	Discharges of stormwater from construction activities which result from the disturbance of one or more total acres of land.	Construction footprint	Construction Stormwater Registration and preparation of Stormwater Pollution Prevention Plan	
State	DEEP Office of Long Island Sound Program Structures, Dredging and Fill & Tidal Wetlands Permit	The DEEP's Land and Water Resources Division (LWRD) regulates all activities conducted in tidal wetlands and in tidal, coastal or navigable waters. DEEP must consider the effects of proposed discharges on ground and surface water quality, and on existing and designated uses of the waters of the state. Examples of such discharges include, the discharge of stormwater during construction; the discharge of stormwater from a facility once it is constructed; and any excavation, land clearing and grading in or affecting navigable waters.	Construction, dredge, or fill below the Mean High Water Line for the Cedar Creek outfall. This would trigger a 401 Water Quality Certification.	Cedar Creek	Pre-application is recommended to determine permit required.	90 days - General Permits and Certificates of Permission. 180 days - Individual Permit
State	DEEP IWRD, Office of Long Island Sound Program	401 Water Quality Certification is required for any applicant for a federal license or permit who seeks to conduct an activity that may result in any discharge into the navigable waters, including all wetlands, watercourses, and natural and man-made ponds.	Any applicant for a federal license or permit, including a dredge and fill permit from the USACE.	Cedar Creek	Permit Application Form For Programs Administered by the Office of Long Island Sound Program.	180 days
State	DEEP Connecticut Coastal Management Act Consistency Review/Concurrence	All actions conducted by State or Federal agencies must be consistent with the policies of the Connecticut Coastal Management Act.	Federal agency activity within or outside the coastal zone that affects any land or water use or natural resource of the coastal zone.	Johnson Street	Coastal Management Consistency Review Form for Federal Activities	90 days
State	DEEP Air Emissions Permit	New Source Review Stationary Sources of Air Pollution Permit Application	If the pump station design includes a back up generator.	Cedar Creek	New Source Review Stationary Sources of Air Pollution Permit Application Forms	180 days

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** Time provided by corresponding agency website. Actual time may vary depending on design detail and agency review times.

Level	Permit or Requirement*	Description of Permit or Requirement	Permit or Requirement Trigger	Related Project Component	Application Method	Average Processing Times (when provided by Agency)**
State	CT State Historic Preservation Office Review	SHPO considers the effects of projects they carry out, approve, or fund on historic properties.	Projects involving construction, renovation, repair, rehabilitation, or ground or visual disturbances on historic properties. Historic properties include those on the National Register of Historic Places and will be identified in the NEPA process.	Seaside Village in relationship to Johnson Street Extension	SHPO will comment through NEPA process.	Up to 12 months for Phase I Cultural Resource Investigation. Extended timeframes for Phase II and III. Occurs during NEPA process
State	Connecticut Call Before You Dig	Identification of utilities before performing any excavation.	Any excavation	Construction footprint	Dial 811	48 hours before excavation
Local	City of Bridgeport Building Permit	The Building Department issues permits and inspects work done to all buildings and other structures. Permits include building, electrical, plumbing, heating, air conditioning, fire protection sprinklers and extinguishing systems, refrigeration, demolition and signs.	Structures in the park including walls and other small structures within the terraced park.	All construction components	Building Permit Application	
Local	City of Bridgeport Plumbing/Electrical Permit	The Building Department issues permits and inspects work done to all buildings and other structures. Permits include building, electrical, plumbing, heating, air conditioning, fire protection sprinklers and extinguishing systems, refrigeration, demolition and signs.	Electrical and mechanical permits for pump station.	Pump Station	Building Department Application	
Local	City of Bridgeport Street Excavation and Sidewalk	The Public Facilities Department issues permits to perform street and sidewalk excavation within the City of Bridgeport.	Street and sidewalk excavation	Force main on South Avenue	City of Bridgeport Public Facilities	
Local	City of Bridgeport Sidewalk Permit	The Public Facilities Department issues permits for sidewalks within the City of Bridgeport.	Sidewalk construction	Force main on South Avenue	City of Bridgeport Public Facilities	
Local	City of Bridgeport Public right of way occupancy	The Public Facilities Department issues permits to occupy the public right-of-way.	Work within the public right of way.	All construction components	City of Bridgeport Public Facilities	
Local	City of Bridgeport Planning and Zoning Commission Approval	May include zoning compliance and coastal site plan review.	Compliance with Master Plan and development in the coastal boundary.	All construction components	Planning and Zoning Applications	15 days
Local	City of Bridgeport Sewer Extension Approval	Approval for extension of a proposed connection to the sewer system must comply with Sewer Extension Conditions.	Construction of force main.	Force main	City of Bridgeport Engineering Department	
Local	City of Bridgeport City Council	Council Resolution	Street discontinuance and acceptance for extending Johnson Street. Possible discontinuance of the section of Ridge Avenue between Iranistan and Walnut.	Johnson Street and Ridge Avenue	Council Resolution	
Local	Board of Police Commissioners	Commission Resolution	Change of Johnson Street or Ridge Avenue from one-way traffic to two-way traffic.	Johnson Street and Ridge Avenue	Commission Resolution	

