Valley Creek Feasibility Study, Bessemer and Birmingham, Alabama

Appendix B: Economics

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US Army Corps of Engineers ®
Kansas City District

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Table of Contents

List of Figures

List of Tables

Introduction

This economic appendix documents the feasibility-level economic analysis of the proposed Valley Creek flood risk management project. Demographic data and economic development background pertaining to the community are discussed, and the development of a complete structure inventory is detailed. The inventory serves as the basis for a risk-based analysis which evaluates flood damages in the study area on an average annualized basis and calculates project performance by simulating multiple possible events, considering all pertinent economic and engineering data including uncertainty related factors.

Section I documents the flood damage reduction analysis, which is referred to as National Economic Development (NED) and Section II discusses the Regional Economic Development (RED) impact for the project alternatives.

Section I: Flood Risk Management

1.0. Purpose

Due to a number of damaging flood events in the Valley Creek Basin, the City of Bessemer and the U.S. Army Corps of Engineers (USACE) Kansas City District (NWK) entered into a Feasibility Cost Sharing Agreement. The agreement calls for the City and the Corps to perform the analyses necessary to determine whether a Federal interest exists to reduce the risk of flooding. This document explains what is known about the study area, the floodplain characteristics, existing condition flood damages and expected future condition flood damages in the absence of flood damage reduction measures. This report then documents the procedures used to analyze various measures designed to reduce the risk of flood damages, incorporating National Economic Development (NED) guidelines, and recommends an alternative plan.

1.1. Study Area

The Valley Creek study area is located within the city of Birmingham, Alabama; in north central Alabama. Birmingham, Alabama is approximately 244 miles east of Jackson, Mississippi and 147 miles west of Atlanta, Georgia. The Valley Creek drainage area lies entirely within Jefferson County Alabama and encompasses nearly 255 square miles. The economic analysis focused on 20 miles of Valley Creek, which is a major tributary of the Black Warrior River. The Valley Creek drainage area is within the larger Mobile-Tombigbee Basin. Valley Creek flows southwest through the cities of Midfield, Brighton, Hueytown, and Bessemer.

Birmingham and Bessemer, like most major urban centers in the Southeastern United States, have not been immune to flooding problems. The pre- and immediate post-World War One (WWI) era witnessed considerable residential, commercial and industrial development. The development pre-dated the establishment of the Federal Flood Insurance Program by almost an entire generation. As a consequence of this development, many residential and non-residential structures are located within the boundaries of Valley Creek's 0.01 annual chance exceedance (AEP) floodplain, an area so designated because it describes the physical boundaries of a flood event on Valley Creek with a 1% chance of occurrence annually (i.e. a 1-in-100 chance of being equaled or exceeded in one year). Indeed, surveys of existing structures conducted in 2018 demonstrate that a significant number of structures are located within the boundaries of much more frequent flood events, including the 0.1 (10% chance of occurring annually) and even the 0.2 (20% chance of occurring annually) AEP floodplains. Damaging floods have been frequent, and as a result, the affected structures suffer economic flood losses very frequently.

The Federal Government has an interest in reducing those losses, as doing so not only contributes to NED, but may also improve the living conditions of some minority and low-income groups, provide opportunities to enhance the environment, and reduce the costs of administering the Federal Flood Insurance program, of which Birmingham is a participating community. The City of Birmingham also has

a valid interest in reducing such losses, as improved economic conditions benefit the metro area's economy while allowing the city to save on emergency, repair, maintenance, and clean-up costs.

For the purposes of the economic and social studies portions of the Feasibility Report, the 'Study Area' is defined as the area drained by Valley Creek, extending to the boundaries of the 0.002 AEP. This floodplain also includes areas encompassing the 0.1 AEP and other more frequent flood probabilities. Unless otherwise designated by its recurrence chance, the floodplain discussed in this report is the stage associated with the 0.002 (500-year) AEP event. See below Figure 1. Valley Creek Study Area Location for a visual reference of the Valley Creek study area geographical location.

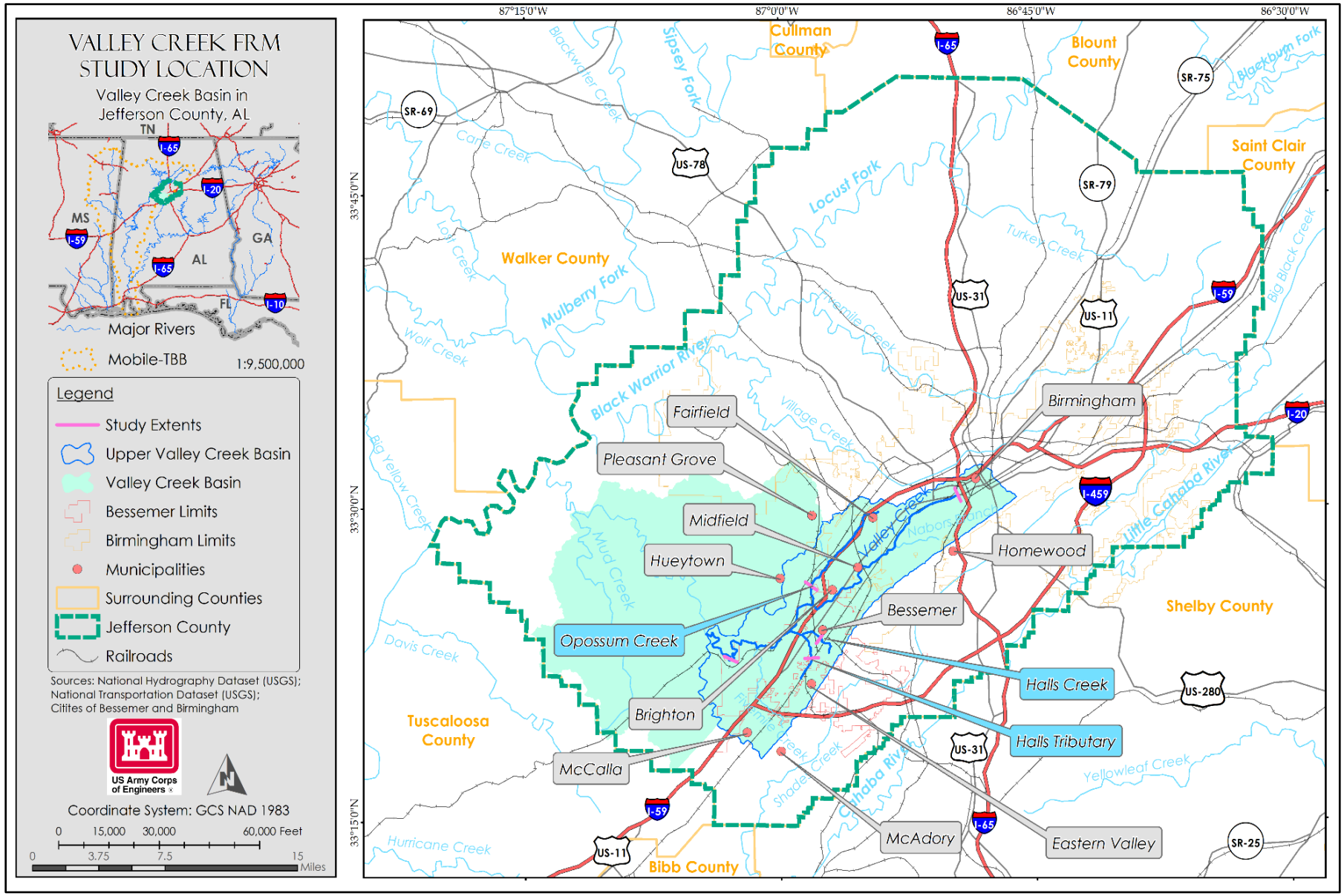

Figure 1. Valley Creek Study Area Location.

