

ATTACHMENT F: BENEFIT COST ANALYSIS

Overview

This section provides an overview of the purpose of the BCA, the approach taken to conduct the analysis, and presents analysis results. Phase 2 applicants pursuing funding for covered projects through HUD's National Disaster Resilience Competition (NDRC) must complete a comprehensive benefit cost analysis (BCA). The BCA must consider economic, environmental, social, and resiliency factors to ensure that project benefits outweigh the costs. The results of the BCA alone are not cause to reject or approve a proposal. For the purposes of this grant competition, HUD recognizes that soundness of approach includes fundamental project elements such as feasibility, replicability, public desirability, meeting unmet needs, reducing risk, and improving resiliency. The value of the project will increase as it prevents future loss time and time again.

Cook County's demonstration area has suffered through many flooding events, in addition to the qualifying 2013 event (DR-4116), that have caused widespread damage from basement backups and overland flooding. Resiliency efforts proposed by the County are focused on two primary activities: a set of five proposed Complete Communities Projects in discrete geographic areas and a proposed Single-Family Rehab Program throughout the demonstration area.

Complete Communities are projects that encompass three primary building blocks fundamental to long term resiliency within the demonstration area: flooding mitigation, economic redevelopment, and community enhancement. Five individual projects are proposed within this activity and are identified by the community in which they are located, and function primarily at the community level. Three projects, those in Riverdale, Blue Island - Calumet Park, and Robbins, include all of the primary elements mentioned above. Two projects, those in

Dolton and Calumet City, are focused on housing improvements for low to middle income residents, but include portions of the Complete Communities elements. The *Single Family Rehab Program* addresses flood mitigation, specifically basement backups, on an individual homeowner level. It provides a range of gray and green alternatives that provide resiliency and will minimize future damages to structures and valuables and reduce stress to residents from constant flood cleanup for events as low as a 2-year design storm. Taken together, these activities will integrate resiliency components into the urban fabric of the demonstration area by implementing and increasing protection efforts against stormwater and combined sewer related flooding and loss of affordable housing, while increasing connectivity between neighborhoods and enhancing the community landscape.

Quantified Results

The BCA considers both quantified and unquantified benefits in accordance with the NDRC NOFA Appendix H. The quantified benefits, which can be represented in monetary terms and are used to develop the benefit-cost ratio (BCR) are broadly divided into Resiliency values and Inherent values. Results are provided in three ways: annual benefits, net present value, and the BCR.

- **Annual Benefits:** Annual benefits are the avoided damages and added benefits per year expected over the useful life of the project.
- **Net Present Value:** In order to compare the future benefits to the current cost of a project, a discount rate, or coefficient, is applied over the life of the project to calculate the net present value of annual benefits. The present value coefficient used in this analysis is 13.80 for a 50-year project useful life. The net present value is the benefit used in the benefit-cost ratio, and once all benefits are aggregated, the project net present value is the sum of the benefits

minus the net present costs. Annual benefits and net present value are calculated for each value measure presented herein so that they may be incorporated into the benefit cost ratio.

- **Benefit Cost Ratio:** To evaluate cost effectiveness, a project’s total net benefits are divided by the total project cost, resulting in a benefit cost ratio. A project is considered to be cost-effective when the ratio is greater than or equal to 1.0, indicating that the benefits are sufficient to justify the costs.

The application in total, as shown in Table 1 below, is cost beneficial with benefits of almost \$200 million compared to a total estimated cost of just over \$100 million. While the Complete Communities projects in Blue Island - Calumet Park and Riverdale have BCRs well over 1.0, the remaining project areas have BCRs that range from 0.78 to 0.88. While the benefits do not match the costs for these areas, in general these communities have the most low- to moderate-income and vulnerable populations within the demonstration area. The proposed housing projects and flood mitigation efforts recommended for these communities are drastically needed and would help the long-term resiliency of these areas.

Table 1: Project Benefit-Cost Ratio Summary

Project Area	Estimated Cost	Net Total Benefits¹	BCR
Blue Island - Calumet Park	\$29,656,586	\$77,933,822	2.63
Robbins	\$4,874,838	\$4,304,643	0.88
Riverdale	\$15,563,260	\$66,348,320	4.26
Dolton	\$21,189,250	\$17,980,956	0.85
Calumet City	\$32,929,153	\$25,840,649	0.78
TOTAL	\$104,713,087	\$192,408,390	1.84

¹ NPV coefficient for a 50 year project useful life using a 7% discount rate.

A summary of methodologies used to calculate these benefits and the associated results and uncertainty related to the analysis are provided for each project area on the following pages in Tables 2, 3, 4 and 5.

This BCA was prepared by Arcadis, a consultant to MWRD on the Stormwater Master Plan for the Little Calumet River/Calumet Sag Channel Drainage Area. Arcadis is a design firm focused on natural and built assets, and through its consultant agreement with MWRD, is providing support to Cook County for this NDRC application. The County worked with Arcadis to develop a full list of benefit categories and provided input throughout the analysis. In particular, the County provided significant input on the valuation of social value and economic revitalization.

Table 2: Blue Island - Calumet Park – Methodologies Used to Develop Benefits

Category	Identify	Quantify	Monetize	Uncertainty
Mental & Physical Health	Reduced health costs for severe and mild/moderate illnesses due to flooding of homes	Improvements will reduce doctor visits and sick days of estimated 65 households in Calumet Park and 7 in Blue Island based on number of FEMA claims	Physical health benefit valued at \$2,443/year per person	4: Low Certainty
Loss of Productivity	Reduced productivity due to mental health issues from flooding	Improvements will minimize downtime due to mental health issues for an estimated 65 households in Calumet Park and 7 in Blue Island based on number of FEMA claims	Mental health benefit valued at \$8,736/year per person	4: Low Certainty
Recreation	New wet ponds,	Improvements will avoid cost	Recreational benefit	3: Medium

Category	Identify	Quantify	Monetize	Uncertainty
	bike/pedestrian trails and soccer fields to provide recreational opportunities and reduce cost in health benefits	in health benefits for an estimated 918 local households	valued at \$865/year per person	certainty
Aesthetics	Improved aesthetics from GI based on hedonic pricing/contingent valuation from national tax data assessor data, land cover data, flood zones, location of open spaces	Proposed development includes 8 acres of wet ponds; Phase 2 Design includes 1 acre of GI; green streets program includes 7.5 acres	Improved aesthetics from GI valued at \$1,623/acre	3: Medium certainty
Property Values (Near GI)	Increased property values for homes along greens	Green streets program will provide tree trenches and	Property values expected to increase	3: Medium certainty

Category	Identify	Quantify	Monetize	Uncertainty
	streets	bioswales for 918 nearby homes	by 3.5 to 5.0% when trees and other greenery such as GI added. Home values in the project area average \$128,000 for Calumet Park and \$134,000 for Blue Island.	
Property Values (No Flooding)	Increased property values for homes no longer subject to flooding	MWRD Phase 2 Design, green streets and Single Family Rehab program will reduce basement backups and street flooding to an estimated 918 homes	Property values expected to increase by 2.0 to 8.0% when homes are no longer subject to flooding. Home values in the	3: Medium certainty

Category	Identify	Quantify	Monetize	Uncertainty
			project area average \$128,000 for Calumet Park and \$134,000 for Blue Island.	
Job Creation	New development will create permanent new job opportunities for the region	Proposed development is estimated to create 741 retail jobs (based on 846,800 sf of retail space) and 530 full-time light industrial jobs (based on 1,060,900 sf of industrial space)	Chicago MSA retail jobs at \$10,806/year and industrial jobs at \$26,845/year	2: High certainty
Wildlife Habitat	New wet ponds, green streets, and other green areas provide habitat for various forms of wildlife	Proposed development includes 8 acres of wet ponds	Habitat value for wet ponds estimated at \$7,853/acre	3: Medium certainty

Category	Identify	Quantify	Monetize	Uncertainty
Water Quality	Avoided cost due to improved water quality from stormwater retention and flood prevention	Proposed development includes 8 acres of wet ponds; Phase 2 Design includes 1 acre of GI; green streets program includes 7.5 acres	Water quality improvement value for wet ponds/GI estimated at \$293/acre	3: Medium certainty
Tree Cover	New trees/forest area on site provides habitat and helps reduce carbon footprint		New trees provide carbon sequestration value of \$7,853/acre	3: Medium certainty
Air Quality	Pollutant sequestering value of GI	Proposed development includes 8 acres of wet ponds; Phase 2 Design includes 1 acre of GI; green streets program includes 7.5 acres	New stormwater BMPs provide \$204/acre of air pollutant sequestration	3: Medium certainty
Avoided Treatment Cost	Avoided marginal cost by Metropolitan Water	Annual stormwater runoff captured by 50 gallon rain	Average MWRD cost to treat wastewater	2: High certainty