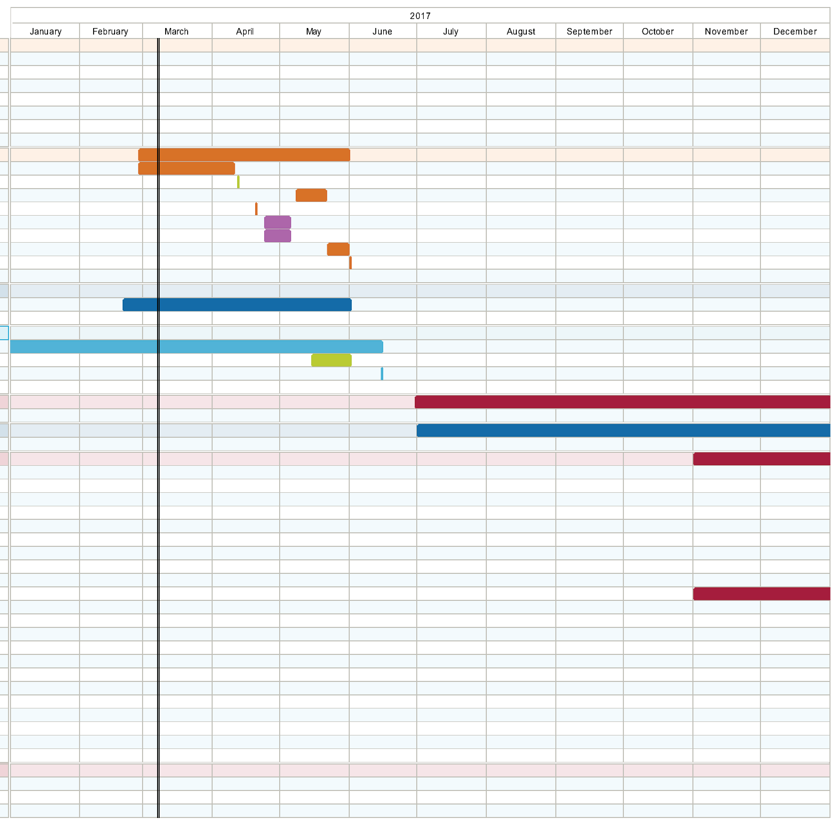
*Not all permits may be necessary depending on the design.
** Time provided by corresponding agency website. Actual time may vary depending on design detail and agency review times.

Level	Permit or Requirement*	Description of Permit or Requirement	Permit or Requirement Trigger	Related Project Component	Application Method	Average Processing Times (when provided by Agency)**
Other	Right-of-way easement	Easement of Right-of-way for force main to outfall from landowners.	Construction of force main.	Force main	Obtain appropriate easement through legal action	

*Not all permits may be necessary depending on the design.
** Time provided by corresponding agency website. Actual time may vary depending on design detail and agency review times.