1.1.1. Valley Creek Historic Flooding

No recent historical floods on Valley Creek have been adequately documented for economic damages. Generally, only anecdotal information is available. Even if more comprehensive and detailed estimates were available, use of such estimates to check or calibrate the economic analysis limits the ability to apply estimate probabilities to the individual flood events. See Appendix A: Engineering section 1.3 Flooding History for the hydraulics and hydrology (H&H) details of the Valley Creek basin recent flood events.

There are local news articles briefly documenting residential flooding which took place early September 2011 as the result of Tropical Storm Lee. In particular it's noted residents of Sunset Homes, a public housing community consisting of 126 apartments located near Ninth Avenue and 34th Street in Bessemer, Alabama, walking through waist-deep overflow water from Valley Creek. It's also reported approximately 90% of the public housing apartments experienced damage from flood inundation.

More recently in early December 2018 the Non- Federal Sponsor (NFS) provided the project delivery team (PDT) a gauged reading of 3.9 inches of water and surveyed high water elevations adjacent to 18th Avenue bridge over Valley Creek. This was the culmination of a local rainfall event that caused localized flooding around the Bessemer area. See the below figures 2, 3, and 4 of Valley Creek high water levels from December 28, 2018 flowing under the 18th Avenue bridge and flooding that occurred near residential structures.

A search of documents summarizing historical flood events in the study area didn't result in any documented mention of life loss related to a previous flood event.

Figure 2. Valley Creek Water Flow Under 18th Avenue Bridge

Figure 3. December 2018 Bessemer, Alabama Residential Inundation.

Figure 4. Bessemer, Alabama Residential Flooding December 2018.

1.1.2. Socioeconomic Data

Population

The study area includes the metropolitan area of Birmingham and its surrounding communities. The City of Birmingham is the most populous municipality in the study area and is the largest city in Alabama. Birmingham contains roughly one third of the population of Jefferson County. Since 2000, Birmingham has experienced a decline in population, although more recently (2010 to 2017), population changes have been stable. Jefferson County has followed the same trend. The communities of Lipscomb, Midfield, and Bessemer have experienced decreases in population in the past two decades. Only the city of Hueytown has seen an increase in residents since 2000. Table 1. shows the population of the cities within the study area as well as Jefferson County and the State of Alabama.

Table 1. Regional Population Trends 2000-2017.Regional Population Trends 2000-2017.

Area	2000	2010	% Change 2000-2010	2017	% Change 2010-2017	% Change 2000-2017
Alabama	4,447,100	4,779,736	7.0%	4,850,771	1.5%	8.3%
Jefferson County	662,047	658,466	-0.5%	659,460	0.2%	-0.4%
Bessemer	29,672	27,456	-8.1%	26,697	-2.8%	-11.1%
Birmingham	242,820	212,237	-14.4%	212,265	0.0%	-14.4%
Brighton	3,640	2,645	-37.6%	2,848	7.1%	-27.8%
Hueytown	15,364	16,105	4.6%	15,698	-2.6%	2.1%
Lipscomb	2,458	2,210	-11.2%	2,040	-8.3%	-20.5%
Midfield	5,626	5,364	-4.9%	5,174	-3.7%	-8.7%

Sources: United States Census Bureau 2000 Census data, 2010 Census Data, 2017 American Community Survey.

Employment and Income

Median household income for municipalities in the study area is considerably lower than both the state and county averages. Lipscomb and Brighton have the lowest median household incomes, while Hueytown has the highest. The unemployment rate varies across the study area. Brighton has the highest unemployment rate, at nearly 8 percent, while Hueytown, Midfield, and Lipscomb have unemployment rates similar to the state and county averages. Table 2 displays the employment data as well as the median household income of the study area.

Table 2. Regional Employment and Household Income.

Area	Employed Labor Force	Unemployment Rate	Median Household Income
Alabama	53.3	3.8%	$48,486
Jefferson County	57.6	4.5%	$51,979
Bessemer	46.0	7.0%	$31,610
Birmingham	53.9	6.1%	$35,346
Brighton	47.3	8.0%	$26,700
Hueytown	53.8	4.4%	$49,705
Lipscomb	54.8	3.7%	$28,472
Midfield	56.9	4.7%	$36,837

Source: United States Census Bureau 2017 American Community Survey

Trends in employment by industry within the study area track national trends. The educational, health care, and social services sectors employ the majority of residents in all cities, with the exception of Brighton. The combined retail and manufacturing areas employ the second largest percentage of study area residents. Table 3: Regional Industry Employment displays the breakdown of employment by industry in the study area.

Table 3. Regional Industry Employment.

Industry	Alabama	Jefferson County	Bessemer	Birmingham	Brighton	Hueytown	Lipscomb	Midfield
Agriculture, forestry, fishing and hunting, and mining	2%	1%	1%	0%	0%	2%	1%	0%
Construction	6%	5%	7%	4%	7%	5%	17%	4%
Manufacturing	14%	9%	14%	8%	16%	9%	11%	9%
Wholesale trade	3%	3%	2%	2%	0%	1%	5%	1%
Retail trade	12%	11%	14%	12%	14%	13%	7%	8%
Transportation and warehousing, and utilities	5%	5%	6%	5%	2%	8%	3%	5%
Information	2%	2%	1%	2%	0%	0%	1%	1%
Finance and insurance, and real estate and rental and leasing	6%	9%	7%	7%	7%	7%	3%	4%
Professional, scientific, and management, and administrative and waste management services	9%	10%	7%	10%	11%	9%	11%	13%

Educational services, and health care and social assistance	23%	26%	20%	27%	11%	25%	14%	31%
Arts, entertainment, and recreation, and accommodation and food services	8%	9%	13%	12%	22%	8%	15%	12%
Other services	5%	6%	5%	5%	8%	8%	11%	6%
Public administration	6%	4%	4%	4%	2%	5%	1%	5%

Source: United States Census Bureau 2017 American Community Survey

Floodplain Characteristics

The floodplain in the study area contains primarily residential development, with commercial structures dispersed along major thoroughfares and residential development in the surrounding area. Most of the commercial structures are slab-on-grade brick, metal, or prefabricated construction with first floor elevations of two feet or less above ground. Many of the residential structures are wood or brick construction with the first-floor elevation ranging from zero to two feet and having an average of 1.5 feet above ground level. The residential development is typical of pre- and early post-WWII construction. Some of the structures typifying post-WWII development have basements, and many more are slab-on-grade ranch and colonial style.

