ATTACHMENT F

BENEFIT COST ANALYSIS

Attachment F
National Disaster Resilience Competition
New Haven Project
Benefit-Cost Analysis

Draft Prepared for Connecticut Department of Housing

Date: October 9, 2015

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Executive Summary

A benefit-cost analysis (BCA) was conducted for the National Disaster Resilience Competition (NDRC) New Haven, Connecticut, Project for submission to the U.S. Department of Housing and Urban Development (HUD) as a requirement of a discretionary grant application for the National Disaster Resilience Competition (NDRC) program. The analysis was conducted in accordance with the benefit-cost methodology as recommended by the U.S.HUD in the OMB Circular, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," Federal Register (79 FR 11854) and conducted for a 100-year analysis period starting in 2015.

The analysis shows a benefit-cost ratio that exceeds 1.0, meaning the project returns economic benefits that exceed project costs over the life of the investment.

The State of Connecticut has formed the State Agencies Fostering Resilience (SAFR) to develop a long-term resilience plan for the State of Connecticut to combat the challenges of climate change and major disasters. SAFR has developed a strategy to develop resilience plans across the nine municipalities in New Haven and Fairfield counties. As described in Exhibit A, Executive Summary, New Haven and Fairfield Counties were designated as the most impacted and distressed counties in the State of Connecticut, due to Hurricane Sandy, the Qualifying Disaster for this competition. These nine communities will launch a statewide program for resilience that will be addressed through the modification of existing programs within the State and new programs designed to combat the effects of climate change. This initial regional program will be launched by pilot projects in the two municipalities who illustrated the greatest need and most advanced approach to creating resilient futures.

In New Haven, Union Station and the Rail Yard are a critical local, regional and national infrastructure asset that must be protected to ensure the continued operations of the Northeast rail corridor. The neighborhood surrounding Union Station experiences chronic flooding from rain events, and when coupled with high tide conditions, this creates a convergence of water, damaging homes, key regional infrastructure, and industrial properties that provide many jobs to New Haven's working class families. These conditions will only be exacerbated with expected sea level rise. The area includes the Church Street Village Housing project which is currently at risk from future storm events. The project approach to New Haven Station will be to solve for the upland and coastal flooding conditions simultaneously, protecting the Long Wharf neighborhood and train station, and in doing so, the project will enable future economic development opportunities in this downtown area.

Results in Brief

There were two alternative computations conducted for this analysis, using a 7.0 percent discount rate, and an alternative using a 5.0 percent discount rate. All benefits and costs were estimated in constant 2015 dollars over an evaluation period extending 100 years. The base year for discounting is 2015.

Table 1 presents the evaluation results for the two cases. For the 7 percent discount rate, the proposed infrastructure investments yield a net present value of $3.3 million, and a benefit-cost ratio of 1.04. At a 5 percent discount rate, the proposed infrastructure investments yield a net present value of $34.0 million, and a benefit-cost ratio of 1.40.

Over the 100-year analysis period (2016-2115), there are $88.6 million in benefits at a 7% discount rate, in 2015 dollars and $119.9 million in benefits at a 5% discount rate.

Table 1. Benefit Cost Analysis Summary Results

Scenario	Net Present Value (2015 $ millions disc.)	Benefit Cost Ratio
Case A (7 percent discount rate)	$3.3	1.04
Case B (5 percent discount rate)	$34.0	1.40

Source: WSP | Parsons Brinckerhoff, 2015

Project Costs

For the benefit cost analysis, capital and program investments ($936 million) were assumed to begin in 2016 and conclude by the end of 2016. These capital costs translate to $85 million when discounted at 7 percent and $86 million when discounted at 5 percent. A breakdown of capital cost components is provided in the Details section of the main body of this report.