Attachment D - Timeline

Activity	Start	End
CDBG-DR Action Plan Substantial Amendment	**November-2016**	**December-2016**
Public Notice	November-2016	November-2016
Open House	November-2016	November-2016
Open House	December-2016	December-2016
Public Comment Period	November-2016	December-2016
Public Hearing	December-2016	December-2016
Submission to HUD	December-2016	December-2016
CDBG-DR Action Plan Substantial Amendment 2	**February-2017**	**June-2017**
Draft Submission	February-2017	April-2017
Public Workshop	April-2017	April-2017
Public Comment Period	April-2017	May-2017
Released to Public	April-2017	April-2017
Public Hearing	April-2017	May-2017
Public Hearing 2	April-2017	May-2017
Finalize SAPA	May-2017	May-2017
Submission to HUD	June-2017	June-2017
30% Design	**February-2017**	**June-2017**
30% Design Set	February-2017	June-2017
Resilience Strategies	**December-2016**	**June-2017**
Draft Resilience Strategies	December-2016	June-2017
Public Workshop	May-2017	June-2017
Strategy Published	June-2017	June-2017
Environmental Impact Statement	**June-2017**	**July-2018**
Final Design	**July-2017**	**November-2018**
Permitting	**November-2017**	**November-2018**
FEMA Letter of Map Revision	August-2018	November-2018
New England District of the U.S. Army Corps of Engineers, Pre-Construction Not…		
DEEP IWRD Flood Management Certification	September-2018	November-2018
Modifcation of City of Bridgeport MS4 Permit		
DEEP IWRD General Permit Registration Form for the Discharge of Stormwater…		
DEEP Office of Long Island Sound Program Structures , Dredging and Fill & Tida…	August-2018	November-2018
DEEP IWRD, Office of Long Island Sound Program	May-2018	November-2018
DEEP CT Coastal Management Act Consistency Review	August-2018	November-2018
DEEP Air Emissions Permit	May-2018	November-2018
Connecticut State Historic Preservation Office Review	November-2017	November-2018
Connecticut Call before you Dig		
City of Bridgeport Building Permit		
City of Bridgeport Plumbing/ Electrical Permit		
City of Bridgeport Street and Sidewalk Excavation		
City of Bridgeport Sidewalk Permit		
City of Bridgeport Public Right of Way Occupancy		
City of Bridgeport Planning and Zoning Commission Approval	October-2018	November-2018
City of Bridgeport Sewer Extension Approval		
City of Bridgeport City Council Resolution		
Board of Police Commissioners Resolution		
Right of Way Easement Landowners		
RBD Project Construction	**November-2018**	**September-2021**
BID Documents Released	November-2018	December-2018
Construction	April-2019	September-2021



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project: Resilient Bridgeport
client: CT DOH
date: March 2017
projectnumber 1522

Amendments
Construction Activities
Public Workshop
Public Hearing
Design Activities

Activity	Start	End
CDBG-DR Action Plan Substantial Amendment	**November-2016**	**December-2016**
Public Notice	November-2016	November-2016
Open House	November-2016	November-2016
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Public Comment Period	November-2016	December-2016
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Public Hearing 2	April-2017	May-2017
Finalize SAPA	May-2017	May-2017
Submission to HUD	June-2017	June-2017
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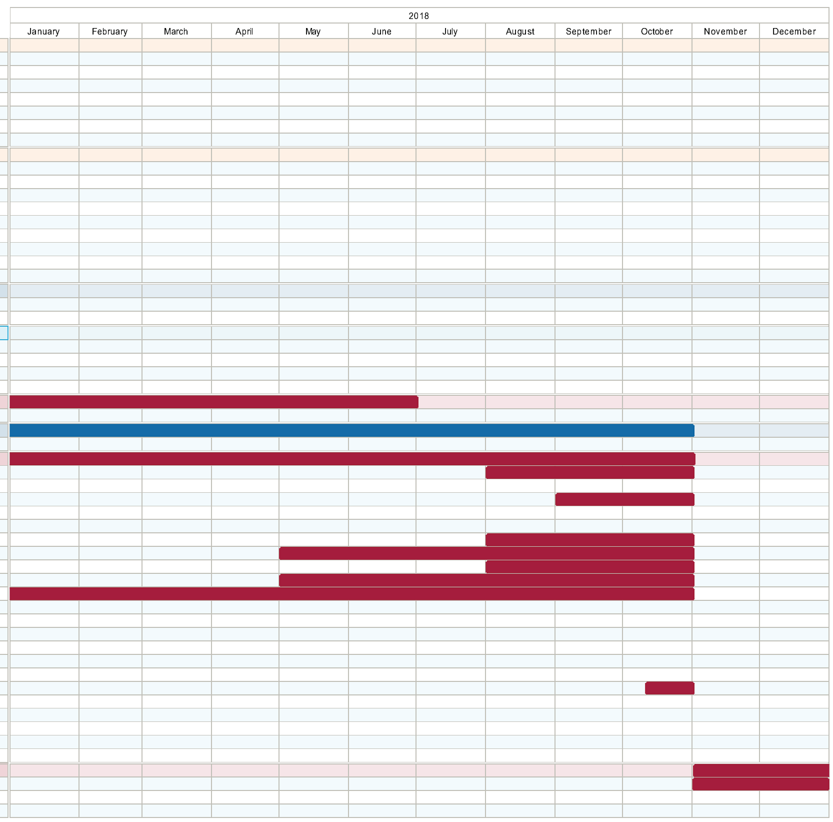
Construction	April-2019	September-2021



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Amendments
Construction Activities
Public Workshop
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Design Activities

Activity	Start	End	2019 January	February	March	April	May	June	July	August	September	October	November	December
CDBG-DR Action Plan Substantial Amendment	**November-2016**	**December-2016**												
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Open House	November-2016	November-2016												
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Released to Public	April-2017	April-2017												
Public Hearing	April-2017	May-2017												
Public Hearing 2	April-2017	May-2017												
Finalize SAPA	May-2017	May-2017												
Submission to HUD	June-2017	June-2017												
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Construction	April-2019	September-2021												