The floodplain is almost exclusively an urban area. No agricultural production is known to occur anywhere within the floodplain, except for very small gardens of one acre or less. Development in the floodplain also includes the transportation, communication and utility infrastructure needed to serve the residents and businesses located in the area. This includes roads, bridges, storm-water collection and drainage structures, telephone networks and systems for water distribution, wastewater collection, natural gas, and electricity. Though most of the structures in the study area are residential, the most valuable structure is a county wastewater treatment plant in the southern region of the study area.

1.2. Existing Condition

The study area structure inventory is made up of nearly 2,377 structures; not including vacant lots, vehicles, or streets. The inventoried structures were categorized as residential, commercial, or public. Of the total structures 2,073 are residential and 304 are nonresidential. The study area total investment value (structure, content, and vehicle value) is an estimated $607 million in October 2019 or fiscal year (FY) 2020 dollars. Most of the structures are located near Birmingham, Alabama in the northern region of the study area.

1.2.1. Reach Delineation

The term “reach” describes a section of the stream having similar hydraulic, hydrologic, political, geographic, or economic characteristics. Dividing the floodplain into reaches facilitates evaluation of flood damages by breaking the floodplain down into several areas having some common features, and analyzing them separately. The Valley Creek floodplain is divided into 18 reaches, which are defined at specific river stations from the Hydrologic Engineering Center–River Analysis System (HEC-RAS) model outputs, reference Appendix A: Engineering Valley Creek Flood Risk Management Study for more details. From north to south going downstream along the Valley Creek main stream, the order of reaches is as follow: Birmingham, Midfield, Brighton_Bessemer, Upper_Bessemer, Bess_Huey_Upper, Bess_Huey_GarUpper_RB, Bess_Huey_GarUpper_LB, Bess_Huey_GarDown_RB, Bess_Huey_GarDown_LB, Bess_Huey_Down, Bess_WWTP_Upper, Bess_WWTP_RB, Bess_WWTP_LB, Bess_WWTP_Down, Bess_Huey_Lower. There are also three reaches (HCTrib, HCU, HCL) along Halls Creek, a significant left bank tributary that drains into Valley Creek. The reaches used

in this study are listed below in Table 4: Valley Creek Economic Study Reaches, which shows the beginning (upstream) and ending (downstream) of each reach as well as its index point.

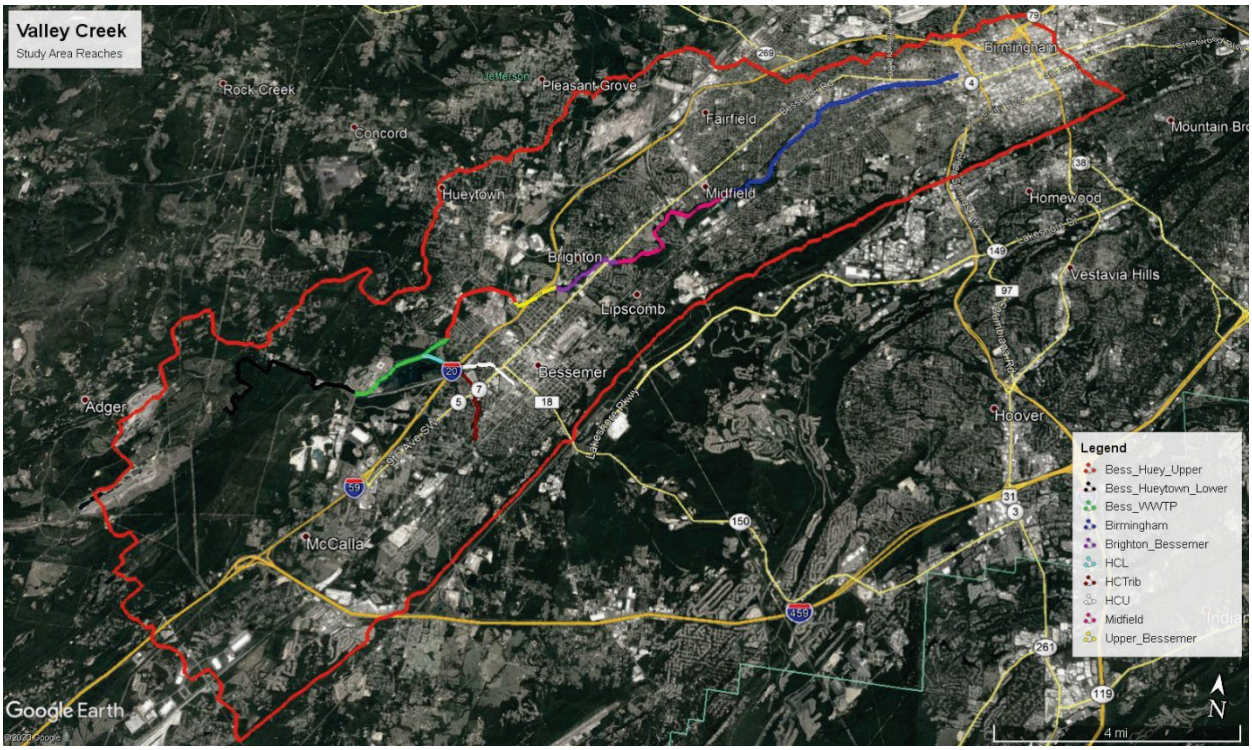

Figure 5. Overview of Valley Creek Reaches.

Table 4. Valley Creek Economic Study Reaches.