Category	Identify	Quantify	Monetize	Uncertainty
	Reclamation District of Greater Chicago of treating its wastewater and stormwater	barrels as part of Single Family Rehab Program is anticipated to be 4,313 gallons/year for 53 homes in Calumet Park and 112 homes in Blue Island	and stormwater is \$0.0000919/gallon	
Avoided Potable Water Cost	Avoided cost potable water cost by homeowner for using rainwater from Rain Barrel for watering lawn or garden	Annual stormwater runoff captured by 50 gallon rain barrels as part of Single Family Rehab Program is anticipated to be 4,313 gallons/year for 49 homes in Calumet Park and 73 homes in Blue Island	Average cost of potable water in the Chicago area is \$0.00381/gallon	2: High certainty
Flood Damage to	Reduced damage to	Hydraulic model indicates	USACE model values	2: High certainty

Category	Identify	Quantify	Monetize	Uncertainty
Property	property from SW BMPs sized to capture 25yr/24hr design storm	497 less structures to be affected by flooding after construction of BMPs	reduced risk to flooded structures at \$7,000/year	

Table 2: Robbins – Methodologies Used to Develop Benefits

Category	Identify	Quantify	Monetize	Uncertainty
Mental & Physical Health	Reduced health costs for severe and mild/moderate illnesses due to flooding of homes	Improvements will reduce doctor visits and sick days of estimated 21 local households based on number of FEMA claims	Physical health benefit valued at \$2,443/year per person	4: Low Certainty
Loss of Productivity	Reduced productivity due to mental health issues from flooding	Improvements will minimize downtime due to mental health issues for an estimated 21 local households based on number of FEMA claims	Mental health benefit valued at \$8,736/year per person	4: Low Certainty
Recreation	Restored Midlothian Creek and new sidewalks/bikeway will provide recreational opportunities and reduce	Improvements will avoid cost in health benefits for an estimated 222 local residents and employees	Recreational benefit valued at \$865/year per person	3: Medium certainty

Category	Identify	Quantify	Monetize	Uncertainty
	cost in health benefits			
Aesthetics	Improved aesthetics from GI based on hedonic pricing/contingent valuation from national tax data assessor data, land cover data, flood zones, location of open spaces	Includes 1 acre for green streets program and 13 acres for Phase 2 Design	Improved aesthetics from GI valued at \$1,623/acre	3: Medium certainty
Property Values (Near GI)	Increased property values for homes along greens streets	Green streets program will provide tree trenches and bioswales for 21 nearby homes	Property values expected to increase by 3.5 to 5.0% when trees and other greenery added. Home values in the project area average \$72,700.	2: High certainty

Category	Identify	Quantify	Monetize	Uncertainty
Property Values (No Flooding)	Increased property values for homes no longer subject to flooding	MWRD Phase 2 Design, green streets and Single Family Rehab program will reduce basement backups and street flooding to an estimated 222 homes	Property values expected to increase by 2.0 to 8.0% when homes are no longer subject to flooding. Home values in the project area average \$72,700.	2: High certainty
Wildlife Habitat	Restored Midlothian Creek and new green areas will provide habitat for various forms of wildlife	Includes 13 acres for Phase 2 Design	Habitat value for wet ponds estimated at \$7,853/acre	3: Medium certainty
Water Quality	Avoided cost due to improved water quality from stormwater retention	Includes 1 acre for green streets program and 13 acres for Phase 2 Design	Water quality improvement value estimated at \$293/acre	3: Medium certainty

Category	Identify	Quantify	Monetize	Uncertainty
	and flood prevention			
Flood Damage to Property	Reduced damage to property from SW BMPs sized to capture 25yr/24hr design storm	Hydraulic model indicates 222 less homes to be affected by flooding after construction of BMPs	USACE model values reduced risk to flooded structures at \$7,000/year	2: High certainty

Table 3: Riverdale – Methodologies Used to Develop Benefits

Category	Identify	Quantify	Monetize	Uncertainty
Mental & Physical Health	Reduced health costs for severe and mild/moderate illnesses due to flooding of homes	Improvements will reduce doctor visits and sick days for an estimated 56 households in the Single Family Rehab program allocation	Physical health benefit valued at \$2,443/year per person	4: Low Certainty
Loss of Productivity	Reduced productivity due to mental health issues from flooding	Improvements will minimize downtime due to mental health issues for an estimated 56 households in the Single Family Rehab program allocation	Mental health benefit valued at \$8,736/year per person	4: Low Certainty
Recreation	New constructed wetlands, trails and park to provide recreational opportunities	Improvements will avoid cost in health benefits for an estimated 595 local	Recreational benefit valued at \$865/year per person	3: Medium certainty

Category	Identify	Quantify	Monetize	Uncertainty
	and reduce cost in health benefits	households		
Aesthetics	Improved aesthetics from GI based on hedonic pricing/contingent valuation from national tax data assessor data, land cover data, flood zones, location of open spaces	Proposed project includes 11 acres of constructed wetlands; and 7.4 acres of residential green streets	Improved aesthetics from GI valued at \$1,623/acre	3: Medium certainty
Property Values (Near GI)	Increased property values for homes along greens streets	Green streets program will provide GI for 409 nearby homes	Property values expected to increase by 3.5 to 5.0% when trees and other greenery added. Home values in the project	2: High certainty

Category	Identify	Quantify	Monetize	Uncertainty
			area average \$91,100.	
Property Values (No Flooding)	Increased property values for homes no longer subject to flooding	Green streets and Single Family Rehab program will reduce basement backups and street flooding to an estimated 447 homes	Property values expected to increase by 2.0 to 8.0% when homes are no longer subject to flooding. Home values in the project area average \$91,100.	2: High certainty
Wildlife Habitat	New wet ponds, green streets, and other green areas provide habitat for various forms of wildlife	Proposed project includes 11 acres of constructed wetlands	Habitat value for wet ponds estimated at \$7,853/acre	3: Medium certainty
Water Quality	Avoided cost due to improved water quality	Proposed project includes 11 acres of wet ponds; and 7.4	Water quality improvement value for	3: Medium certainty

Category	Identify	Quantify	Monetize	Uncertainty
	from stormwater retention and flood prevention	acres of residential GI	wet ponds/GI estimated at \$293/acre	
Air Quality	Pollutant sequestering value of GI	Proposed project includes 11 acres of wetlands; 1 acre of commercial GI; and 7.4 acres of residential GI	New stormwater BMPs provide \$204/acre of air pollutant sequestration	3: Medium certainty
Avoided Treatment Cost	Avoided marginal cost by Metropolitan Water Reclamation District of Greater Chicago of treating its wastewater and stormwater	Annual stormwater runoff captured by 50 gallon rain barrels as part of Single Family Rehab Program is anticipated to be 4,313 gallons/year for 56 homes	Average MWRD cost to treat wastewater and stormwater is \$0.0000919/gallon	2: High certainty
Avoided Potable Water Cost	Avoided cost potable water cost by homeowner for using rainwater from Rain	Annual stormwater runoff captured by 50 gallon rain barrels as part of Single	Average cost of potable water in the Chicago area is	2: High certainty

Category	Identify	Quantify	Monetize	Uncertainty
	Barrel for watering lawn or garden	Family Rehab Program is anticipated to be 4,313 gallons/year for 56 homes	\$0.00381/gallon	
Flood Damage to Property	Reduced damage to property from SW BMPs sized to capture 25yr/24hr design storm	Hydraulic model indicates 447 less homes to be affected by flooding after construction of BMPs	USACE model values reduced risk to flooded structures at \$7,000/year	2: High certainty

Table 4: Dolton – Methodologies Used to Develop Benefits

Category	Identify	Quantify	Monetize	Uncertainty
Mental & Physical Health	Reduced health costs for severe and mild/moderate illnesses due to flooding of homes	Improvements will reduce doctor visits and sick days of estimated 132 local households based on number of households for Single Family Rehab program allocation	Physical health benefit valued at \$2,443/year per person	4: Low Certainty
Loss of Productivity	Reduced productivity due to mental health issues from flooding	Improvements will minimize downtime due to mental health issues for an estimated 132 local households based on number of households for Single Family Rehab program allocation	Mental health benefit valued at \$8,736/year per person	4: Low Certainty

Category	Identify	Quantify	Monetize	Uncertainty
Recreation	New constructed wetlands, trails and park to provide recreational opportunities and reduce cost in health benefits	Improvements will avoid cost in health benefits for an estimated 58 local households	Recreational benefit valued at \$865/year per person	3: Medium certainty
Aesthetics	Improved aesthetics from GI based on hedonic pricing/contingent valuation from national tax data assessor data, land cover data, flood zones, location of open spaces	Proposed project includes 2 acres of residential green streets	Improved aesthetics from GI valued at \$1,623/acre	3: Medium certainty
Property Values (Near GI)	Increased property values for homes along greens streets	Green streets program will provide GI for 58 nearby homes	Property values expected to increase by 3.5 to 5.0% when	2: High certainty