Table 2. Project Capital Costs

Capital Cost Category	Costs (2015 $)	Costs (2015 $ discounted at 7 %)	Costs (2015 $ discounted at 5 %)
NDRC New Haven Project	$93 Million	$85 Million	$86 Million
Total	$93 Million	$85 Million	$86 Million

Project Benefits by Category

The following quantifiable benefits have been included in this Benefit Cost Analysis:

- Lifecycle costs
- Resilience value
- Environmental value
- Social value or Community development value
- Economic revitalization

Benefits have been estimated in the categories listed below. The estimated values have been entered into a cost-benefit spreadsheet model. The model is used to estimate benefit and cost streams over time, and for discounting to present value to arrive at the benefit-cost ratio.

Benefit—Cost Analysis Details

Analytical Assumptions

Discount Rates

For project investments, dollar figures in this analysis are expressed in constant 2015 dollars. In instances where certain cost estimates or benefit valuations were expressed in dollar values in other (historical) years, the U.S. Bureau of Labor Statistics' Consumer Price Index for Urban Consumers (CPI-U) was used to adjust them.[1]

The real discount rates used for this analysis was 7.0 percent, consistent with the base-case discount rate in OMB Circular A-94[2].

Evaluation Period

For the NDRC New Haven Project, the evaluation period includes the relevant (post-design) construction period during which capital expenditures are undertaken, through 100 years of operations within which to accrue benefits. This period is chosen to represent the return period of the 100-year storm.

For the purposes of this study, it has been assumed that capital investments will occur in the year 2016. The analysis period begins with the project's first expenditures in 2016 and continues through 100 years of analysis, or through 2115.

All benefits and costs are assumed to occur at the end of each year, and benefits begin in the calendar year immediately following.[3]

[1] U.S. Bureau of Labor Statistics. Consumer Price Index, All Urban Consumers, U.S. City Average, Series CUSR0000SA0. 1982-1984=100

[2] White House Office of Management and Budget, Circular A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* (October 29, 1992). (http://www.whitehouse.gov/omb/circulars_a094).

(Note that in the benefit cost model, 2015 is the first year of the analysis (year zero) and all values are discounted to that year. Present value is calculated with respect to 2015. Unit costs and benefit factors are in 2015 dollars.)

Summary of Project Improvements

A series of improvements will be made to strengthen the resiliency of New Haven. Union Station and the Rail Yard are a critical local, regional and national infrastructure asset that must be protected to ensure the continued operations of the Northeast rail corridor.

The neighborhood surrounding Union Station experiences chronic flooding from rain events, and when coupled with high tide conditions, this creates a convergence of water, damaging homes, key regional infrastructure and industrial properties that provide many jobs to New Haven's working class families. These conditions will only be exacerbated with expected sea level rise. The area includes the Church Street Village Housing project which is currently at risk from future storm events.

The project approach to New Haven Station will be to solve for the upland and coastal flooding conditions simultaneously, protecting the Long Wharf neighborhood and train station, and in doing so, the project will enable future economic development opportunities in this downtown area. Project applications in New Haven include the following broad strategic components (which are described in more detail in Exhibit E.a.1 of the CDBG-NDR application):

- Management of coastal and inland storm water convergence in Long Wharf neighborhood, including components for railyard berm; pumping station; and retention system

[3] In the benefit cost model, 2015 is the first year of the analysis (year zero) and all values are discounted to that year. Present value is calculated with respect to 2015.

- Street and neighborhood improvements at Church Street Village Housing, including components for complete streets; and affordable housing design
- Coastal Protection Strategy, including component for coastal revetment

The proposed NDRC project recognizes the critical position of New Haven Union Station and associated rail yard in the regional economy and it advocates for a hybrid of passive, green infrastructure and mechanically engineered solutions in adapting the surrounding neighborhood to be more resilient to future natural disasters and long term change along the Northeastern United States seaboard.

Cost-Benefit Analysis Methodology

This benefit cost analysis was done using a benefit cost analysis spreadsheet that uses a methodology consistent with the guidelines in OMB Circular A-94.

This benefit cost analysis takes into account pumping station construction, railyard berm protection construction, bioswale construction, economic benefits, and risk reduction benefits ONLY. The quantitative analysis does not include additional ecological or social benefits or costs, as ecological and social benefits were not monetized as part of this analysis, and thus could not be compared to the costs using this framework. For a summary of the additional ecological and social benefits, which are not likely to be quantitatively large, see the “expanded benefits” section.