Stream	Reach	Downstream Cross Section	Upstream Cross Section	Index Location	Top of Levee Elevation
Valley Creek	Bess_Hueytown_Lower	178,800*	203,466	192,254	
Valley Creek	Bess_WWTP_Down	203,467	204,067*	203,467	
Valley Creek	Bess_WWTP_LB	204,068	206,011	205,237	
Valley Creek	Bess_WWTP_RB	204,068	206,011	205,237	440.59
Valley Creek	Bess_WWTP_Upper	206,012	214,169	212,634	
Valley Creek	Bess_Huey_Down	214,170	218,999	216,429	
Valley Creek	Bess_Huey_GarDown_LB	219,000*	220,499*	220,366	
Valley Creek	Bess_Huey_GarDown_RB	219,000*	220,499*	220,366	463.85
Valley Creek	Bess_Huey_GarUpper_LB	220,500	222,715	222,267	
Valley Creek	Bess_Huey_GarUpper_RB	220,500	222,715	222,267	465.45
Valley Creek	Bess_Huey_Upper	222,716	225,029	223,694	
Valley Creek	Upper_Bessemer	225,030	229,933	227,272	
Valley Creek	Brighton_Bessemer	229,934	237,701	233,059	
Valley Creek	Midfield	237,702	255,201	246,113	
Valley Creek	Birmingham	255,202	286,000	267,785	
Halls Creek Lower	HCL	3,200	4,010	3,800	
Halls Creek Upper	HCU	4,020	10,700	6,940	
Halls Creek Tributary	HCTrib	4,075	12,330	7,317.17	

Note: *Not a H&H model cross section.

Bess_Hueytown_Lower is the southernmost reach on the Valley Creek stream. It is a small predominately undeveloped reach, containing two residential structures and multiple streets. Total investment is estimated at $510,000.

Bess_WWTP is a region that was sub-divided into reaches Bess_WWTP_Down, Bess_WWTP_LB, Bess_WWTP_RB, Bess_WWTP_Upper in order to model an existing right bank levee.

Bess_WWTP_Down is the southernmost reach in this region. There are no structures in this reach.

Bess_WWTP_LB is the reach immediately upstream of Bess_WWTP_Down and includes only the left bank of Valley Creek. There is one high value structure in this reach estimated to have a total value just over $9.7 million. This structure is one facility making up the Jefferson County Waste Water Treatment Plant. The building is relatively new with specialized contents that are susceptible to flood inundation damage. Bess_WWTP_LB total investment is $9.7 million.

Bess_WWTP_RB is directly across the stream from Bess_WWTP_LB and includes only the right bank section of the stream. The majority of the Jefferson County Waste Water Treatment Plant is located in this reach. This facility is the most expensive structure in the study's structure inventory valued at approximately $319 million. Since this is the only structure in the Bess_WWTP_RB reach the structure's total value is the same as the reach's total investment. There is an existing levee in this reach, with a top of levee elevation stage of 440.59. Per dialogue with a local subject matter expert on the historic flood damage susceptibility of the treatment plant and FWOP H&H inundation extents, it's anticipated the existing levee retains flows up to the AEP 0.005 event. During larger events than that, flood inundation starts in the Bess_WWTP_RB reach and the treatment plant begins to sustain first floor damages.

Bess_WTTP_Upper is the northern most reach within the Bess_WWTP region. The upper region of this reach contains a cluster of structures, which are predominately single-family residences. Excluding streets and cars of the 445 total structures in the Bess_WWTP_Upper reach, 40 of the structures are residential. Within this reach there are also a few nonresidential properties, including two churches, one warehouse, and one other commercial structure. Total investment is $3.6 million.

Similar to the Bess_WWTP region, the Bess_Huey_Upper region was sub-divided into five reaches to model within HEC-FDA (Hydrologic Engineering Center- Flood Damage Reduction Analysis) two existing right bank levees. Bess_Huey reaches in order from downstream going upstream along Valley Creek include: Bess_Huey_Down, Bess_Huey_GarDown_LB, Bess_Huey_GarDown_RB, Bess_Huey_GarUpper_LB, Bess_Huey_GarUpper_RB, Bess_Huey_Upper.

Bess_Huey_Down is located in the southern region of the study area. Residential structures make up the vast majority of the 329 structures in this reach. Single family structures, built between 1940 and 1960, make up a large percentage of the Bess_Huey_Down 303 residential structures. The single family structure values range from $11,000 to $105,000, with the majority of the structures within the high $30,000 to low $40,000 range. Commercial activity in this reach are spaced sporadically throughout the reach, and generally consists of churches, offices, and restaurants. There are 26 commercial structures in the Bess_Huey_Down reach. Total investment is just over $30 million.

Bess_Huey_GarDown_LB is a small reach and only encompasses the left bank of the stream. There are a total of 24 structures in this reach, with 80% of the structures being single family residences. The three commercial structures present in this reach are an automotive service shop, a gas station and a retail shop. Total investment, excluding streets and automobiles, is $1.9 million.

Bess_Huey_GarDown_RB is even smaller than its left bank counterpart, encompassing six structures. Of the six structures four are single family residences. The remaining two are industrial warehouses. The Bess_Huey_GarDown_RB reach was delineated to model the effects of an existing right bank levee, Bessemer Gardens, in HEC-FDA. Bessemer Gardens levee runs along the southern perimeter

of the Bessemer Garden neighborhood. Bessemer Gardens levee was divided into two HEC-FDA segments, namely reaches Bess_Huey_GarDown_RB and Bess_Huey_GarUpper_RB. The downstream levee extent starts near 2510 19th Street in Hueytown, Alabama and curves north in a C-shape towards and along the Bessemer Garden neighborhood. The levee is approximately 4,730 feet and ends just north of the U.S. Pipe & Foundry Co. factory. Susceptibility to economic flood damages is relatively low here. Bess_Huey_GarDown_RB total investment is $720,000.

Bess_Huey_GarUpper_LB – This reach contains no structures.

Bess_Huey_GarUpper_RB – There are two single family residences and no commercial activity in this small reach. Total investment is $190,000.

Bess_Huey_Upper includes 28 structures and is almost evenly split between residences (13 single family homes) and commercial or industrial activity (15 buildings). Commercial and industrial activity in Bess_Huey_Upper consists of multiple warehouses and manufacturing facilities. There are three service shops and commercial buildings in Bess_Huey_Upper. Major commercial and industrial points of interest in this reach include Airgas, a welding supply store and Birmingham Tank Wash, a water tank cleaning company. Total investment is $5.3 million.

Upper_Bessemer is the northern most reach in the Bess_Huey_Upper region. There are 188 structures in this reach, with over 90% of the structures being residential. The remaining structures are a mix of primarily commercial offices and churches. Of the residential structures, the vast majority are single family 1-story homes with no basements. A few of the residential structures, nearly 3.4%, have basements. Total investment is $17.7 million.

Brighton_Bessemer is in close proximity to the city of Brighton. This reach is situated near the center of the study area along the Valley Creek mainstream. Valley Creek bisects Brighton_Bessemer starting southwest going upstream northeast. The right bank contains most of the reach's residential structures, with a small cluster of commercial activity to the south. In the northern portion of the reach there are several mobile homes in a neighborhood called Holiday Mobile Home Park. The typical residence in Brighton_Bessemer is a one-story single-family house without a basement. The average residential value in this reach is $33,000. Brighton City Hall and Police Department are in the southern commercial region of the right bank, near Interstate 59. The left bank is predominately commercial. Of the 180 structures in this reach, 114 are residential and 66 are commercial. The left bank commercial activity includes restaurants, auto sales or repair shops, hotels, and mixed retail stores. Total investment is $18.7 million.