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Public Workshop	May-2017	June-2017
Strategy Published	June-2017	June-2017
Environmental Impact Statement	**June-2017**	**July-2018**
Final Design	**July-2017**	**November-2018**
Permitting	**November-2017**	**November-2018**
FEMA Letter of Map Revision	August-2018	November-2018
New England District of the U.S. Army Corps of Engineers, Pre-Construction Not...		
DEEP IWRD Flood Management Certification	September-2018	November-2018
Modifcation of City of Bridgeport MS4 Permit		
DEEP IWRD General Permit Registration Form for the Discharge of Stormwater...		
DEEP Office of Long Island Sound Program Structures , Dredging and Fill & Tida...	August-2018	November-2018
DEEP IWRD, Office of Long Island Sound Program	May-2018	November-2018
DEEP CT Coastal Management Act Consistency Review	August-2018	November-2018
DEEP Air Emissions Permit	May-2018	November-2018
Connecticut State Historic Preservation Office Review	November-2017	November-2018
Connecticut Call before you Dig		
City of Bridgeport Building Permit		
City of Bridgeport Plumbing/ Electrical Permit		
City of Bridgeport Street and Sidewalk Excavation		
City of Bridgeport Sidewalk Permit		
City of Bridgeport Public Right of Way Occupancy		
City of Bridgeport Planning and Zoning Commission Approval	October-2018	November-2018
City of Bridgeport Sewer Extension Approval		
City of Bridgeport City Council Resolution		
Board of Police Commissioners Resolution		
Right of Way Easement Landowners		
RBD Project Construction	**November-2018**	**September-2021**
BID Documents Released	November-2018	December-2018
Construction	April-2019	September-2021

2020: January, February, March, April, May, June, July, August, September, October, November, December

WAGGONNER & BALL

project: Resilient Bridgeport
client: CT DOH
date: March 2017
projectnumber 1522

Amendments
Construction Activities
Public Workshop
Public Hearing
Design Activities

Activity	Start	End	2021 January	February	March	April	May	June	July	August	September	October	November	December
CDBG-DR Action Plan Substantial Amendment	**November-2016**	**December-2016**												
Public Notice	November-2016	November-2016												
Open House	November-2016	November-2016												
Open House	December-2016	December-2016												
Public Comment Period	November-2016	December-2016												
Public Hearing	December-2016	December-2016												
Submission to HUD	December-2016	December-2016												
CDBG-DR Action Plan Substantial Amendment 2	**February-2017**	**June-2017**												
Draft Submission	February-2017	April-2017												
Public Workshop	April-2017	April-2017												
Public Comment Period	April-2017	May-2017												
Released to Public	April-2017	April-2017												
Public Hearing	April-2017	May-2017												
Public Hearing 2	April-2017	May-2017												
Finalize SAPA	May-2017	May-2017												
Submission to HUD	June-2017	June-2017												
30% Design	**February-2017**	**June-2017**												
30% Design Set	February-2017	June-2017												
Resilience Strategies	**December-2016**	**June-2017**												
Draft Resilience Strategies	December-2016	June-2017												
Public Workshop	May-2017	June-2017												
Strategy Published	June-2017	June-2017												
Environmental Impact Statement	**June-2017**	**July-2018**												
Final Design	**July-2017**	**November-2018**												
Permitting	**November-2017**	**November-2018**												
FEMA Letter of Map Revision	August-2018	November-2018												
New England District of the U.S. Army Corps of Engineers, Pre-Construction Not…														
DEEP IWRD Flood Management Certification	September-2018	November-2018												
Modifcation of City of Bridgeport MS4 Permit														
DEEP IWRD General Permit Registration Form for the Discharge of Stormwater…														
DEEP Office of Long Island Sound Program Structures , Dredging and Fill & Tida..	August-2018	November-2018												
DEEP IWRD, Office of Long Island Sound Program	May-2018	November-2018												
DEEP CT Coastal Management Act Consistency Review	August-2018	November-2018												
DEEP Air Emissions Permit	May-2018	November-2018												
Connecticut State Historic Preservation Office Review	November-2017	November-2018												
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City of Bridgeport Building Permit														
City of Bridgeport Plumbing/ Electrical Permit														
City of Bridgeport Street and Sidewalk Excavation														
City of Bridgeport Sidewalk Permit														
City of Bridgeport Public Right of Way Occupancy														
City of Bridgeport Planning and Zoning Commission Approval	October-2018	November-2018												
City of Bridgeport Sewer Extension Approval														
City of Bridgeport City Council Resolution														
Board of Police Commissioners Resolution														
Right of Way Easement Landowners														
RBD Project Construction	**November-2018**	**September-2021**												
BID Documents Released	November-2018	December-2018												
Construction	April-2019	September-2021												