Category	Identify	Quantify	Monetize	Uncertainty
			trees and other greenery added. Home values in the project area average \$116,200.	
Property Values (No Flooding)	Increased property values for homes no longer subject to flooding	Green streets (58) and Single Family Rehab program (132) will reduce basement backups and street flooding to an estimated 190 homes	Property values expected to increase by 2.0 to 8.0% when homes are no longer subject to flooding. Home values in the project area average \$116,200	2: High certainty
Wildlife Habitat	New wet ponds, green streets, and other green	Proposed project includes 2 acres of GI	Habitat value for GI estimated at	3: Medium certainty

Category	Identify	Quantify	Monetize	Uncertainty
	areas provide habitat for various forms of wildlife		\$7,853/acre	
Water Quality	Avoided cost due to improved water quality from stormwater retention and flood prevention	Proposed project includes 2 acres of residential GI	Water quality improvement value for GI estimated at \$293/acre	3: Medium certainty
Air Quality	Pollutant sequestering value of GI	Proposed project includes 2 acres of residential GI	New stormwater BMPs provide \$204/acre of air pollutant sequestration	3: Medium certainty
Avoided Treatment Cost	Avoided marginal cost by Metropolitan Water Reclamation District of Greater Chicago of treating its wastewater and	Annual stormwater runoff captured by 50 gallon rain barrels as part of Single Family Rehab Program is anticipated to be 4,313	Average MWRD cost to treat wastewater and stormwater is \$0.0000919/gallon	2: High certainty

Category	Identify	Quantify	Monetize	Uncertainty
	stormwater	gallons/year for 132 homes		
Avoided Potable Water Cost	Avoided cost potable water cost by homeowner for using rainwater from Rain Barrel for watering lawn or garden	Annual stormwater runoff captured by 50 gallon rain barrels as part of Single Family Rehab Program is anticipated to be 4,313 gallons/year for 132 homes	Average cost of potable water in the Chicago area is \$0.00381/gallon	2: High certainty
Flood Damage to Property	Reduced damage to property from SW BMPs sized to capture 25yr/24hr design storm	Hydraulic model indicates 132 less homes to be affected by flooding after construction of BMPs	USACE model values reduced risk to flooded structures at \$7,000/year	2: High certainty
Housing Affordability	New housing developments will provide opportunities to low and moderate income persons	Proposed project will add 30 new units of affordable housing	Benefit of affordable housing is \$611/unit	2: High certainty

Table 5: Calumet City – Methodologies Used to Develop Benefits

Category	Identify	Quantify	Monetize	Uncertainty
Mental & Physical Health	Reduced health costs for severe and mild/moderate illnesses due to flooding of homes	Improvements will reduce doctor visits and sick days of estimated 177 local households based on number of Single Family Rehab program allocation	Physical health benefit valued at \$2,443/year per person	4: Low Certainty
Loss of Productivity	Reduced productivity due to mental health issues from flooding	Improvements will minimize downtime due to mental health issues for an estimated 177 local households based on number of Single Family Rehab program allocation	Mental health benefit valued at \$8,736/year per person	4: Low Certainty
Property Values (No Flooding)	Increased property values for homes no longer subject	Single Family Rehab program will reduce basement backups	Property values expected to increase	2: High certainty

Category	Identify	Quantify	Monetize	Uncertainty
	to flooding	and street flooding to an estimated 177 homes	by 2.0 to 8.0% when homes are no longer subject to flooding. Home values in the project area average \$111,500	
Avoided Treatment Cost	Avoided marginal cost by Metropolitan Water Reclamation District of Greater Chicago of treating its wastewater and stormwater	Annual stormwater runoff captured by 50 gallon rain barrels as part of Single Family Rehab Program is anticipated to be 4,313 gallons/year for 177 homes	Average MWRD cost to treat wastewater and stormwater is \$0.0000919/gallon	2: High certainty
Avoided Potable Water Cost	Avoided cost potable water cost by homeowner for using rainwater from Rain	Annual stormwater runoff captured by 50 gallon rain barrels as part of Single	Average cost of potable water in the Chicago area is	2: High certainty

Category	Identify	Quantify	Monetize	Uncertainty
	Barrel for watering lawn or garden	Family Rehab Program is anticipated to be 4,313 gallons/year for 177 homes	\$0.00381/gallon	
Flood Damage to Property	Reduced damage to property from SW BMPs sized to capture 25yr/24hr design storm	Hydraulic model indicates 177 less homes to be affected by flooding after construction of BMPs	USACE model values reduced risk to flooded structures at \$7,000/year	2: High certainty
Housing Affordability	New housing developments will provide opportunities to low and moderate income persons	Proposed project will add 145 new units of affordable housing	Benefit of affordable housing is \$611/unit	2: High certainty

Project Description

Cook County's Phase 2 application puts forth a resilience portfolio of seven projects and three programs to improve the County's capacity to respond and adapt to current and future threats and hazards, including climate change. Projects are as follows:

- A project to complete the Cal-Sag Trail, a planned 28-mile multi-use path with a gap in the demonstration area, will link the project areas and foster social cohesion among the communities and beyond.
- Three projects to support 'complete communities' resilience-building by addressing community need within a demonstration area containing residential, industrial, and commercial properties with significant opportunities for revitalization and co-benefits. The projects are located in the communities of Riverdale, Robbins, and Blue Island / Calumet Park.
- One project to build out a 'green streets' concept in a flood-prone neighborhood in Dolton.
- Two housing projects in Calumet City and Dolton to rehabilitate multi-family housing rental units and construct new single-family ownership housing units, respectively, while incorporating resilient measures in both to provide affordable, resilient housing.

Several programs will then be overlaid with both these project areas and the wider demonstration area to build resilience. Programs are as follows:

- A single-family rehabilitation program to address unmet housing need and incorporates resilience measures into the area's existing single-family housing stock.
- A community planning and capacity building program to enhance resilience at the local level. Planning programs will support a range of needs including redevelopment

site planning, stormwater modeling capacity, assessment of shared service potential and the regional resilience efforts.

- An educational program to build individual and government capacity by sharing information on climate change and how green infrastructure – particularly on private property – can be a solution.

A more detailed description of each of these projects and programs is provided in Exhibit E – Soundness of Approach in the narrative.

Existing Conditions

Several existing conditions, as noted in the County’s Phase 1 application, exacerbate vulnerability but will be reduced through the proposed activities. These conditions include an outmoded and aging infrastructure; a strained natural environment exacerbated by population growth and climate change; environmental contamination from years of manufacturing; segregation of low-income and minority populations; a lack of affordable housing; job loss and economic disinvestment; and government fragmentation. A detailed description of how these risks and vulnerabilities will be reduced by the proposed resiliency portfolio is addressed in Exhibit E – Soundness of Approach in the narrative.

Benefits Not Included in the Benefit-Cost Ratio

Benefits discussed in this section are not included in the benefit cost ratio (BCR) for one of the following reasons:

- There is no currently available or defensible method to assign a dollar value to the effect
- It is not logical to include the benefit value in the benefit cost analysis, although the benefits are important to understanding the full value of the proposed projects

The benefit categories that were evaluated but not included in the BCR and the rationale for their exclusion are provided below.

Avoided Costs from Displacement

This category includes reduced relocation of residents/ businesses due to flooding and reduced use of shelters due to flooding. County records show that 1,160 households in the pilot area received FEMA rental assistance from DR-4116; however, there was no data available to quantify the costs for the displacement efforts. It is evident from the number of displaced residents above that a significant amount of households were affected by DR-4116 and the proposed resiliency efforts should significantly reduce future relocation and use of shelters by residents in the pilot area.

Avoided Injuries/Deaths

This category includes reduction in the number of injuries and deaths due to flooding. Three fatalities were recorded within last 10 years in Cook County due to flood events and one moderate injury from a sinkhole related to the 2013 flood was noted, but the location of these events could not be confirmed for the project area. It is highly likely that injuries from DR-4116 event occurred, but were just not recorded by the County or FEMA. The proposed resiliency efforts should significantly reduce future injuries or deaths with the pilot area.

Emergency Response

This category includes reduced cost of emergency response to flooding. No specific data was available for the cost for emergency response to historic events. It is likely that any emergency response efforts to attend to the vulnerable population within the pilot area should be reduced future wet weather events if the proposed resiliency efforts are implemented.

Tax Base for City/Village

This category addresses increased revenue from new commercial and industrial businesses that are tied to resiliency efforts within the pilot area. Information for the tax base generated for proposed commercial and industrial development within the project areas was not evaluated since the developments are currently at the concept stage. However, a portion of the tax base from these businesses can be allocated to address future resilience efforts such as O&M and expansion of green infrastructure, and are critical to improved living for residents with the pilot area.