Economic Costs Included

The capital costs in this project will include the following components:

- Railyard Berm, $16 M
- Pumping Station, $6 M

- Retention System, $39 M
- Complete Streets, $4 M
- Coastal Revetment, $18 M
- Affordable Housing Design, $350 K
- Grand Total Capital Costs $84 M

Economic Benefits Included

This section identifies and groups the benefits that are included in the BCA for the NDRC New Haven project.

The following broad categories and quantifiable benefits have been included in this Benefit Cost Analysis:

- Lifecycle costs:
    - Resilient corridor construction
    - Pumping station
    - Rail yard berm
    - Bioswale and environmental modification
- Resiliency value
    - Reduction in property damage
    - Reduction in accidents and casualties
    - Reduction in displacements
    - Reduction in property damage (rail fleet and downtown buildings)
- Environmental value
    - Improvement in riparian landscape
    - Improvement in neighborhood water quality
    - Protection of species breeding ground
    - Stormwater retention pond system
- Social value or Community development value
    - Community benefits value
    - Benefits to low/moderate income households
    - Improved living environment
    - Redesign of Church Street village housing development
- Economic revitalization
    - Regional economic impact
    - Increased property value
    - Reduced insurance cost
    - West River Outfall design modification
    - Construction jobs/maintenance jobs

- Potential redevelopment along Church Street extension

Lifecycle Costs

This benefit cost analysis captures the life cycle costs of the capital, maintenance, and operating costs of the proposed components of the project. The Life Cycle costs include the components of resilient corridor construction, pumping station, rail yard berm, and bioswale and environmental modification.

Resiliency Value

In the BCA, the group of benefits under the heading of Resiliency Value captures the following components of the New Haven project:

- Reduction in property value. With the construction of the various resilience elements of the project, a significant set of homes and businesses will no longer be directly affected by coastal flooding. Property damages associated with major 100-year storms and extreme weather will be reduced or avoided.
- Reduction in casualties. With the construction of the various elements, people will be safer and better protected from direct impacts of storms and severe weather. The number and seriousness of accidents/casualties and/or hospitalizations will be reduced or avoided.
- Reduction in displacements. With the construction of the various elements, homes and businesses will no longer be directly affected by coastal flooding. The number of community displacements of residents and businesses will be reduced or avoided.
- Reduction in property damage for the rail fleet and downtown buildings. With the construction of rail yard berm and storm water retention/dry canal, the New Haven Line rail fleet in the rail yard will suffer a much smaller direct threat of coastal flooding. Damage to or loss of use of railcars due to storms will be reduced or avoided. For the purposes of this BCA analysis, it was assumed that a portion of the rail fleet would be damaged in the event of a major storm event (100-year storm or higher).
- Reduction in rail operations down time. With the construction of the berm and coastal protection, the New Haven Railyard will no longer be directly affected by coastal flooding, and rail operations losses will be reduced.

- Protection of Long Wharf Park breakwater from erosion

Casualties and Accident Cost Savings

The cost savings that arise from a reduction in the number of casualties, injuries, and deaths include direct savings (e.g., reduced personal medical expenses, lost wages, and lower individual insurance premiums), as well as significant avoided costs to society (e.g., second party medical and litigation fees, emergency response costs, incident congestion costs, and litigation costs). The value of all such benefits – both direct and societal – could also be approximated by emergency response costs to the region, medical costs, litigation costs, property damages, and economic productivity loss due to workers' inactivity.

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Environmental Value

In the BCA, the group of benefits under the heading of Environmental Value captures the following components of the New Haven project:

- Improvement in riparian landscape
- Improvement in neighborhood water quality. Wetland restoration has been shown to reduce pollutants and improve water quality, which reduces plant treatment needs.
- Protection of species breeding ground. There is habitat for blue crab, fish, along the coast of Long Wharf. New Haven Bay represents 82% of CT's $62 million annual aquaculture industry, and protecting species breeding grounds is important ecologically and economically.
- Stormwater retention pond system. The retention pond system has the potential to create new wildlife and ecosystem habitats.