WAGGONNER & BALL

project: Resilient Bridgeport
client: CT DOH
date: March 2017
projectnumber 1522

Amendments
Construction Activities
Public Workshop
Public Hearing
Design Activities

Attachment E – Legal Notice for Public Hearing/Public Comment Period

NOTICE OF PUBLIC COMMENT PERIOD

The State of Connecticut, Department of Housing is seeking public comment on the 5th Substantial Amendment to the Community Development Block Grant – Disaster Recovery (CDBG-DR) Action Plan. This Substantial Amendment is intended to address the following: the definition of the pilot project or activity under Rebuild by Design (RBD); implementation plan for the RBD pilot project; and the Benefit Cost Analysis and flood risk reduction of the RBD pilot project.

A thirty day public-examination and comment period will begin on April 20, 2017, and end on May 22, 2017. All State residents, including residents of the City of Bridgeport, are invited to provide comment on the State of Connecticut's 5th Substantial Amendment to the CDBG-DR Action Plan, which addresses the following: the definition of the pilot project or activity under Rebuild by Design (RBD); implementation plan for the RBD pilot project; and the Benefit Cost Analysis and flood risk reduction of the RBD pilot project. Written comments may be sent to Michael C. Santoro, Director, Office of Policy, Research and Housing Support, Department of Housing, 505 Hudson Street, Hartford, CT 06106-7106 or to CT.Housing.Plans@ct.gov through midnight on Monday, May 22, 2016.

A Public Hearing and Community Forum will be held on Wednesday, May 10, 2017 at Eleanor Apartments Multi-Purpose Room, 695 Park Avenue, Bridgeport, CT 06604. Please dial 100 for entry to building. There will be an Open House from 6-7 PM, and a Public Hearing at 7 PM with discussion to follow. Parking is on surrounding streets or in the rear of the surface lot located behind the building and accessed off of Black Rock Avenue or Garden Street.

An additional Public Hearing will be held on Monday, May 1, 2017 at 1pm at the Department of Housing, Room 466, 505 Hudson Street, Hartford, CT 06106. Please check in with security in the lobby for entry to the building. Parking is on surrounding streets or there is limited visitor parking in the surface lot accessed off of Hudson Street.

All comments received at the Public Hearings and in writing will be summarized and included in the 5th Substantial Amendment CDBG-DR Action Plan submitted to HUD. Please refer to the Department of Housing website Hurricane Sandy page at www.ct.gov/doh to view a copy of the 5th Substantial Amendment to the CDBG-DR Action Plan.

The Department of Housing programs are administered in a nondiscriminatory manner, consistent with equal employment opportunities, affirmative action, and fair housing requirements. Questions, concerns, complaints or requests for information in alternative formats may be directed to the ADA (504) Coordinator at 860-270-8261.

Publication Date: April 20, 2017

Attachment F – Public Hearing Transcripts

ATTACHMENT F-1

STATE OF CONNECTICUT

DEPARTMENT OF HOUSING

* * * * * * * * * * * * * *

RE: CDBG-DR SUB AMENDMENT MAY 1, 2017

* * * * * * * * * * * * * *

BEFORE: DAVID KOORIS, DIRECTOR OF RBD & NDR PROGRAMS

. . .Verbatim proceedings of a hearing before the State of Connecticut, Department of Housing, in the matter of CDBG-DR Sub Amendment, held at 505 Hudson Street, Hartford, Connecticut, on May 1, 2017 at 1:00 p.m. . . .

MR. DAVID KOORIS: Okay. It is 1:00 p.m. We're at 505 Hudson in the City of Hartford. This is the first of two public hearings for the State of Connecticut's fifth substantial amendment on the CDBG-DR Action Plan for post-Sandy disaster spending.

This Action Plan amendment identifies and defines the pilot project that will be funded through Rebuild by Design, as well as the benefit cost analysis and the implementation strategy for that project.

We will be holding a subsequent public hearing in about a week's time on May 10th in the City of Bridgeport at 695 Park Avenue at 7:00 p.m., but, for today's purpose, at 1:01, we will call the public hearing open.

And as no public speakers have yet arrived, we will suspend the public meeting until such time as we have someone appear before us. Thank you.

(Off the record)

MR. KOORIS: Okay. We're back on the record at 1:40 p.m. There has been no attendees for public comment, therefore, we are going to close and adjourn the meeting. Thank you.

(Whereupon, the hearing adjourned at 1:40 p.m.)