Trickle Down to Local Business

This category addresses increased revenue for local retailers from new jobs. Information on the impacts of the proposed commercial and industrial developments related to trickle down revenue increases for local businesses was unavailable and not evaluated. However, it is anticipated that this effect would occur if new commercial and industrial businesses are located in the pilot area.

Cultural Value

This category includes improved culture within the pilot area due to new retail development. Information on the impacts of the proposed commercial and industrial developments on the local culture could not be quantified; however, the pilot area is a known food desert and lacks other retail options. It is anticipated that these businesses would have a very positive impact on the culture within the local communities.

Soil Contamination

This category includes remediation or removal of contaminated soils in the proposed project areas. This category was not evaluated further because SSMMA has brownfield redevelopment

efforts currently underway that will be addressing soil contamination within the pilot area communities.

Methodologies

This section provides an understanding of the research and processes that developed the benefit-cost ratios that represent the analysis results for Cook County's Phase 2 application. The proposed projects described herein will provide residents of the selected demonstration area with significant benefits.

Attachment F has been broken into segments by benefit type to facilitate understanding. First, the method through which detailed results from each benefit evaluation are compiled together into a single benefit cost ratio is discussed. Next, the methodologies and detailed results associated with Resiliency Value, or the losses avoided expected as a result of project implementation are provided. Losses avoided include direct physical damage and disruption, displacement, and human impacts, such as injury or loss of life. Third, this section presents methodologies and detailed results associated with the programmed elements of the project. These are the inherent social, economic, and environmental benefits that are associated with improvements being made to the pilot area communities.

It is important to note that the circumstances surrounding the NDRC require that alternatives proposed for each activity are evaluated for cost-effectiveness. These project alternatives are not final and as project designs move forward, benefits and costs of the project will likely change. The overall benefits considered and those used in the Benefit Cost Analysis (BCA) are detailed in Table 6 on the following page.

Table 6: Overall Benefits Considered

Benefit Category	Description	Benefit Calculated
Resiliency		
Direct Physical Damages to Buildings	Used USACE depth-damage functions (DDFs) of vulnerable structures in the proposed project areas. Includes content and inventory loss.	<ul style="list-style-type: none"> • Avoided flood damage to residential and commercial/ industrial property
Displacement	Not used.	<ul style="list-style-type: none"> • Reduced relocation of residents/ businesses due to flooding • Reduced use of shelters due to flooding
Stormwater Management	Avoided costs and additional resiliency provided by use of stormwater BMPs to capture runoff before it enters the combined sewer system	<ul style="list-style-type: none"> • Avoided treatment cost • Avoided potable water cost • Additional resiliency to flooding
Avoided Injuries/Deaths	Not used.	<ul style="list-style-type: none"> • Reduction in injuries deaths due to flooding
Emergency Response	Not used.	<ul style="list-style-type: none"> • Reduced cost of emergency response to flooding

Benefit Category	Description	Benefit Calculated
Economic Impacts		
Tax Base for City/Village	Not used.	<ul style="list-style-type: none"> • Increased revenue to address future resilience efforts
Increased Property Values	Increased property values for homes that benefit from GI and reduced flooding/basement backups	<ul style="list-style-type: none"> • Increase value for homes along greens streets • Increased value for homes no longer subject to flooding
Trickle Down to Local Business	Not used.	<ul style="list-style-type: none"> • Increased revenue for local retailers from new jobs
Job Creation	New commercial and industrial developments impacted by resiliency measures will create permanent new job opportunities for the region	<ul style="list-style-type: none"> • New permanent jobs created
Social Impacts		
Mental & Physical Health	Reduced health costs to residents for illnesses and workers for loss productivity due to flooding of homes.	<ul style="list-style-type: none"> • Reduced health costs due to flooding • Reduced productivity due to flooding
Recreation	New wet ponds, bike/ped trails and soccer fields provide recreational opportunities that	<ul style="list-style-type: none"> • Reduced cost in health benefits

Benefit Category	Description	Benefit Calculated
	reduce costs in health care	
Aesthetics	Improved aesthetics from green infrastructure provides added value to the community	<ul style="list-style-type: none"> Improved aesthetics from GI
Cultural Value	Not used.	<ul style="list-style-type: none"> Improved culture due to new retail development
Environmental Impacts		
Wildlife Habitat	New wet ponds, green streets, and other green areas provide habitat for various forms of wildlife	<ul style="list-style-type: none"> New habitat from GI
Improved Water Quality	Avoided cost due to improved water quality from stormwater retention/ flood prevention	<ul style="list-style-type: none"> Improved WQ from GI
Soil Contamination	Not used.	<ul style="list-style-type: none"> Remediation/removal of contaminated soils
Tree Cover	New trees and forested areas provide habitat and help reduce carbon footprint	<ul style="list-style-type: none"> New habitat/carbon footprint reduction from trees
Air Quality	Green infrastructure provides some pollutant sequestering value similar to trees	<ul style="list-style-type: none"> Pollutant sequestering value of GI

Stormwater Backup and Flooding

Most communities in the demonstration area collect wastewater from buildings and stormwater from streets, sidewalks, homes, and businesses in a combined sewer system. Combined sewer systems are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipes. In general, interceptor sewers receive wastewater flow from trunk sewer mains and lateral sewers, which take flow from homes, businesses, and catch basins on streets.

Under dry weather conditions, the combined sewer system transports all wastewater to a sewage treatment plant managed by MWRD, where it is treated and then discharged to a local water body. During periods of heavy rainfall or snowmelt, the capacity of the interceptors are exceeded and a large portion of the flow is diverted to through outfalls directly to the receiving water body. The resulting mix of sewage and stormwater, referred to as a combined sewer overflow, then adversely affects water quality. In addition, during large storm events such as DR-4116, the capacity of the trunk sewers and lateral sewers within the various communities in the pilot area is exceeded, causing street flooding and basement backups. During dry weather conditions combined sewers generally run partially full with depths cycling through the day based on water usage. However, during large storm events the flows tributary to these sewers, which are often shallow and undersized, exceed the pipe capacity and water levels within manholes begin to rise. Street flooding occurs when water levels get above the rim of sewer system manholes. Basement backups occur when water levels are high enough to cause backflow into homes and businesses through their sewer laterals. Communities within the pilot area are also affected by flooding from local creeks, which overflow their banks during large storm events causing similar impacts to nearby homes and businesses.

Immediate damages include inundation impacts to the structure itself, losses from damage to affected contents, and health impacts on residents during the clean-up. Long-term, if a flooded structure is not cleaned up and dried out fully and immediately, the wet environment created by the floodwaters, whether stormwater only or a mix of sewage and stormwater, provides an ideal breeding ground for mold.

Hydraulic models of the various stormwater conveyance systems causing flooding, whether combined sewer systems or local creeks, were developed to establish system impacts and explore the benefits of potential solutions within the selected project area. For the Riverdale and Calumet Park project areas, coarse planning-level models of the local combined sewer system were developed using conservative assumptions for pipe slopes and inverts (Manning's pipe slope), where survey elevations were not available. For the Blue Island project area and the analysis of Midlothian Creek in Robbins, existing models from MWRD's Phase 2 design projects were used to support the BCA. Results for the Dolton and Calumet City project areas were developed from the Riverdale model results with adjustments for project area size and total number of structures. Model simulations were performed for a wide range of design storms, including the following return periods:

- 2 year(50% annual chance flood event)
- 5 year (20% annual chance flood event)
- 10 year (10% annual chance flood event)
- 25 year (4% annual chance flood event)
- 50 year (2% annual chance flood event)
- 100 year (1% annual chance flood event)

For the Riverdale and Calumet Park project areas, 24-hour duration design storms with an SCS Type 2 distribution were used for analysis of flooding impacts and potential solutions. For Blue Island and Midlothian Creek, the critical durations for those project areas were used for the BCA. These critical durations, 2 hours for Blue Island and 48 hours for Midlothian Creek, were identified during the on-going Phase 2 design projects.

Estimates of the number of structures affected by either basement backups or overland flooding from manholes or local creeks were then developed for each model simulation. Structures affected by overland flooding were identified by overlaying the structure location and estimated ground elevation (from Cook County LiDAR data) with the inundation extents for each simulation. Structures potentially affected by basement flooding for a specific design storm were identified based on water levels in the nearest manhole downstream of the structure's lateral connection to the sewer system. Basement backups were assumed to occur at all structures, where water levels at that nearest manhole came within five feet of the ground surface.

The total rainfall for DR-4116 is similar in magnitude to a 10-year 24-hour design storm event; however, storm intensities were quite low when compared with the SCS Type 2 distribution. Where possible based on available area, a 25-year 24-hour design storm was used as the basis for design to provide additional resiliency.