Community Development Value

In the BCA, the group of benefits under the heading of Community Development Value or Social Value captures the following components of the New Haven project:

- Benefits to low/moderate income households. With the construction of the various elements of the New Haven project, homes will have a reduced chance of being directly affected by coastal flooding. As a result of lowered risk, home values will increase.
- Improved living environment. New AFH will be introduced, improving the living arrangements for these households. There will be another benefit in terms of improved access to greenway, which provides a more active and healthy lifestyle.
- The redesign of housing development. Redesign of housing developments such as Church Street Village will provide cultural protection and expansion. Reactivation and extension of the vision trail.

Economic Redevelopment

In the BCA, the group of benefits under the heading of Community Development Value or Social Value captures the following components of the New Haven project:

- Regional economic impact. With the construction of the various elements, homes and businesses will have a reduced likelihood of being directly affected by coastal flooding. There will be fewer days and weeks lost to full or partial closings. Worker productivity will be maintained.
- Increased property value.
- Reduced insurance cost. With the construction of the various elements, homes and businesses will have a reduced probability of being directly affected by coastal flooding. To the degree that their flood ratings change, their insurance premiums will be reduced.
- West River Outfall design modification
- Construction jobs/maintenance jobs. Each improvement project will create temporary construction jobs where the workers will spend a portion of their income on the local economy. Additionally, any AFH created brings in permanent jobs, where the workers also spend money within the local economy.
- Potential redevelopment along Church Street extension between Church and Brewery.

For the purposes of the benefit cost analysis, it is assumed that properties that are in higher flood zones are more likely to suffer damage. It is assumed that the average reconstruction cost for

affected properties (residential and commercial), facilities (parks, etc), and infrastructure (roads, rail, etc.) depends on the flood zone of the property. The highest cost per unit (square foot, mile, etc.) is assumed for properties in the Erosion zone, and the lowest cost is for properties in the A zone.

Economic Costs Included and Assumptions

In the benefit-cost analysis, the term "cost" refers to the additional resource costs or expenditures required to implement, and maintain the investments associated with the NDRC New Haven Project.

The BCA uses project costs that have been estimated for the project on an annual basis. Operations and maintenance costs and rehabilitation costs were initially expressed in real dollars while the capital costs were initially expressed in real 2015 dollars. All costs were converted to real 2015 dollars based on CPI-U adjustments.[4]

Initial Project Investment Costs

Initial project investment costs include engineering and design, construction, other capital investments, and contingency factors.

The capital expenditures for the project will be a total of $84 million in 2016.

Note that outlays spent for the acquisition of real estate or real assets (right of way) are generally excluded from total costs in BCAs. This is because when the government acquires a real asset, it

[4] Bureau of Labor Statistics, Consumer Price Index, All Urban Consumers, U.S. City Average, All Items, Series CUSR0000SA0.

is classified as an asset purchase and not a cost. The owning agency would be in possession of tangible assets that, generally, does not depreciate in value.

Key Benefit-Cost Evaluation Measures

The benefit-cost analysis converts potential gains (benefits) and losses (costs) from the Project into monetary units and compares them. The following two (2) common benefit-cost evaluation measures are included in this BCA.

Net Present Value (NPV): NPV compares the net benefits (benefits minus costs) after being discounted to present values using the real discount rate assumption. The NPV provides a perspective on the overall dollar magnitude of cash flows over time in today's dollar terms.

Benefit Cost (B/C) Ratio: The evaluation also estimates the benefit-cost ratio; the present value of incremental benefits is divided by the present value of incremental costs to yield the benefit-cost ratio. The B/C ratio expresses the relation of discounted benefits to discounted costs as a measure of the extent to which a project's benefits either exceed or fall short of their associated costs.

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The analysis shows a benefit-cost ratio that exceeds 1.0, meaning the project returns economic benefits that exceed project costs over the life of the investment.