Midfield reach starts near the intersection of U.S. Route 11 and Oakmont St in Brighton, Alabama and travels upstream along Valley Creek, roughly following U.S. Route 11 northeast towards the city of Midfield, and ends north of By Williams Sr. Drive. In terms of the number of structures per reach, Midfield is the second largest reach containing 447 structures. The vast majority of these structures are residential, with 419 residences in Midfield reach. Similar to the rest of the study area single family houses without a basement constitute the majority of residential structures in this reach. The average single-family residence structure value is around $36,000. There are very few split level residences or homes with a basement. The few multi-family residences present are duplexes, one, or two-story apartment buildings. The Midfield reach commercial activity traces closely alongside U.S. Route 11. Most businesses are generally small or medium restaurants, retail stores, convenience stores, auto shops or storage buildings. There are multiple churches scattered throughout the Midfield reach and a funeral home. Points of interest include the Midfield City outdoor recreation park; Western Health Center; and the Roosevelt City Recreation, another outdoor recreation center. Public service points of interest include: The City of Birmingham Fire Station 11, Midfield High School, and Midfield Elementary School. Total investment is nearly $62 million, equivalent to 10% of the study area's $607 million total investment.

Birmingham is the largest reach, both in terms of the number of structures, 1,053, and total investment, $130 million. This reach starts just north of the Holcim Us Inc. cement manufacturer on Hartman

Industrial Blvd and stretches northeast towards Birmingham, Alabama. The reach ends at the intersection of 5th Avenue N and 7th Street N. Over 87.5% of the structures are residential. The majority of the structures are single family residential houses. From the middle of the reach upstream towards central Birmingham, the number of commercial structures increase. Total investment is $130 million, or 21% of the study area total investment.

Halls Creek is a Valley Creek inflowing tributary, located in the southern region of the study area near the City of Bessemer. This tributary was divided into three reaches: Halls Creek Lower (HCL), Halls Creek Upper (HCU), and Halls Creek Tributary (HCTrib). HCL constitutes the upper section of Halls Creek stream. Immediately south of U.S. Interstate 20 Halls Creek stream forks, creating HCU and HCTrib. The northern fork is HCU and the southern fork is HCTrib.

HCL is the smallest of the Halls Creek reaches, containing a total of five residential structures. All these residences are single family 1-story houses without basements. The average house value, not including contents, is approximately $37,000. HCL total investment is $460,000.

HCU includes a total of 51 structures, 40 residential and 11 nonresidential. The majority of the HCU structures are located between U.S. Route 11 and 4th Ave N. The commercial activity within HCU follows along U.S Route 11 and includes auto repair or service shops and small restaurants. Total investment is $4.1 million.

HCTrib has a total of 16 structures: 12 residential and 4 non-residential. Total investment is $3.7 million. This reach is mostly comprised of undeveloped wooded land, with single family houses located along the perimeter of the undeveloped lands. Total investment is $3.5 million.

The setting of Valley Creek is predominately urban and the floodplain itself is almost fully developed, except in areas where previous property buyouts have occurred. However, it is unlikely that the floodplain itself will experience significant development in the future. The structure inventory has changed in the last decade as a result of buyouts, abandonment, and condemnation; which has contributed to a reduction of structures since 2010. Currently, the Valley Creek structure inventory contains 2,377 structures, excluding streets and vehicles. Residential structures account for 2,073 structures, with the remaining 304 being a mix of public, commercial, and industrial. Table 5: Valley Creek Existing Condition Structure Inventory per Reach summarizes the number of structures per reach, the structures depreciated replacement cost, and vehicle depreciated replacement cost. Table 5 also shows the study area inventory value for residential and non-residential properties per reach in 2020 dollars.

Table 5. Valley Creek Existing Condition Structure Inventory per Reach.

Stream	Reach	Residential Structures[1]	Non-Residential Structures[1]	Total Structures[1]	Total Structure Value	Total Content Value	Total Vehicle Value	Total Investment
Valley Creek	Bess_Hueytown_Lower	2	-	2	$240	$240	$30	$510
Valley Creek	Bess_WWTP_Down	-	-	-	$-	$-	$-	$-
Valley Creek	Bess_WWTP_LB	-	1	1	$7,200	$2,500	$-	$9,700
Valley Creek	Bess_WWTP_RB	-	1	1	$236,300	$82,700	$-	$319,000
Valley Creek	Bess_WWTP_Upper	40	4	44	$1,600	$1,400	$620	$3,620
Valley Creek	Bess_Huey_Down	303	26	329	$13,300	$12,200	$4,600	$30,100
Valley Creek	Bess_Huey_GarDown_LB	21	3	24	$860	$750	$320	$1,930
Valley Creek	Bess_Huey_GarDown_RB	4	2	6	$410	$250	$60	$720
Valley Creek	Bess_Huey_GarUpper_LB	-	-	-	$-	$-	$-	$-
Valley Creek	Bess_Huey_GarUpper_RB	2	-	2	$80	$80	$30	$190
Valley Creek	Bess_Huey_Upper	13	15	28	$3,400	$1,700	$200	$5,300
Valley Creek	Upper_Bessemer	176	12	188	$7,900	$7,100	$2,700	$17,700
Valley Creek	Brighton_Bessemer	114	66	180	$11,000	$6,000	$1,700	$18,700
Valley Creek	Midfield	419	28	447	$32,200	$23,100	$6,300	$61,600
Valley Creek	Birmingham	922	131	1,053	$67,000	$49,500	$13,700	$130,200
Halls Creek Lower	HCL	5	-	5	$190	$190	$80	$460
Halls Creek Upper	HCU	40	11	51	$2,000	$1,500	$610	$4,110
Halls Creek Tributary	HCTrib	12	4	16	$2,300	$1,100	$180	$3,580
Grand Total	N/A	2,073	304	2,377	$385,980	$190,310	$31,130	$607,420

Note: [1] Table columns structure counts exclude streets and vehicles.
Price level: October 2019 (FY20), Values are displayed in $1,000's

The abovementioned structure inventory was modeled in HEC-FDA using stage-damage relationship with uncertainty, along with stage-probability relationship with uncertainty. The HEC-FDA model used economic and engineering inputs to generate a stage-damage relationship for each structure category in each study reach in the existing and future conditions. The possible occurrences of each economic variable were derived using the Monte Carlo simulation and a total of 800 iterations were executed by the model for the Valley Creek study. The sum of all sampled values was divided by the number of iterations to yield the expected value for a specific simulation. A mean and standard deviation were automatically calculated for the damages at each stage.