Resiliency

Direct Physical Damages to Buildings

Direct physical damages are damages that occur to residential, commercial, industrial, institutional, and public property that result from the action of flooding from local sewers and creeks. These damages include the destruction and degradation of property and are quantifiable

as monetary losses. For the purpose of the benefit cost analysis (BCA), property loss is categorized as structural damage and contents damage. Structural damage is damage that applies to real property and contents damage is damage that applies to personal property.

Flood damage can be predicted in two ways: through a review of historical impacts and through modeling expected damages from future events. This section provides an overview of the existing conditions upon which the evaluation is based, introduces historical impacts and how these impacts have been used in the evaluation; describes how expected losses avoided were calculated; reviews limitations, uncertainties, assumptions, and sensitivities; and provides an overview of the detailed results. In general, the number of potential basement backups were significantly higher than the number of structures affected by overland flooding from manholes. As such, estimates of the direct physical damage to buildings were developed based on the number of potential basement backups, where both types of problems occurred.

Tables 7 and 8 summarize the number of structures affected by flooding damage for the six design storms under existing conditions and following implementation of the NDRC projects. Table 9 provides the number of structures directly benefitting from project implementation by the elimination of flooding impacts. As noted above, the total rainfall for DR-4116 is similar in magnitude to a 10-year 24-hour design storm event; however, storm intensities were quite low when compared with the SCS Type 2 distribution. The resulting number of structures affected by flooding for DR-4116 were generally similar to the estimates for the 2-year design storm, causing flooding impacts at nearly 2,500 structures. And with implementation of the NDRC projects, flooding impacts at nearly 1,200 structures will be eliminated if the April 2013 event occurs again.

Table 7: Existing Conditions – Projected Number of Structures Affected by Flooding

Community	2-year Design Storm	5-year Design Storm	10-year Design Storm	25-year Design Storm	50-year Design Storm	100-year Design Storm
Blue Island- Calumet Park	888	900	909	912	915	915
Calumet City	721	899	899	926	937	943
Dolton	536	667	667	687	695	700
Riverdale	327	408	408	420	425	428
Robbins	0	0	3	8	31	73
Total	2,472	2,874	2,886	2,953	3,003	3,059

Table 8: Future Conditions after NDRC Project Implementation – Projected Number of Structures Affected by Flooding

Community	2-year Design Storm	5-year Design Storm	10-year Design Storm	25-year Design Storm	50-year Design Storm	100-year Design Storm
Blue Island- Calumet Park	390	491	538	649	729	729
Calumet City	544	722	722	749	760	766
Dolton	360	480	480	498	505	510
Riverdale	0	109	123	259	369	372
Robbins	0	0	0	2	16	26

Total	1,294	1,802	1,863	2,157	2,379	2,403
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Table 9: Projected Number of Structures Benefitting from NDRC Project Implementation

Community	2-year Design Storm	5-year Design Storm	10-year Design Storm	25-year Design Storm	50-year Design Storm	100-year Design Storm
Blue Island- Calumet Park	498	409	371	263	186	186
Calumet City	177	177	177	177	177	177
Dolton	176	187	187	189	190	190
Riverdale	327	299	285	161	56	56
Robbins	0	0	3	6	15	47
Total	1,178	1,072	1,023	796	624	656

Expected Impacts

Direct physical damages associated with modeled flood frequencies are calculated through the use of standardized depth-damage functions (DDFs) specific to the characteristics and occupancy of a structure. The percent of structural and contents damage is related to 1-foot depth increments multiplied by a structure or contents replacement value. The United States Army Corps of Engineers (USACE) produces DDFs that were used to model direct physical damages.

The steps taken to determine the affected number of structures in each community and the avoided losses that can be expected for the six design storms included:

1. Develop structure inventory from Cook County address points data for the project area

2. Map structure types and occupancies to USACE depth damage functions by overlaying the Cook County address points with Hazus data for each project within the overall area.
3. Calculate the overall building and contents replacement value for the project area
4. Compare the resulting damage estimates for a range of depths with FEMA claim data for basement backups from CNT and DR-4116. Based on those comparisons, select the DDFs for use in each project area.
5. Calculate the percent damage and physical loss values for existing conditions and proposed solutions to determine the avoided losses totals.

Data Sources

The following data sources have been used to calculate expected structure and contents damages and associated losses avoided for the proposed projects:

- U.S. Army Corps of Engineers: USACE modeled six design storms, 50%, 20%, 4%, 2%, and 1%, for the project area to determine avoided damage costs for structures.
- RS Means Building Construction Cost Data (2014): This publication provides location-specific building replacement square foot costs to calculate the total replacement values for structures in the project area.
- FEMA claims data from DR-4416 in the project area.
- Center for Neighborhood Technology's analysis for FEMA claims data for Cook County from 2007 through 2012.

Limitations, Uncertainties, Assumptions, and Sensitivities

Structural Replacement Costs were calculated using a combination of FEMA Hazus default values and R.S. Means 2014, where available by structure and use type, inflated to 2015 values. As Hazus values are national figures, these figures may be significantly lower than actual

construction costs in the Chicago area. Limitations with the direct physical damage calculations include:

- USACE depth damage functions were developed for use with overland flooding from rivers and creeks, rather than basement backups from local sewers.
- Since the majority of the impacted structures are located in residential areas, all affected properties for the analysis were assumed to be residential structures. This assumption is likely conservative, considering commercial properties generally have larger footprints and would have more content and inventory loss.
- Limitations on available data regarding number of homes with basements and basement elevations.
- USACE damage functions provide default shares by structure occupancy in order to determine contents and inventory replacement values. Contents and inventory were combined within the USACE damage functions to come up with one avoided cost number.

Detailed Results

Avoided costs by annual chance flood event, annual benefits and net total benefits for each community within the project area are shown in Table 10 on the following page.

Table 10: Avoided Costs for Direct Physical Damage to Buildings

Project Area	Expected Avoided Costs in 2015 Dollars by Annual Chance Flood Event						Post Mitigation Benefits	
	2yr Design Storm (50%)	5yr Design Storm (20%)	10yr Design Storm (10%)	25yr Design Storm (4%)	50yr Design Storm (2%)	100yr Design Storm (1%)	Annual Benefits	Net Total Benefits ²
<i>Blue Island- Calumet Park</i>	\$5,163,811	\$3,196,787	\$2,404,532	\$617,369	\$23,100	\$11,550	\$3,486,988	\$48,120,439
<i>Robbins</i>	\$0	\$1,760	\$61,767	\$76,170	\$149,996	\$421,722	\$16,793	\$231,738
<i>Riverdale</i>	\$3,867,661	\$4,130,104	\$3,710,530	\$2,666,241	\$164,856	\$163,596	\$3,242,487	\$44,746,319
<i>Dolton</i>	\$1,032,328	\$651,376	\$94,965	\$42,758	\$18,480	\$9,240	\$658,108	\$9,081,893
<i>Cal City</i>	\$619,500	\$247,800	\$123,900	\$49,560	\$24,780	\$12,390	\$374,302	\$5,165,366
<i>Total Avoided Costs</i>	\$10,683,300	\$8,227,828	\$6,395,693	\$3,452,098	\$381,212	\$618,498	\$7,778,678	\$107,345,756

² NPV coefficient for a 50 year project useful life using a 7% discount rate

Stormwater Management

Avoided Treatment Cost

Use of green infrastructure can capture stormwater runoff and prevent it from reaching the combined sewer system. This flow eventually makes its way to a wastewater treatment plant where it is treated before being release back to local waterbodies.

Expected Impacts

The total annual number of gallons intercepted by each green infrastructure feature was calculated using the equation below:

$$[\text{annual precipitation (inches)} * \text{GI area (SF)} * \% \text{ retained}] * 144 \text{ sq inches per SF} * 0.0043 \text{ gallons per cubic inch} = \text{total runoff reduction (gal)}$$

Where % retained = 80% for bioretention and 30% for pervious pavement

In addition, 50 gallon rain barrels proposed for the Rain Ready Program were also analyzed. An annual maximum storage capacity per barrel that would be expected was projected as 4,313 gallons/year. This volume was multiplied by the number of homes proposed for the Rain Ready Program to come up with a total volume captured. Table 11 provides the estimated volume reduction of all proposed GI.

Table 11: Estimated Annual Volume Reduction of Proposed GI

Project Area	Wet Ponds & Other GI (acres)
Blue Island-Calumet Park	16.5
Dolton	2.0
Riverdale	19.4
Robbins	14.0
TOTAL	51.9

The volume captured by all GI was then multiplied by the current cost (2014) of wastewater treatment by MWRD of \$0.0019139/gallon to obtain the annual avoided treatment costs. This value ended up being almost negligible when factored in with the other benefit categories.

Data Sources

The following data sources were used to determine the removal efficiency of various GI and the maximum storage capacity of a 50 gallon rain barrel over the course of an average year:

- NDRC, *The Green Edge: How Commercial Property Investment in Green Infrastructure Creates Value*, P. 22 (based on original data from Jennings et al., 2013).
- New York City DEP study of GI removal performance

Limitations, Uncertainties, Assumptions, and Sensitivities

The cited study was not in the Chicago area but was for another Great Lakes area community with similar annual rainfall and housing sizes to the project area.