The State of Connecticut has formed the State Agencies Fostering Resilience (SAFR) to develop a long-term resilience plan for the State of Connecticut to combat the challenges of climate change and major disasters. SAFR has developed a strategy to develop resilience plans across the nine municipalities in New Haven and Fairfield counties. As described in Exhibit A, Executive Summary, New Haven and Fairfield Counties were designated as the most impacted and distressed counties in the State of Connecticut, due to Hurricane Sandy, the Qualifying Disaster for this competition. These nine communities will launch a statewide program for resilience that will be addressed through the modification of existing programs within the State and new programs designed to combat the effects of climate change. This initial regional program will be launched by pilot projects in the two municipalities who illustrated the greatest need and most advanced approach to creating resilient futures.

In Bridgeport, South End East encompasses the eastern portion of South End as well as Downtown Bridgeport, extending north to just above Bridgeport Station. With South End located on a barrier peninsula, and the downtown facing the Pequonnock River, South End East remains one of the most vulnerable communities in Bridgeport. The specific needs of Bridgeport are described in more detail in the main application in Exhibit D.a, Unmet Recovery Need and Target Geography.

During Hurricane Sandy, the downtown area experienced flooding as surge inundated from the Pequonnock River. This water flowed down to the South End, converging with surge from the Long Island Sound to inundate the South End East community. Within the target area, 31.2 acres containing 211 buildings were inundated resulting in over 100 FEMA Individual Assistance Household inspections completed in this area, with 89 properties affected.

Downtown Bridgeport, located to the north of the rail line, contains mostly commercial and institutional buildings. Surge ranged from 1 to 5 feet along the coastline, but only inundated the area as far inland as Water Street, sparing most properties in the Downtown from damage. South of I-95, the community consists of single family homes, industry, and critical infrastructure including the PSE&G Plant, Bridgeport Power, and the Fuel Depot. Surge as high as 7 feet inundated this area, flooding streets and damaging residential properties.

Throughout the target area, residents relayed accounts of power outages that lasted from a few hours to over a week.

Over 200 buildings in the target area were inundated during Sandy, with an additional 100 located within the FEMA designated 100-year floodplain. Following Sandy, over $1.9 million was been spent in recovery to homes and infrastructure in Bridgeport. Receiving $1,317,104 in FEMA Individual and Household Program grants, Bridgeport still faces an unmet need of $42,610,158 for owner occupied housing ($1,110,158) and multi-family housing ($41,500,000).

This recovery, and repairs to homes and infrastructure in the area, however, did not include resilient measures to protect these damages from future storm events. The community faces the continued threat of future storm events and sea level rise, as well as economic and social needs that hinder the community's resiliency and ability to recover from future events. Looking forward, the target area has continued recovery needs that if met, will enhance the resilience of community moving forward against current and future threats.

Hurricane Sandy emphasized the need for protective measures in the South End East that will mitigate flooding during future coastal storm events. A system of integrated coastal protection measures would reduce the risk of flooding and damages to local housing, streets, and infrastructure, including key assets such as the United Illuminating power facilities.

These strategies need to be developed in conjunction with drainage improvements that mitigate stormwater flooding that occurs on a more chronic basis and which exacerbates flooding from surge during coastal storm events.

Results in Brief

There were two alternative computations conducted for this analysis, using a 7.0 percent discount rate, and an alternative using a 5.0 percent discount rate. All benefits and costs were estimated in constant 2015 dollars over an evaluation period extending 100 years. The base year for discounting is 2015.

Table 1 presents the evaluation results for the two cases. For the 7 percent discount rate, the proposed infrastructure investments yield a net present value of $9.6 million, and a benefit-cost ratio of 1.23. At a 5 percent discount rate, the proposed infrastructure investments yield a net present value of $19.9 million, and a benefit-cost ratio of 1.47.

Over the 100-year analysis period (2016-2115), there are $52.0 million in benefits at a 7% discount rate, in 2015 dollars and $62.6 million in benefits at a 5% discount rate.

Table 1. Benefit Cost Analysis Summary Results

Scenario	Net Present Value (2015 $ millions disc.)	Benefit Cost Ratio
Case A (7 percent discount rate)	$9.6	1.23
Case B (5 percent discount rate)	$52.0	1.47

Source: WSP | Parsons Brinckerhoff, 2015

Project Costs

For the benefit cost analysis, capital and program investments ($41 million) were assumed to begin in 2016 and conclude by the end of 2016. These capital and program costs translate to $42 million when discounted at 7 percent and $43 million when discounted at 5 percent. A breakdown of capital cost components is provided in the Details section of the main body of this report.