Referencing Engineering Manual 1110-2-1619, Risk-Based Analysis for Flood Damage Reduction Studies, 1996, Table 4-5 Equivalent Record Length Guidelines, an equivalent record of 25 years was used in the HEC-FDA model. This equivalent record of length was selected due to the hydrology model being calibrated per multiple short-interval gaged rainfall events within the watershed. The HEC-FDA model used an equivalent record length of 25 years, verified with the PDT H&H Engineer, for each reach to generate a stage-probability relationship with uncertainty for the FWOP and FWP conditions. The graphical method was used because discharge-probability was not viable for use in the model.

The HEC-FDA model used the eight stage-probability events together with the 25 years equivalent record length to define the full range of the stage-probability functions by interpolating between the data points. The eight AEP events pulled from the water surface profiles for use in the damage calculations are as follows: 0.5, 0.2, 0.1, 0.04, 0.02, 0.01, 0.004, and 0.002. Damages were aggregated at the index location for each study area reach. Following the conclusion of the Monte Carlo simulation, a mean was calculated from the observed expected annual damage calculation.

Table 6 displays existing condition without project total inundation damages for each of the eight events used in the economic analysis. These totals do not represent annualized impacts, known as expected annualized damages (EAD). Each AEP event total is the estimated total of damages that would occur in each event evaluated, without being discount according to how frequently the event would be expected to occur as in the annualization process. The totals values displayed account for physical damages to homes, businesses, public structures, streets, and residential autos. Also included in total estimates are damages to buildings contents.

Table 6. Existing Condition Single-Event Damages per Reach and Exceedance Probability Event (AEP).

Stream	Reach	AEP 0.5	AEP 0.2	AEP 0.1	AEP 0.04	AEP 0.02	AEP 0.01	AEP 0.004	AEP 0.002
Valley Creek	Bess_Hueytown_Lower	-	0.8	2.9	4.5	45.3	83.9	119.8	171.0
Valley Creek	Bess_WWTP_Down	-	-	-	-	-	-	-	-
Valley Creek	Bess_WWTP_LB	-	-	-	-	-	-	734.9	1,092.2
Valley Creek	Bess_WWTP_RB	-	-	-	-	-	-	-	-
Valley Creek	Bess_WWTP_Upper	1.9	7.9	57.1	121.3	182.4	260.6	332.3	24,652.0
Valley Creek	Bess_Huey_Down	56.4	503.3	1,178.6	5,889.6	7,705.5	8,675.6	9,384.2	11,050.8
Valley Creek	Bess_Huey_GarDown_LB	-	-	-	38.0	211.2	272.8	276.0	460.3
Valley Creek	Bess_Huey_GarDown_RB	43.6	126.9	173.9	270.6	365.2	379.3	380.3	406.4
Valley Creek	Bess_Huey_GarUpper_LB	-	-	-	-	-	-	-	-
Valley Creek	Bess_Huey_GarUpper_RB	24.6	59.7	73.3	101.7	116.5	119.4	119.9	125.0
Valley Creek	Bess_Huey_Upper	-	0.7	125.0	342.2	432.3	511.2	917.6	1,555.3
Valley Creek	Upper_Bessemer	26.6	57.6	271.2	856.4	1,702.1	2,285.4	3,699.9	4,367.4
Valley Creek	Brighton_Bessemer	402.5	1,265.3	2,080.2	3,069.0	3,892.3	4,955.2	6,046.7	6,868.6
Valley Creek	Midfield	487.1	2,685.4	4,543.7	6,754.9	8,424.2	10,518.6	13,090.4	16,846.0
Valley Creek	Birmingham	752.8	2,697.3	4,918.4	8,783.9	11,859.9	15,761.8	19,998.3	24,958.6
Halls Creek Lower	HCL	-	-	-	-	-	-	0.9	6.6
Halls Creek Upper	HCU	12.8	56.4	167.7	233.7	310.4	388.2	475.8	610.1
Halls Creek Tributary	HCTrib	0.7	4.6	11.2	33.5	77.6	103.9	150.3	195.7
Study Area Total	N/A	1,809	7,466	13,603	26,499	35,325	44,316	55,727	93,366

Note: Price level: October 2019 (FY20), Period of Analysis 50 years, Analysis Year: Existing Condition 2023, Values are displayed in $1,000's.

Table 7. Existing Condition Annual Damage by Category and Reach.

Stream	Reach	Damage Category	Expected Annual Damages
Valley Creek	Bess_Hueytown_Lower	Residential	$2.87
Valley Creek	Bess_Hueytown_Lower	Nonresidential	$1.95
Valley Creek	Bess_Hueytown_Lower	Total	$4.82
Valley Creek	Bess_WWTP_LB	Residential	$-
Valley Creek	Bess_WWTP_LB	Nonresidential	$11.77
Valley Creek	Bess_WWTP_LB	Total	$11.77
Valley Creek	Bess_WWTP_Upper	Residential	$18.43
Valley Creek	Bess_WWTP_Upper	Nonresidential	$289.51
Valley Creek	Bess_WWTP_Upper	Total	$307.94
Valley Creek	Bess_Huey_Down	Residential	$729.47
Valley Creek	Bess_Huey_Down	Nonresidential	$78.53
Valley Creek	Bess_Huey_Down	Total	$808.00
Valley Creek	Bess_Huey_GarDown_LB	Residential	$13.66
Valley Creek	Bess_Huey_GarDown_LB	Nonresidential	$0.87
Valley Creek	Bess_Huey_GarDown_LB	Total	$14.53
Valley Creek	Bess_Huey_GarDown_RB	Residential	$1.59
Valley Creek	Bess_Huey_GarDown_RB	Nonresidential	$0.44
Valley Creek	Bess_Huey_GarDown_RB	Total	$2.03
Valley Creek	Bess_Huey_GarUpper_RB	Residential	$0.62
Valley Creek	Bess_Huey_GarUpper_RB	Nonresidential	$-
Valley Creek	Bess_Huey_GarUpper_RB	Total	$0.62
Valley Creek	Bess_Huey_Upper	Residential	$7.40
Valley Creek	Bess_Huey_Upper	Nonresidential	$43.84
Valley Creek	Bess_Huey_Upper	Total	$51.24
Valley Creek	Upper_Bessemer	Residential	$149.71
Valley Creek	Upper_Bessemer	Nonresidential	$57.00
Valley Creek	Upper_Bessemer	Total	$206.71
Valley Creek	Brighton_Bessemer	Residential	$382.26
Valley Creek	Brighton_Bessemer	Nonresidential	$610.67
Valley Creek	Brighton_Bessemer	Total	$992.93
Valley Creek	Midfield	Residential	$652.59
Valley Creek	Midfield	Nonresidential	$1,252.13
Valley Creek	Midfield	Total	$1,904.72
Valley Creek	Birmingham	Residential	$1,835.25
Valley Creek	Birmingham	Nonresidential	$599.98
Valley Creek	Birmingham	Total	$2,435.23
Halls Creek Lower	HCL	Residential	$0.22
Halls Creek Lower	HCL	Nonresidential	$0.09
Halls Creek Lower	HCL	Total	$0.31
Halls Creek Upper	HCU	Residential	$48.62
Halls Creek Upper	HCU	Nonresidential	$23.06
Halls Creek Upper	HCU	Total	$71.68
Halls Creek Tributary	HCTrib	Residential	$2.70
Halls Creek Tributary	HCTrib	Nonresidential	$8.60

Stream	Reach	Damage Category	Expected Annual Damages
Halls Creek Tributary	HCTrib	Total	$11.30
Existing Condition EAD	N/A	N/A	$6,823.83

Note: Price level: October 2019 (FY20), Analysis Year: Existing Condition 2023, Period of Record: 50 years, Values displayed in $1,000's.