ATTACHMENT F-2

STATE OF CONNECTICUT

DEPARTMENT OF HOUSING

* * * * * * * * * * * * * *

RE: CDBG-DR SUB AMENDMENT   MAY 10, 2017

* * * * * * * * * * * * * *

BEFORE: DAVID KOORIS, DIRECTOR OF RBD & NDR PROGRAMS

. . . Verbatim proceedings of a hearing before the State of Connecticut, Department of Housing, in the matter of CDBG-DR Sub Amendment, held at 695 Park Avenue, Bridgeport, Connecticut, on May 10, 2017 at 7:00 p.m. . . .

MR. DAVID KOORIS: Okay. Thank you all for coming. It is now 7:00 p.m., which was the publically noticed time to start the hearing; and so we will call the hearing to order at 7:00.

My name is David Kooris. I'm the director of Rebuild by Design and National Disaster Resilience for the State of Connecticut at the Department of Housing.

I will just briefly kind of indicate what this public hearing is and the overall arc of the project and then briefly describe the current project description as has been submitted or will be submitted to HUD following this public comment period and then invite any of you to give comment on the record about the project.

So this is technically a public hearing on the State's fifth substantial amendment to its action plan to HUD for the expenditures of the post Sandy Community Development Block Grant disaster recovery funds.

The purpose of this amendment, per HUD requirement, for the Rebuild by Design Bridgeport project is to describe the pilot project that we will be using the bulk of the first award of $10 million to construct. And per HUD -- HUD regulations the stated purpose of that project was to minimize flood risk to the most vulnerable public housing in the South End of Bridgeport and Black Rock Harbor areas and surrounding neighborhood.

And so our proposed project -- which you've all seen various iterations of over the course of this planning process where we've gone from a lot of ideas down to a very short list of potential project components that we presented last December to now a list of components that we think we can construct -- based on our estimates for the funding available, and it's about $8.2 million available for both soft and hard costs which would result in a construction budget of just under seven million.

And so we're proposing two overall components of this project. One is for dry egress and one is for stormwater management. For dry egress we are proposing to regrade a portion of Johnson Street from midway between Park Ave and Columbia to Columbia and then create a new Johnson Avenue extension all the way to Iranistan that would serve as dry egress for the redevelopment of the former -- or soon to be former Marina Village. That would be built above the 500-year flood elevation plus sea level rise, that would allow for emergency access and egress in times of crisis, meeting the state standards for pedestrians and stretchers, etc.

The second component is stormwater management where we are proposing to divert the stormwater from the redevelopment of Marina Village as well as several of the surrounding blocks to a new what we're calling the stormwater terraces, which would be a new park space that would provide benefit to the community 364 days a year -- or 365 I suppose you could say -- and in major rain events would collect all that rainwater and delay its discharge into a new stormwater pipe and pump out to Cedar Creek.

The primary benefit of this is creating basically a parallel stormwater management system that is disconnected from the underlying combined system so that you will both reduce the incidence of combined sewer overflow as well as reduce the chronic flooding that happens in several intersections within the neighborhood.

So that is the outline of the project. I encourage folks, if you have not yet done so, to look at the actual content of the substantial amendment, which is available online in both English and Spanish. So make sure that your neighbors and constituents are aware of that. And it has a lot of detail in it. It has a benefit cost analysis that goes through all of the quantifiable benefits to the neighborhood and risk reduction and flood reduction compared to the cost. And it has a series of analyses around implementation but primarily details the project as we propose developing it.

I will, I guess, make a note on timeline before opening up the comment. We are at the kind of late stages of the planning phase. We're now transitioning into engineering and environmental review. Over the course of the next 12-15 months or so we will be conducting that environmental review where we'll have a lot more meetings, a lot more opportunities for formal public comment, where we will be quantifying the impacts of the project and identifying mitigation strategies, if necessary, which will then lead into final design and permitting with the target of construction in the late winter/ early spring of 2019.

And, with that, I will open it to public comment. I know we had a sign-in sheet. And, Lydia, you are the only one signed in to speak so I will invite you to do so and then anyone else is certainly --

MR. GREG BRELAND: Can we ask a question or is that legal?

MR. KOORIS: It's not --

MR. BRELAND: Oh.

MR. KOORIS: -- really set up for that. I'm -- we are absolutely -- myself and Ronny from Arcadis, who is our engineering firm, and Andre from Yale were very willing to stay and answer any questions; but I think first we should just do the formal public comment we called it.

MS. LYDIA SILVAS: Well, I didn't have anything really formal to say. I -- I didn't know if I would so I just put my -- my name down. But you explained everything very well and very clearly, and I feel positive about what you're doing.