Detailed Results

Avoided treatment costs for each community are shown in Table 12 below.

Table 12: Avoided Treatment Costs

Project Area	Post Mitigation Benefits	
	Annual Benefits	Net Total Benefits ³
Blue Island-Calumet Park	\$65	\$903
Robbins	\$0	\$0
Riverdale	\$22	\$306
Dolton	\$52	\$722
Calumet City	\$70	\$968

³ NPV coefficient for a 50 year project useful life using a 7% discount rate

TOTAL AVOIDED COSTS	\$210	\$2,899
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Avoided Potable Water Cost

Use of green infrastructure can capture stormwater runoff which can be reused for watering plants and gardens by homeowners with the pilot area. This water reuse allows homeowners to avoid use of potable water which costs money to treat and transport, and saves money for the homeowners by reducing their water bill.

Expected Impacts

The analysis focused on the 50 gallon rain barrels proposed for the Rain Ready Program and the annual maximum storage capacity that could be expected, projected as 4,313 gallons/year. This volume was multiplied by the number of homes proposed for the Rain Ready Program and the current customer cost of water, \$3.81 per 1,000 gallon in the project area, to obtain the annual avoided user purchase costs. The water treatment/transport cost was not considered in the analyzation.

Data Sources

The following data source was used to determine the maximum storage capacity of a 50 gallon rain barrel over the course of an average year and current potable water cost for residential customers in Northeastern Illinois:

- NDRC, *The Green Edge: How Commercial Property Investment in Green Infrastructure Creates Value*, P. 22 (based on original data from Jennings et al., 2013).
- http://www.cityofchicago.org/city/en/depts/water/provdrs/cust_serv/svcs/know_my_water_sewerrates.html

Limitations, Uncertainties, Assumptions, and Sensitivities

- The cited study was not in the Chicago area, but was for another Great Lakes area community with similar annual rainfall and housing sizes to the project area.
- The water rates are not specifically for the pilot area but are representative of the area

Detailed Results

Avoided potable water costs for each community within the project area are shown in Table 13.

Table 13: Avoided Potable Water Cost

Project Area	Post Mitigation Benefits	
	Annual Benefits	Net Total Benefits ⁴
Blue Island-Calumet Park	\$2,005	\$27,666
Robbins	\$0	\$0
Riverdale	\$920	\$12,699
Dolton	\$2,169	\$29,933
Calumet City	\$2,169	\$29,933
TOTAL AVOIDED COSTS	\$7,263	\$100,232

Additional Resiliency to Flooding

Additional stormwater volume was provided for several BMPs within proposed development areas to provide additional resiliency for future large wet weather events.

Expected Impacts

The BMPs increased above standard design requirements to provide additional stormwater storage to meet the 25 year/24 hour storm event include:

- Blue Island-Calumet Park Subarea B – Redevelopment wet ponds

⁴ NPV coefficient for a 50 year project useful life using a 7% discount rate

- Riverdale Subarea A – Constructed wetlands

These BMPs were generally increased from a required 1-inch of stay on volume, equivalent to a 15-year design storm, to a 25 year/24 hour design storm.

Data Sources

Standard design criteria and costs were obtained from a spreadsheet specifically developed for this project based on national and local design/cost data.

Limitations, Uncertainties, Assumptions, and Sensitivities

Benefits for the upsized BMPs are already being considered in several other categories; therefore, a benefit value was not calculated for this item.

Detailed Results

N/A

Economic Impacts

Economic impacts in general are inherent values that include:

- Jobs created, especially for vulnerable populations
- Increased economic output and value
- Property value benefits that are expected to be impacted by the project

Indirect economic losses as a result of natural disasters can be quantified in several ways including lost output, retail sales, wages and work time, utility disruptions, lost tourism, and increased financial market volatility.

Tax Base for City/Village

Information for the tax base generated for proposed commercial and industrial development within the project areas was not evaluated since the developments are currently at the concept stage.

Increased Property Values

There have been many studies that have looked at the impact trees and green infrastructure has on property values. Similarly, homes no longer subject to flooding also will have an increase in property values.

Expected Impacts

The Green Streets projects are proposed for neighborhoods within the majority of the demonstration area communities including Blue Island, Calumet Park, Dolton, Riverdale, and Robbins. Improvements will include bioswales, tree trenches, permeable pavers, and other green features. The Center for Neighborhood Technology's "*The Value of Green Infrastructure*" publication states that property values are expected to increase by 3.5 to 5.0% when trees and other greenery such as GI added. A 4% increase for green infrastructure has been used for the analysis. The same CNT publication states that property values are expected to increase by 2.0 to 8.0% when homes are no longer subject to flooding. MWRD's Phase 2 Design, the Green Streets Program and Single Family Rehab program will reduce basement backups and street flooding to an estimated 1,954 homes within the pilot area. A 5.0% increase for elimination of flooding has been used for the analysis. Expected property increases from green infrastructure and flood reduction are shown in Table 14 on the following page.

Table 14: Increased Property Values by Community

Community	Average Property Value	Increase Value Due to Green Infrastructure (4% increase)	Increase Value Due to Reduced Flooding (5% increase)
Blue Island	\$134,000	\$5,360	\$6,700
Calumet Park	\$128,000	\$5,120	\$6,400
Dolton	\$116,200	\$4,648	\$5,810
Riverdale	\$91,000	\$3,640	\$4,550
Robbins	\$72,700	\$2,908	\$3,635

Data Sources

- Property Value Increase from GI: Center for Neighborhood Technology, "The Value of Green Infrastructure", P. 48 (Increased property values from LID/GI based on original data from Status 2009; Ward et al. 2008)
- Property Value Increase from Flood Reduction: Center for Neighborhood Technology, "The Value of Green Infrastructure", P. 24 (Floodplain home values based on original data from Braden and Johnston 2004; Bin and Polasky 2004; MacDonald et al 1990; Harrison, Smersh and Schwartz 2001; Shilling, Benjamin and Sermins 1985; MacDonald, Murdoch and White 1987)
- Community Property Values: <http://quickfacts.census.gov/qfd/states/17000.html>

Limitations, Uncertainties, Assumptions, and Sensitivities

National not local values were used for the project area.

Detailed Results

Increased property values for each community within the project area are shown in Table 15 below.

Table 15: Increased Property Values

Project Area	Post Mitigation Benefits	
	Annual Benefits	Net Total Benefits ⁵
Blue Island-Calumet Park	-	\$4,849,200
Robbins	-	\$61,068
Riverdale	-	\$1,490,396
Dolton	-	\$269,584
Calumet City	-	\$0
TOTAL ADDED VALUE	\$0	\$6,670,248

Trickle Down to Local Business

Information on the impacts of the proposed commercial and industrial developments related to trickle down revenue increases for local businesses was unavailable and were not evaluated.

Job Creation

One of the primary components of the “complete communities” concept that ties the various cities and villages within the demonstration area together is industrial and commercial redevelopment. These developments not only become a part of the effort to increase resiliency to flooding but to provide capacity for local governments. The economic benefits of these new businesses include added economic output and employment. Added retail employment may

⁵ NPV coefficient for a 50 year project useful life using a 7% discount rate

benefit the low to moderate income population by contributing to the reduction of economic inequality in the project area. Additionally, this expanded retail employment opportunity is anticipated to reduce the number of residents who travel outside the project area for work. Increased economic output will benefit the entire community, as goods and services are traded and economic activity is increased, and increased employment is an economic benefit for many reasons. First, unemployment is an economic burden to society as a whole and for the unemployed. Furthermore, employment generally provides income security, as well as increased production of goods and services and increased spending, which stimulate economic activity. There are various social benefits associated with created jobs which are difficult to quantify but worthy of mention, including financial security; higher living standards; decreased crime; benefit to the elderly; improved income distribution and reduced inequality; as well as reduced social costs such as those related to drug abuse, poor health, or family disruption.

Expected Impacts

The proposed industrial and commercial development in Blue Island-Calumet Park is estimated to create 741 retail jobs based on 846,800 sf of retail space and 530 full-time light industrial jobs based on 1,060,900 sf of industrial space. The proposed industrial and commercial development in Riverdale is estimated to create 303 full-time and 616 indirect jobs. Chicago MSA estimates retail jobs at \$10,806/year and industrial jobs at \$26,845/year.