Existing condition expected annual flood damages in the study area total approximately $6.82 million. The existing condition flood damages are the potential average annual dollar damages to structures, contents, streets, and vehicles affected by flooding at the time of the study. No projection is involved, and the existing condition encompasses relevant factors that best characterize the planning perceptions of the affected area in the situation without a plan.

1.3. Future without Project Condition

The years 2023-2073 were selected to represent the future without project condition in HEC-FDA; however, the project will require a five-year implementation period and will not be operational until 2028. It is at that point in which the 50-year period of analysis begins and will run until 2078. HEC-FDA will not be adjusted to reflect a new base year since a 50-year stream of benefits were calculated. No additional development within the 0.01 AEP floodplain of the study area is anticipated, since the floodplain is essentially fully developed now and since the study area is a participant in the Federal Flood Insurance Program. In other words, there is no distinction in the analysis between existing and future without project conditions. Water surface profiles and the economic structure inventory are considered stable over the 50 years period of analysis. The same 2,377 structures lying in the floodplain will continue to be affected by the risk of flooding. The following tables display future without project condition water surface profiles at the index location for each study area reach, Table 8, and single event damages without consideration for uncertainty in the study area, Table 9.

Table 8. Future Without Project Condition Water Surface Profile Stage per Reach.

Stream	Reach	AEP 0.5	AEP 0.2	AEP 0.1	AEP 0.04	AEP 0.02	AEP 0.01	AEP 0.004	AEP 0.002
Valley Creek	Bess_Hueytown_Lower	408.31	410.86	412.58	414.86	416.6	418.13	419.48	421.16
Valley Creek	Bess_WWTP_Down	423.21	425.08	426.4	428.7	430.32	431.51	432.38	433.99
Valley Creek	Bess_WWTP_LB	428.11	430.13	431.67	434.94	436.59	437.82	440.85	441.79
Valley Creek	Bess_WWTP_RB	428.11	430.13	431.67	434.94	436.59	437.82	440.85	441.79
Valley Creek	Bess_WWTP_Upper	443.87	446.30	447.64	449.09	449.86	451.05	452.00	453.85
Valley Creek	Bess_Huey_Down	450.79	452.56	453.48	456.06	457.06	457.62	458.04	459.04
Valley Creek	Bess_Huey_GarDown_LB	454.58	456.46	457.77	460.52	462.91	463.58	463.66	465.38
Valley Creek	Bess_Huey_GarDown_RB	454.58	456.46	457.77	460.52	462.91	463.58	463.66	465.38
Valley Creek	Bess_Huey_GarUpper_LB	457.21	458.81	459.86	461.95	463.84	464.59	464.99	467.03
Valley Creek	Bess_Huey_GarUpper_RB	457.21	458.81	459.86	461.95	463.84	464.59	464.99	467.03
Valley Creek	Bess_Huey_Upper	462.14	464.56	466.96	468.00	468.65	469.1	470.49	471.7
Valley Creek	Upper_Bessemer	465.98	468.05	469.55	471.31	472.3	472.72	473.71	474.5
Valley Creek	Brighton_Bessemer	474.82	477.22	478.66	479.81	480.8	482.09	483.25	483.53
Valley Creek	Midfield	494.03	496.16	497.61	499.15	500.21	501.28	502.49	503.64
Valley Creek	Birmingham	529.63	531.52	531.93	532.57	533.01	533.82	534.57	534.75
Halls Creek Lower	HCL	444.25	446.48	447.78	449.25	450.03	450.89	451.78	453.84

Stream	Reach	AEP 0.5	AEP 0.2	AEP 0.1	AEP 0.04	AEP 0.02	AEP 0.01	AEP 0.004	AEP 0.002
Halls Creek Upper	HCU	459.7	460.3	460.79	461.12	461.43	461.69	461.94	462.22
Halls Creek Tributary	HCTrib	465.59	468.4	470.33	472.42	473.75	474.71	475.51	476.88

Note: *AEP = Exceedance Probability Event. Displayed water surface profile stages are in feet.

Table 9. Future Without Project Total Single-Event Damages.

AEP* Event	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Study Area Total	$1,809	$7,466	$13,603	$26,500	$35,325	$44,316	$55,727	$93,367

Notes: *AEP = Exceedance Probability Event.

Price level: October 2019 (FY20), Analysis Year: Future Without Project Condition 2023, Period of Analysis: 50 years, Values displayed in $1,000's.

As with the existing condition, HEC-FDA used a Monte Carlo simulation to sample from the stage-probability curve with uncertainty for the future without-project condition. For each of the iterations within the simulation, stages were simultaneously selected for the entire range of probability events. The sum of all damage values divided by the number of iterations run by the model yielded the expected value, or mean damage value, with confidence bands for each probability event. The probability-damage relationships are integrated by weighting the damages corresponding to each magnitude of flooding (stage) by the percentage chance of exceedance (probability). From these weighted damages, the model determined the EAD with confidence bands (uncertainty). For the FWOP, the EAD were totaled for each study area reach to obtain the total FWOP EAD under future (2023 and 2073) conditions as shown in the following table.

Table 10. Future Without Project Condition Estimated Annual Damages per Reach.

Stream	Reach	FWOP EAD
Valley Creek	Bess_Hueytown_Lower	$4.81
Valley Creek	Bess_WWTP_LB	$11.77
Valley Creek	Bess_WWTP_Upper	$307.94
Valley Creek	Bess_Huey_Down	$808.01
Valley Creek	Bess_Huey_GarDown_LB	$14.53
Valley Creek	Bess_Huey_GarDown_RB	$2.03
Valley Creek	Bess_Huey_GarUpper_RB	$0.62
Valley Creek	Bess_Huey_Upper	$51.24
Valley Creek	Upper_Bessemer	$206.71
Valley Creek	Brighton_Bessemer	$992.93
Valley Creek	Midfield	$1,904.72
Valley Creek	Birmingham	$2,435.23
Halls Creek Lower	HCL	$0.31
Halls Creek Upper	HCU	$71.68
Halls Creek Tributary	HCTrib	$11.30
Total FWOP EAD	N/A	$6,823.83

Note: Price level: October 2019 (FY20), Analysis Year: Future Without Project 2023, Period of Analysis: 50 years, Values displayed in $1,000's.