Table 2. Project Capital Costs

Capital Cost Category	Costs (2015 $)	Costs (2015 $ discounted at 7 %)	Costs (2015 $ discounted at 5 %)
NDRC Bridgeport Project	$41 Million	$42 Million	$43 Million
Total	$41 Million	$42 Million	$43 Million

Project Benefits by Category

The following quantifiable benefits have been included in this Benefit Cost Analysis:

- Lifecycle costs
- Resilience value
- Environmental value
- Social value or Community development value
- Economic revitalization

Benefits have been estimated in the categories listed below. The estimated values have been entered into a cost-benefit spreadsheet model. The model is used to estimate benefit and cost streams over time, and for discounting to present value to arrive at the benefit-cost ratio.

Benefit—Cost Analysis Details

Analytical Assumptions

Discount Rates

For project investments, dollar figures in this analysis are expressed in constant 2015 dollars. In instances where certain cost estimates or benefit valuations were expressed in dollar values in other (historical) years, the U.S. Bureau of Labor Statistics' Consumer Price Index for Urban Consumers (CPI-U) was used to adjust them.[1]

The real discount rates used for this analysis was 7.0 percent, consistent with the base-case discount rate in OMB Circular A-94[2].

Evaluation Period

For the NDRC Bridgeport Project, the evaluation period includes the relevant (post-design) construction period during which capital expenditures are undertaken, through 100 years of operations within which to accrue benefits. This period is chosen to represent the return period of the 100-year storm.

For the purposes of this study, it has been assumed that capital investments will occur in the year 2016. The analysis period begins with the project's first expenditures in 2016 and continues through 100 years of analysis, or through 2115.

All benefits and costs are assumed to occur at the end of each year, and benefits begin in the calendar year immediately following.[3]

[1] U.S. Bureau of Labor Statistics. Consumer Price Index, All Urban Consumers, U.S. City Average, Series CUSR0000SA0. 1982-1984=100

[2] White House Office of Management and Budget, Circular A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* (October 29, 1992). (http://www.whitehouse.gov/omb/circulars_a094).

(Note that in the benefit cost model, 2015 is the first year of the analysis (year zero) and all values are discounted to that year. Present value is calculated with respect to 2015. Unit costs and benefit factors are in 2015 dollars.)

Summary of Project Improvements

A series of improvements will be made to strengthen the resiliency of Bridgeport. These projects are designed to create more vital, resilient neighborhoods in the present and future, ultimately allowing the communities to withstand and recover more quickly from all future extreme events, shocks and stresses. The proposed project in Bridgeport represents a vision of a resilient corridor and transit oriented development in the historic Connecticut coastline.

The proposed NDRC project in Bridgeport, Connecticut includes redeveloping key streets in Bridgeport's South End East neighborhood to form a network of resilient corridors, construction of a multi-purpose earthen berm between Tongue Point and the rail viaduct on Ferry Access Road, a feasibility study for connecting existing, isolated, neighborhood energy initiatives and a revision of existing flood plain development guidelines governing future growth in Bridgeport's South End. Each broad strategic project element is listed here (and described in more detail in the main application in Exhibit E.a.1.a, NDRC Bridgeport Project Proposal):

- Street raising and street improvements to create a Resilient Corridor Network
- Earthen berm
- Revision of existing flood plain design guidelines governing South End East neighborhood
- Bridgeport South End District Energy Infrastructure

[3] In the benefit cost model, 2015 is the first year of the analysis (year zero) and all values are discounted to that year. Present value is calculated with respect to 2015.

The Resilient Corridor Network in South End East Bridgeport not only enables community evacuation and reliable access to electricity during a major storm event, while increasing the neighborhoods flood storage capacity, but it also ensures protection of existing developments and creates incentives for growth of future businesses and industries in this key area of downtown Bridgeport.