Just off the top of my head, I -- I am a little -- I want to be hopeful about the terrace effects of the stormwater park. It -- and I think the terracing will slow it down, I hope that -- that -- that grade of land slopes down anyway. It's just a little bit frightening, being that I'm at the bottom of that hill; but hopefully the -- that and the pump that -- or pumps that you put in will move the water out to the creek effectively. I -- I -- I'm -- I feel good about that.

And really the only -- when I look at these plans I -- I feel happy and I've been involved all along and I -- I think a lot of -- I've just seen an awful lot of work and thought being put into this. I -- I -- I know that there's still an awful lot of unmet need for the community. There certainly is for Seaside Village, you know, with erosion to our foundations of our home, our -- still of our combined stormwater system which is extremely old and insufficient.

And although it's not directly related to this, it does make me wonder how this team has --

will go forward in letting the rest of the South End Community know how we can meet the needs that are unmet currently, in terms of funding and helping us as a community address effectively what -- what -- what we -- what we need to do to make -- protect our property and to know that we can get -- get things done, especially now that we've got an administration that certainly is not going to be providing us with the kind of help that we've had in the past administration.

And that is a real concern for me to know and something that I hope that this project will take, not just the resilient team but the team that's going to be working going forward on the other side of the South End peninsula and really help the entire South End learn how we can all work together to -- to get -- to get funding and to collectively work towards doing that together to really extend the work that's begun here.

Because it's really the first time the South End's gotten a break and I'd like to keep it going. So thank you for everything that -- that's been happening so far.

MR. KOORIS: Great. Thank you, Lydia.

Other that?

MR. JOE PROVEY: Joe Provey, Seaside Village. I'd just like to thank everybody who was involved in this process which has gone on for more than a year at least. I think that you've all listened to residents here and come up with a very practical pilot project.

There -- you know, there are details that still have to be worked out. The -- you know, the traffic impact of Johnson Street jumping into Iranistan, the -- you know, the -- I guess the physics of the water displacement when you raise up these two sites, one and two, and how much water that those two sites used to hold and how much of it is now, you know, going to be coming into this water park. And so -- but, you know, I trust that the engineers are more aware of that than -- than I am and will just stay with it over the next couple years and see how it goes. But anyway, thank you.

MR. KOORIS: Thank you. Others comment?

MS. CARMEN NIEVES: So like Joe I'd like to thank everybody who's been part of this process because we've been working on it for about two years.

My name is Carmen Nieves, and I wear a couple different hats as it relates to Resilient Bridgeport.

First, I am a property owner. I have a three-family home that we live in right over on Atlantic Street. I'm also a business owner. I have a small photography business company that I run out of my home. And I'm also the president and chair of the South End NRZ, and we've been doing a lot of work with David, his team, over the past two years just to get into this study. And I think one of the things that is difficult for communities to understand is that when we say research you're not going to see a building come up tomorrow, that it's really about doing a study of how our community can, you know, fight against large damage that we've had with Sandy, all the flooding, all the water, all the sewage that was coming up.

So in this study, I mean, we've had many, many conversations about, you know, that this is -- might seem like a little project; but this study does a wider scale so that any new projects will have to follow some of the things that we found so that, when we build, that we're already making some sense of what some standards are so, when other things are being built, they're complementing what's already happening.

Because for a long time we weren't able to get money. I don't know how many of our residents know that, because we're in the 100-year flood area, we can't get certain money to build anything. So we've got to have a place to start that starts to build that and have that conversation so that any new buildings that come up will follow some of this formula. What we're doing as part of this formula, we're, on behalf -- and I speak on behalf of the NRZ -- that we very much support this project and this study. Because it's an open door, if you want to think of it as an open door, as a starting point, as to what can be in communities. And the great thing is that this study becomes, you know, best practices in other communities that are developing or having the same thing.

So we're very fortunate to have been picked out of -- how many was it, David?

MR. KOORIS: Seven.

MS. NIEVES: Out of seven. And this is

national so this is huge for us. And Bridgeport is on the cutting edge of getting things done. Every project and every dollar that we take a look at, we want it to complement this because this is the starting point. All of this to say that we support the opportunity to have less damage in our communities and our streets, less sewage. And the way to do that so that it's nice looking -- I don't know how many people came to the many conversations that we've had, but the last one that we did was physically taking a look at that part and how do we want it to look. And we discussed -- I know that Emily was there, Betsy was here, some of the other people were here too. And we talked about how the lighting -- you know, how do we do it so that it's transparent, that it's accessible to all communities.

This will ultimately give us the opportunity to ask for more money and get our community really, really kind of on -- on the -- on the cutting edge of what could be and will be on behalf of Bridgeport.