Data Sources

- *No. of Jobs*: SSMMA, based on numbers sourced from Minnesota Implan Group, Cambridge Systematics, Internal Revenue Service (Sales to Assets Ratio) and DHK

- **Value of Full-time Industrial Jobs:** BLS - May 2014, Chicago MSA - Median Hourly Wage for Production Occupations http://www.bls.gov/oes/2014/may/oes_16974.htm#41-0000
- **Value of Part-time Retail Jobs:** BLS - May 2014, Chicago MSA - Median Hourly Wage for Retail Salespersons http://www.bls.gov/oes/2014/may/oes_16974.htm#41-0000

Limitations, Uncertainties, Assumptions, Sensitivities

- The Blue Island-Calumet Park development would likely be moving forward without local resiliency work so no additional benefit is assumed
- The Riverdale developments are critical to the improved economic health of the village and would not be moving forward without local resiliency efforts

Detailed Results

Estimated jobs creation within Blue Island-Calumet Park, Riverdale and Robbins are shown in Table 16 below.

Table 16: Anticipated Jobs Creation

Project Area	Post Mitigation Benefits	
	Annual Benefits	Net Total Benefits ⁶
Blue Island-Calumet Park	\$0	\$0
Robbins	\$0	\$0
Riverdale	\$813,404	\$11,224,968
Dolton	\$0	\$0
Calumet City	\$0	\$0
TOTAL ADDED VALUE	\$813,404	\$11,224,968

⁶ NPV coefficient for a 50 year project useful life using a 7% discount rate

Social Impacts

Social impacts in general are also inherent values that include:

- Recreational value
- Aesthetic value
- Expected improvements in health of those who make use of the project improvements

Mental/Physical Health

Natural disasters like flooding can 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. Residents with initially low levels of health, social, or economic resources are more vulnerable to the negative impacts of natural disasters and tend to experience relatively steeper declines in emotional and physical health.

The alternatives proposed in the pilot area will provide flood protection for low to moderate income and vulnerable populations, and these populations are at a higher risk to mental/physical health impacts after a disaster event. These residents have fewer resources to prepare for disaster events and are less prepared to invest in recovery, which can lead to a progressive depletion of resources and hamper recovery efforts.

Expected Impacts

The project area has a large proportion of low to moderate income households and vulnerable population including seniors, people with disabilities, and non-English proficient residents. These populations are at a higher risk of mental and physical health issues after a disaster event, as they may have lower levels of health, social, or economic resources.

The analysis looks at reduced mental/physical health costs for illnesses due to flooding. The resources used to quantify impacts in this analysis include HUD's "*Benefit Cost Analysis: Data Resources and Expert Tips*", which provides a standard value per person for treatment costs after a disaster. This value was applied to the number of residents that would be impacted if the project did not occur. The result of the analysis is avoided treatments costs due to the implementation of the pilot area projects.

An estimated 65 households in Calumet Park, 8 in Blue Island, 15 in Robbins, and 85 in Riverdale had confirmed FEMA claims for DR-4116 and may have been susceptible to physical or mental health issues. Physical health benefits for affected residents are valued at \$2,443/year per person. The number of known households impacted by DR-4116 was multiplied by the average number of residents (2.6 per household) and by the probability of design storm occurrence to come up with the avoided mental/physical health cost.

Data Sources

- ***Mental/Physical Health Benefit:*** HUD, "Benefit Cost Analysis: Data Resources and Expert Tips" Webinar, 2015
- ***Avg. People Per Residence:*** <http://quickfacts.census.gov/qfd/states/17000.html>

Limitations, Uncertainties, Assumptions, and Sensitivities

- Benefits are calculated for only 41% of the impacted population because research indicates that only that portion of the population with mental health issues will seek treatment. This significantly lowers the calculated treatment costs.

Detailed Results

A summary of the mental stress and anxiety treatment costs expected to be avoided are shown in Table 17 below.

Table 17: Avoided Mental Health Issues

Project Area	Post Mitigation Benefits	
	Annual Benefits	Net Total Benefits ⁷
Blue Island-Calumet Park	\$44,316	\$611,561
Robbins	\$12,826	\$176,995
Riverdale	\$34,202	\$471,988
Dolton	\$80,619	\$1,112,542
Calumet City	\$108,103	\$1,491,818
TOTAL AVOIDED COSTS	\$280,066	\$3,864,904

Avoided Loss of Productivity

Work productivity can be lost due to mental and physical illness. The impacts described in the previous section indicate that mental health issues will increase after a disaster, and research related to lost productivity due to mental problems indicates that economic productivity can be impacted by an increase in mental health issues post-disaster. Lost work productivity can be avoided by implementation of the proposed alternatives in the pilot area because an increase in mental health impacts will be avoided, as people will not experience as many stressors, such as damage to homes, as a result of the disaster. The protection of life, property, and critical infrastructure for low to moderate income and vulnerable populations allows these groups to recover more quickly after disasters, preventing increased psychological distress, stress, and symptoms of mental illness.

Expected Impacts

⁷ NPV coefficient for a 50 year project useful life using a 7% discount rate

Levinson et al (2010) conducted research using the World Health Organizations Mental Health Surveys and found that individuals in the United States with mental health illnesses experience a significant reduction in earnings. HUD's "*Benefit Cost Analysis: Data Resources and Expert Tips*", was used to quantify impacts for this analysis. Mental health benefits for affected residents are valued at \$8,736/year per person. The number of known households impacted by the 2013 event (DR-4116) was multiplied by the number of wage earners (1.22 per household) and by the probability of design storm occurrence to come up with the number of avoided loss of productivity.

Data Sources

- ***Avoided Loss of Productivity***: HUD, "Benefit Cost Analysis: Data Resources and Expert Tips" Webinar, 2015
- ***Avg. People Per Residence***: <http://quickfacts.census.gov/qfd/states/17000.html>

Limitations, Uncertainties, Assumptions, and Sensitivities

- It is assumed that the average number of workers per household for the affected properties from the 2013 event (DR-4116) entire county.

Detailed Results

A summary of the cost of loss of productivity expected to be avoided is shown in Table 18.

Table 18: Avoided Loss Productivity

Project Area	Post Mitigation Benefits	
	Annual Benefits	Net Total Benefits ⁸
Blue Island-Calumet Park	\$158,471	\$2,186,900
Robbins	\$45,864	\$632,923
Riverdale	\$122,304	\$1,687,795
Dolton	\$288,288	\$3,978,374
Calumet City	\$386,568	\$5,334,638
TOTAL AVOIDED COSTS	\$1,001,495	\$13,820,632

Aesthetics

Research has revealed that parks, green space and other amenities help improve the quality of life and social sustainability of communities by providing recreation opportunities and aesthetic enjoyment, promoting physical health, contributing to psychological well-being, enhancing social ties, and providing opportunities for education. The benefits calculated for this category are added value rather than losses avoided.

Expected Impacts

There are several currently accepted methods to value the aesthetic benefits of amenities such as those proposed for the projects within the pilot area such as green infrastructure, trees, soccer fields, new roads and sidewalks, etc. Improved aesthetics are based on hedonic pricing/contingent valuation from national tax data assessor data, land cover data, flood zones,

⁸ NPV coefficient for a 50 year project useful life using a 7% discount rate

location of open spaces and is valued at \$1,623/acre. Improved aesthetics from green infrastructure and other amenities by community are shown in Table 19 below.

Table 19: Acreage of Improved Aesthetics by Community

Project Area	Wet Ponds & Other GI (acres)
Blue Island-Calumet Park	16.5
Dolton	2.0
Riverdale	19.4
Robbins	14.0
TOTAL	51.9

Data Sources

- Economic Valuation of Riparian Buffer and Open Space in a Suburban Watershed. Journal of the American Resources Association. 42. 6, 1583–1596, Qiu, Z., Prato, T., Boehm, G. 2006.

Limitation, Uncertainties, Assumptions, and Sensitivities

It is assumed that the results of previously conducted studies can be applied to Cook County, even though research reveals that population density, age, and income distribution influence the valuation of benefits.

Detailed Results

A summary of the value of improved aesthetics is shown in Table 20 below.

Table 20: Improved Aesthetics

Project Area	Post Mitigation Benefits	
	Annual Benefits	Net Total Benefits ⁹
Blue Island-Calumet Park	\$26,780	\$369,557
Robbins	\$22,722	\$313,564
Riverdale	\$31,486	\$434,510
Dolton	\$3,246	\$44,795
Calumet City	\$0	\$0
TOTAL ADDED VALUE	\$84,234	\$1,162,425

Recreation

Exercise has a major influence on an individual’s health. Adequate space for outdoor recreation influences how often an individual exercises. Studies reveal that accessible outdoor recreation can increase the exercise rate of a surrounding population by 48 percent. The improved health due to increased exercise leads to reduced health care costs and increased work productivity.

Expected Impacts

Demographic data for the project area was used since the local population would theoretically get the most use of the recreational facilities and amenities due to proximity. The percentage of the population meeting physical fitness guidelines was reviewed and a conservative number of 20% was used based on national data for the typical persons meeting aerobic exercise requirements. The proposed Cal-Sag Trail, walking trails, wet ponds, soccer fields, and other

⁹ NPV coefficient for a 50 year project useful life using a 7% discount rate

recreational amenities will increase recreation throughout the pilot area, which would increase physical activity by 48 percent based on a study conducted by the Trust for Public Land, according to Earth Economics.