Cost-Benefit Analysis Methodology

This benefit cost analysis was done using a benefit cost analysis spreadsheet that uses a methodology consistent with the guidelines in OMB Circular A-94.

This benefit cost analysis takes into account pumping station construction, railyard berm protection construction, bioswale construction, economic benefits, and risk reduction benefits ONLY. The quantitative analysis does not include additional ecological or social benefits or costs, as ecological and social benefits were not monetized as part of this analysis, and thus could not be compared to the costs using this framework.

Economic Costs Included

The capital costs and program costs in this NDRC Bridgeport project will include the following components:

- Resilient Corridors, $5 M

- Earthen Berm, $27 M
- Community Center Restoration, $7 M
- CSO treatment park, $2 M
- Flood Design Guidelines, $300 K
- Grand Subtotal Capital Costs $41 M

Economic Benefits Included

This section identifies and groups the benefits that are included in the BCA for the NDRC

Bridgeport project.

The following broad categories and quantifiable benefits have been included in this Benefit Cost

Analysis:

- Lifecycle costs:
    - Resilient corridor construction
- Resiliency value
    - Reduction in property damage
    - Reduction in accidents and casualties
    - Reduction in displacements
    - Reduction in vulnerability to large scale water and power outages
- Environmental value
    - Enhanced greenway
    - Improvement in water quality
    - New flood design guidelines
- Social value or Community development value
    -
    - Benefits to low/moderate income households
    - Improved living environment
    - Affordable housing
    - Church and community center redevelopment
    -
- Economic revitalization
    - Broad Street economic development
    - Regional economic impact
    - University of Bridgeport future growth
    - Increased property value
    - Reduced insurance cost
    - Construction jobs/maintenance jobs
    - New affordable housing development

- New market rate housing development
-

Lifecycle Costs

This benefit cost analysis captures the life cycle costs of the capital, maintenance, and operating costs of the proposed components of the project. The Life Cycle cost for Bridgeport includes the construction of the resilient corridor.

Resiliency Value

In the BCA, the group of benefits under the heading of Resiliency Value captures the following components of the Bridgeport project:

- Reduction in property value. With the construction of the resilient corridor elements of the project, a significant set of homes and businesses will no longer be directly affected by coastal flooding. Property damages associated with major 100-year storms and extreme weather will be reduced or avoided.
- Reduction in casualties. With the construction of the resilient corridor elements, people will be safer and better protected from direct impacts of storms and severe weather. The number and seriousness of accidents/casualties and/or hospitalizations will be reduced or avoided.
- Reduction in displacements. With the construction of the resilient corridor elements, homes and businesses will no longer be directly affected by coastal flooding. The number of community displacements of residents and businesses will be reduced or avoided.
- Reduction in vulnerability to large scale water and power outages. With the construction of the resilient corridor elements, homes and businesses will have reduced vulnerability to outages caused directly or indirectly by coastal flooding. The number of water and power outages will be reduced or avoided.

Casualties and Accident Cost Savings

The cost savings that arise from a reduction in the number of casualties, injuries, and deaths include direct savings (e.g., reduced personal medical expenses, lost wages, and lower individual

insurance premiums), as well as significant avoided costs to society (e.g., second party medical and litigation fees, emergency response costs, incident congestion costs, and litigation costs). The value of all such benefits – both direct and societal – could also be approximated by emergency response costs to the region, medical costs, litigation costs, property damages, and economic productivity loss due to workers' inactivity.

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Environmental Value

In the BCA, the group of benefits under the heading of Environmental Value captures the following components of the Bridgeport project:

- Enhanced greenway. The greenway will provide increased permeable surface, air quality, more recreational open space.
- Improvement in water quality. The water quality will improve from wetland landscape at the CSO outfall on south side of berm. Wetland restoration has been shown to reduce pollutants and improve water quality, which reduces plant treatment needs.
- New flood design guidelines. The guidelines would reduce environmental damage and pollutants at regional and global scale.