So again I just want to say that, on behalf of the NRZ, we support that. So we know that it's still about another 18 months left to go; but, if you think about it from where we were, we're at the halfway mark. So thank you so, so much for your -- all your work.

MR. KOORIS: Thanks, Carmen. Anyone else like to speak on the record?

Okay. Then, with that, it is 7:15 and we will close the public comment period.

(The hearing adjourned at 7:15 p.m.)

Attachment G - Written Comments

1281 East Main Street, Suite 201
Stamford, Connecticut 06902
T: (203) 348-2644
F: (203) 348-2611

May 21, 2017

David M. Kooris, AICP
Director, Rebuild by Design and National Disaster Resilience
Department of Housing State of Connecticut
505 Hudson Street
Hartford, CT 06106

RE: Community Development Block Grant
Disaster Recovery Program
Bridgeport, Connecticut

Dear Mr. Kooris:

Thank you for keeping us involved as you work to develop, design and implement strategies to address the flooding issues that have for years plagued the Marina Village public housing development and its south-end neighborhood; resulting in the devastation to the entire area that was caused by Superstorm Sandy and Irene. Your cooperation and our ability to work together with you and the Rebuild By Design team to coordinate our efforts is certain to ensure that the flood-mitigation programs that will be implemented will greatly benefit the mixed-income, mixed-use development that will replace Marina Village.

This cooperation and collaboration has resulted in our being able to design an on-site storm water management system that will connect directly to the natural-green and fortified-grey infrastructure system that is being constructed as part of the Rebuild By Design solution. Additionally, we have engineered our development to provide raised building elevations, an auto and pedestrian circulation system and public spaces to ensure that they will compliment and interface with the construction of the Rebuild By Design project's raised corridor and park system; creating flood mitigation and environmental enhancements that will not only revitalize the entire area, but will provide for its sustainability.

The Marina Village site and its surrounding neighborhood have been ignored for much too long. Through neglect it has been allowed to decay into one of the City's most depressed neighborhoods; a situation that is intolerable. Its location, given its presence at the entrance to Bridgeport's underutilized seaside and the highly successful University of Bridgeport as well as its proximity to I-95, public transportation, shopping, employment centers and Bridgeport's Central Business District speak to the area's import. Fortunately, the result of our collaboration with the Rebuild By Design project will allow for the creation of a new, state-of the-art, mixed-use, mixed-income development that will revitalize what was at one time a vibrant, productive Bridgeport neighborhood. Bringing these two developments to fruition will further spur economic growth and development in this long-ignored neighborhood; development and growth that will resonate through and benefit all of Bridgeport and the surrounding communities.

We look forward to continuing to work together with you throughout the future.

Sincerely,

Todd D. McClutchy
Authorized Member

Cc: Michael Santorto, CT DOH

RECEIVED

MAY 19 2017

DEPARTMENT OF HOUSING

Robert E. Halstead
55 Sterling Place
Bridgeport, CT., 06604
203 362 7757
Halcar5@optonline.net

May 16, 2017

Michael C. Santoro, Director
Office of Policy, Research and Housing Support
Department of Housing
Rm. 466
505 Hudson Street
Hartford, CT., 06106-7106

Re: Rebuild By Design, Bridgeport

Dear Michael,

I have the following comments to make about the above referenced plan:

- The public presentations and hearings I have attended have been perfunctory in nature without real input from Bridgeport residents other than a specific neighborhood in the South End.
- There are virtually no Bridgeport people in the planning process for their city in spite of the fact that there are many qualified people to do so.
- I have been extremely frustrated in being ignored on my alarm at the hurricane damage to the breakwater going out to Fayerweather Island that protects Black Rock Harbor and the Black Rock neighborhood.
- I think the amount of HUD funding dedicated to planning for this project is extremely excessive and wasteful
- No mention is even made that there are several highly important and successful community gardens that provide neighborhood stability and a food source to many of the South End residents with no provision made for their support or preservation
- BNT has a very bad track record with flood issues in the South End as they have eliminated one community garden with a permeable surface and are installing housing and parking lots that would create more run off into the Iranistan basin. They had also pushed through a plan to eliminate the 35 year old Gregory Street garden in favor of making money on a housing development in the lowest flood level of the neighborhood creating parking and roofing runoff. BNT is not qualified to spearhead this project and the development they have planned for Columnbia Street and Court is very adverse to any storm runoff remediation plan.
- Many players seemed to be left out of the planning process

Thank you for the opportunity to comment

Sincerely,

Robert E Halstead
Lifelong Bridgeport resident
Masters in City and Regional Planning Pratt Institute
Former City Councilman
President, Bridgeport Community Land Trust