The number of residents was multiplied by the percentage meeting the physical fitness guidelines and by the 48 percent anticipated increase in physical activity to obtain the increase in the number of residents meeting fitness guidelines. The increase in the population was applied to health care cost savings based on Pratt et al. 2000 data on increased exercise. The outcome is the avoided health care costs for each age group due to increased physical activity.

Data Sources

The health care cost savings was taken from the Center for Neighborhood Technology's "The Value of Green Infrastructure", P. 49, which referenced Pratt et al. 2000 data on increased exercise.

Limitation, Uncertainties, Assumptions, and Sensitivities

- National not local percentages of people meeting physical fitness guidelines were used for the project area.
- Benefits to employees who work in the project area and use the recreation spaces but do not live there are not considered.
- For this analysis, the entire population in the project area was assumed to benefit from the added recreational opportunities regardless of distance from the amenity.

Detailed Results

A summary of the equivalent cost of improved recreation is shown in Table 21 below.

Table 21: Improved Recreation

Project Area	Post Mitigation Benefits	
	Annual Benefits	Net Total Benefits ¹⁰
Blue Island-Calumet Park	\$198,200	\$2,735,158
Robbins	\$44,634	\$615,949
Riverdale	\$123,522	\$1,704,604
Dolton	\$12,041	\$166,163
Calumet City	\$0	\$0
TOTAL ADDED VALUE	\$378,397	\$5,221,874

Environmental Impacts

Environmental impacts in general are also inherent values that include:

- Recreational value
- Aesthetic value
- Reduced energy use
- Reduced air pollution
- Reduced carbon dioxide emissions

Wildlife Habitat

The addition of new wet ponds, bioswales and other green areas can provide habitat for various forms of wildlife. Habitat value for GI is estimated at \$7,853/acre. The value of wildlife habitat from green infrastructure and other amenities by community are shown in Table 22 below.

¹⁰ NPV coefficient for a 50 year project useful life using a 7% discount rate

Table 22: Acreage of GI for Wildlife Habitat by Community

Project Area	Wet Ponds & Other GI (acres)
Blue Island-Calumet Park	8.0
Dolton	2.0
Riverdale	11.0
Robbins	13.0
TOTAL	34.0

Data Sources

- HUD, "Benefit Cost Analysis: Data Resources and Expert Tips" Webinar, 2015

Limitations, Uncertainties, Assumptions, and Sensitivities

Various forms of green infrastructure are assumed to have similar habitat which is not necessarily true in nature.

Detailed Results

A summary of the equivalent cost of wildlife habitat is shown in Table 23 below.

Table 23: Value of Wildlife Habitat

Project Area	Post Mitigation Benefits	
	Annual Benefits	Net Total Benefits ¹¹
Blue Island-Calumet Park	\$62,824	\$866,971
Robbins	\$102,089	\$1,408,828
Riverdale	\$86,383	\$1,192,085
Dolton	\$15,706	\$216,743

¹¹ NPV coefficient for a 50 year project useful life using a 7% discount rate

Calumet City	\$0	\$0
TOTAL ADDED VALUE	\$267,002	\$3,684,628

Improved Water Quality

The addition of new wet ponds, bioswales and other green areas can improve water quality. The water quality improvement value for wet ponds/GI is estimated at \$293/acre. The acreage of wet ponds and other GI by community is shown in Table 24 below.

Table 24: Acreage of GI for Improved Water Quality

Community	Wet Ponds & Other GI (acres)
Blue Island-Calumet Park	16.5
Dolton	2.0
Riverdale	19.4
Robbins	14.0
TOTAL	51.9

Data Source

- Trust for Public Land, "The Economic Benefits of Seattle's Park and Recreation System", 2011 (<http://cloud.tpl.org/pubs/ccpe-seattle-park-benefitsreport.pdf>)

Limitations, Uncertainties, Assumptions, and Sensitivities

National, rather than local information, on the water quality benefits was used.

Detailed Results

A summary of the equivalent cost of improved water quality is shown in Table 25.

Table 25: Value of Improved Water Quality

Project Area	Post Mitigation Benefits	
	Annual Benefits	Net Total Benefits ¹²
Blue Island-Calumet Park	\$4,835	\$66,716
Robbins	\$4,102	\$56,608
Riverdale	\$5,684	\$78,442
Dolton	\$586	\$8,087
Calumet City	\$0	\$0
TOTAL ADDED VALUE	\$15,207	\$209,852

Tree Cover

Trees are not only an excellent habitat for various creatures, but help reduce the carbon footprint. The proposed new development in Blue Island-Calumet Park includes 8 acres of new trees. Trees included as part of a tree trench Green Streets system have not been included in the evaluation. Trees provide carbon sequestration valued at \$7,853/acre.

Data Source

- HUD, "Benefit Cost Analysis: Data Resources and Expert Tips" Webinar, 2015

Limitations, Uncertainties, Assumptions, and Sensitivities

Tree morbidity is not factored into the analysis.

Detailed Results

A summary of the added value of tree cover is shown in Table 26.

¹² NPV coefficient for a 50 year project useful life using a 7% discount rate

Table 26: Value of Tree Cover

Project Area	Post Mitigation Benefits	
	Annual Benefits	Net Total Benefits ¹³
Blue Island-Calumet Park	\$62,824	\$866,971
Robbins	\$0	\$0
Riverdale	\$5,684	\$78,442
Dolton	\$0	\$0
Calumet City	\$0	\$0
TOTAL ADDED VALUE	\$68,508	\$945,413

Air Quality

Benefits quantified for air quality include the annual uptake and avoided pollutant emissions captured by trees and other green infrastructure. The added value by GI of avoided pollutant emissions is valued as \$204/acre. The acreage of wet ponds and other GI by community that is improving air quality in the project area is shown in Table 27.

Table 27: Acreage of GI for Improved Air Quality

Community	Wet Ponds & Other GI (acres)
Blue Island-Calumet Park	16.5
Dolton	2.0
Riverdale	19.4
Robbins	14.0
TOTAL	51.9

¹³ NPV coefficient for a 50 year project useful life using a 7% discount rate

Data Source

- David Suzuki Foundation, "Ontario's Wealth, Canada's Future: Appreciating the Value of the Greenbelt's Eco-Services. Vancouver, Canada. Wilson, S.J., 2008.
(<http://www.davidsuzuki.org/publications/downloads/2008/DSF-Greenbelt-web.pdf>)

Limitations, Uncertainties, Assumptions, Sensitivities

The level of benefit is based on an estimated acreage of feature area.

Detailed Results

A summary of the improved air quality is shown in Table 28.

Table 28: Value of Improved Air Quality

Project Area	Post Mitigation Benefits	
	Annual Benefits	Net Total Benefits ¹⁴
Blue Island-Calumet Park	\$3,366	\$46,451
Robbins	\$0	\$0
Riverdale	\$3,958	\$54,615
Dolton	\$408	\$5,630
Calumet City	\$0	\$0
TOTAL ADDED VALUE	\$7,732	\$106,696

Affordable Housing

Research indicates that affordable housing increases employment and spending in the surrounding economy. The availability of affordable housing attracts employers, and lower housing costs increase disposable household income. By lowering housing costs for low- and moderate-income families, affordable housing can increase residual income that households have

¹⁴ NPV coefficient for a 50 year project useful life using a 7% discount rate

at their disposal, thus increasing spending and driving economic growth. Research indicates that low- to moderate- income households are more likely to spend additional income from rent reductions to fulfill basic needs that would otherwise not be met, such as food, clothing, healthcare, and transportation. If housing costs are kept low, families and local businesses will benefit, as families have more disposable income to contribute to the local economy.

With regard to resiliency, if these households can spend a smaller percentage of their income for housing, it can be presumed that they would have a bit more to spend in times of emergency and recovery from disaster, providing a higher level of resiliency to natural hazards such as flooding. By protecting affordable housing from future storms, the proposed projects will preserve the economic benefits that affordable housing generates. The benefit of affordable housing is estimated by the Cook County Housing Authority as \$611/unit.

Data Source

- Housing Authority of Cook County

Limitations, Uncertainties, Assumptions, Sensitivities

None.

Detailed Results

A summary of the added value of affordable housing is shown in Table 29 below.

Table 29: Value of Affordable Housing

Project Area	Post Mitigation Benefits	
	Annual Benefits	Net Total Benefits¹⁵
Blue Island-Calumet Park	\$0	\$0
Robbins	\$0	\$0
Riverdale	\$0	\$0
Dolton	\$18,330	\$252,954
Calumet City	\$88,595	\$1,222,611
TOTAL ADDED VALUE	\$106,925	\$1,475,565

¹⁵ NPV coefficient for a 50 year project useful life using a 7% discount rate