Community Development Value

In the BCA, the group of benefits under the heading of Community Development Value or Social Value captures the following components of the Bridgeport project:

- Benefits to low/moderate income households. With the construction of the elements of the resilience corridor, homes will have a reduced chance of being directly affected by coastal flooding. As a result of lowered risk, home values will increase.
- Improved living environment. The project will result in the elimination of vacant land and the preservation of cultural amenities. There will be increased social cohesion due to the improved visual aesthetic. There will be another benefit in terms of improved access to greenway and complete

streets, which provides convenient access to biking and walking and a more active and healthy lifestyle.

- Affordable housing
- Church and community center redevelopment. This will provide high cultural value and social cohesion.

Economic Redevelopment

In the BCA, the group of benefits under the heading of Community Development Value or

Social Value captures the following components of the Bridgeport project:

- Broad Street economic development. This will foster the new businesses and mixed use land.
- Regional economic impact. With the construction of the elements of the resilient corridor, homes and businesses will have a reduced likelihood of being directly affected by coastal flooding. There will be fewer days and weeks lost to full or partial closings. Worker productivity will be maintained.
- Increased property value. As the community becomes more safe (crime) and beautiful and more commercial development moves in, land values go up.
- Reduced insurance cost. With the construction of the various elements, homes and businesses will have a reduced probability of being directly affected by coastal flooding. To the degree that their flood ratings change, their insurance premiums will be reduced.
- Local tourism. Visitors who come to walk on the greenway will contribute to the local economy.
- Construction jobs/maintenance jobs. Each improvement project will create temporary construction jobs where the workers will spend a portion of their income on the local economy. Additionally, redevelopment of vacant land downtown brings in permanent jobs, where the workers also spend money within the local economy.
- University of Bridgeport. There will be opportunities for future growth using new flood design policy.

- New affordable housing development at Broad Street and Gregory Street. There is a current design at the City of Bridgeport.
- New market rate housing development at Henry and Main Street.

For the purposes of the benefit cost analysis, it is assumed that properties that are in higher flood zones are more likely to suffer damage. It is assumed that the average reconstruction cost for affected properties (residential and commercial), facilities (parks, etc), and infrastructure (roads, rail, etc.) depends on the flood zone of the property. The highest cost per unit (square foot, mile, etc.) is assumed for properties in the Erosion zone, and the lowest cost is for properties in the A zone.

Economic Costs Included and Assumptions

In the benefit-cost analysis, the term "cost" refers to the additional resource costs or expenditures required to implement, and maintain the investments associated with the NDRC Bridgeport.

The BCA uses project costs that have been estimated for the project on an annual basis. Operations and maintenance costs and rehabilitation costs were initially expressed in real dollars while the capital costs were initially expressed in real 2015 dollars. All costs were converted to real 2015 dollars based on CPI-U adjustments.[4]

Initial Project Investment Costs

Initial project investment costs include engineering and design, construction, other capital investments, and contingency factors.

The capital expenditures for the project will be a total of $84 million in 2016.

[4] Bureau of Labor Statistics, Consumer Price Index, All Urban Consumers, U.S. City Average, All Items, Series CUSR0000SA0.

Note that outlays spent for the acquisition of real estate or real assets (right of way) are generally excluded from total costs in BCAs. This is because when the government acquires a real asset, it is classified as an asset purchase and not a cost. The owning agency would be in possession of tangible assets that, generally, does not depreciate in value.

Key Benefit-Cost Evaluation Measures

The benefit-cost analysis converts potential gains (benefits) and losses (costs) from the Project into monetary units and compares them. The following two (2) common benefit-cost evaluation measures are included in this BCA.

Net Present Value (NPV): NPV compares the net benefits (benefits minus costs) after being discounted to present values using the real discount rate assumption. The NPV provides a perspective on the overall dollar magnitude of cash flows over time in today's dollar terms.

Benefit Cost (B/C) Ratio: The evaluation also estimates the benefit-cost ratio; the present value of incremental benefits is divided by the present value of incremental costs to yield the benefit-cost ratio. The B/C ratio expresses the relation of discounted benefits to discounted costs as a measure of the extent to which a project's benefits either exceed or fall short of their associated costs.

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