1.4. Future with Project Condition

The FWP is the most likely condition expected to exist in the future if a specific project is undertaken. There are potentially as many FWP conditions as there are project alternatives. A total of 13 initial array of alternatives were considered for the Valley Creek Flood Risk Management Study. Of these, seven were structural, two were nonstructural, and the remaining four alternatives were a combination of structural and nonstructural plans. The economic analysis for alternative selection did not formulate for recreation

because it is considered incidental to the project. Residual flood damages and flood damage reduction for each alternative are discussed below.

Table 11. Valley Creek Initial Array of Alternatives.

Alternative	Description
FWOP	No federal construction or implementation of Valley Creek flood risk reduction actions during the 50-yr period of analysis.
Structural Alternatives	
Alternative 1: Channel and Bridge Modification (VC1+VB8)	120-ft. wide, 3000-ft length channel modification from Murphy's Ln to Halls Creek Tributary + Murphy's Lane bridge span length increase from 160-ft to 310-ft.
Alternative 2: Channel & Bridge Mod (VC1+VB8+VB9)	Alternative 1 + 18th Ave. bridge modification, lengthening spans from 125-ft to 200-ft.
Alternative 3: Detention Basins (VD1+VD2+VD4)	Construction of detention basins VD1 + VD2 + VD4. Requiring containment berms 2-ft to 6-ft in height, erosion control, and outlet works for drainage back to river.
Alternative 4: Detention Basins (VD1+VD2)	Construction of detention basins VD1 + VD2. Requiring containment berms 2-ft to 6-ft in height, erosion control, and outlet works for drainage back to river.
Alternative 5: Alt 1 + Alt 4	Combines the smaller of the channel & bridge mod plans with the smaller of the detention plans
Alternative 6: Alt 2 + Alt 4	Combines the larger of the channel & bridge mod plans with the smaller of the detention plans
Alternative 7: Alt 1 + Alt 3	Combines the smaller of the channel & bridge mod plans with the larger of the detention plans
Non-Structural Alternatives	
Alternative 8: Non-structural 2-yr	Acquisition of 0.5 AEP (2-yr) damaged structures
Alternative 9: Non-structural 5-yr	Acquisition of 0.2 AEP (5-yr) damaged structures
Structural + Non-Structural Alternatives	
Alternative 10: Alt 8 + Alt 1 + VD1	Combines 0.5 AEP acquisition, the smaller of the channel & bridge mod plans, and a single detention basin
Alternative 11: Alt 8 + Alt 1 + Alt 4	Combines 0.5 AEP acquisition, the smaller of the channel & bridge mod plans, and the small detention plans
Alternative 12: Alt 3 + Residual Risk 2-yr floodplain buyout	Combines detention basins with a buyout of the residual risk 0.5 ACE floodplain.
Alternative 13: Alt 1 + Residual Risk 2-yr floodplain buyout	Combines channel and bridge modification with a buyout of the residual risk 0.5 AEP floodplain.

Alternative 1, Channel and Bridge Modification (VC1+VB8): includes channel modification from Murphys Lane to Halls Creek Tributary and expansion of Murphys Lane Bridge. Channel modification widens the channel from roughly 45 feet to approximately 120 feet for about 3,000 feet. Bridge modification would lengthen the span from about 160 feet to 310 feet.

Alternative 2, Channel & Bridge Mod (VC1+VB8+VB9): includes the work proposed under Alterative 1 plus bridge modification at 18th Street N. Currently, the 18th Street N. bridge is approximately 125 feet in length with 3 sets of piers configured to give a semi-circular hydraulic cross section. The modified configuration would increase to 5 sets of piers and lengthen the bridge deck to approximately 200 feet maintaining the same semi-circular hydraulic cross section. There would be no additional O&M cost to the bridge modification as it would continue to be part of the owner's regular maintenance program.

Alternative 3, Detention Basins (VD1+VD2+VD4): includes construction of detention basins VD1, VD2, and VD4. Approximately 600,000 cubic yards of material would require disposal from excavation of the detention basins. Possible disposal locations include Vulcan Materials in Bessemer or the New Georgia Landfill in Birmingham. Both are suitable locations; a conservative haul distance was assumed in the cost estimate for purposes of evaluating and comparing alternatives. Each of the basins would require containment berms of 2-feet to 6-feet in height, erosion control, and outlet works for drainage back to the river. Sites are predominately open space with some clearing and grubbing. Sites VD1 and VD2 are former buyout locations and utility demolition was assumed.

In general, relocations were assumed to be within existing utility corridors (Appendix D).

Alternative 4, Detention Basins (VD1+VD2): includes construction of detention basins VD1 and VD2. Approximately 325,000 cubic yards of material would need to be disposed, with potential disposal locations being Vulcan Materials in Bessemer or the New Georgia Landfill in Birmingham. Both would be suitable locations and conservative haul distance was assumed in the cost estimate. Each of the basins would require containment berms 2-feet to 6-feet in height, erosion control, and outlet works for drainage back to the creek. Sites are predominately open space with some clearing and grubbing. Sites VD1 and VD2 are former buyout locations, utility demolition was expected. In general, relocations were assumed to be within existing utility corridors (Appendix D).

Alternative 5, Alt 1 + Alt 4: includes alternative 1 in addition to the implementation of alternative 4; which is channel modification (VC1), Murphys Lane Bridge (VB8), plus detention basins VD1 and VD2.

Alternative 6, Alt 2 + Alt 4: Alternative 6 includes proposed alternative 2 in addition to alternative 4; which is channel modification (VC1), Murphys Lane Bridge (VB8), 18th Street N Bridge (VB9), plus detention basins VD1 and VD2.

Alternative 7, Alt 1 + Alt 3: Alternative 7 includes proposed alternative 1 plus alternative 3; which is channel modification (VC1), Murphys Lane Bridge (VB8), plus detention basins VD1, VD2, and VD4.

Alternative 8, Non-structural 2-yr: includes physical nonstructural acquisition of structures incurring damages by the 0.50 AEP event. Approximately 100 structures would be acquired, with the owners receiving moving assistance. The properties are a mix of residential, commercial, and industrial properties within all participating municipalities. All structures would be demolished and removed from the site.

Passive recreation could be an approved land use post removal of the structures. Utilities would be disconnected from the structure but infrastructure such as power poles, water lines, sewers, etc. would remain in place.

Alternative 9, Non-structural 5-yr: includes physical nonstructural acquisition of structures damaged by the 0.20 AEP event. Approximately 300 structures would be acquired and moving assistance provided to owners. The properties are a mix of residential, commercial, and industrial properties within all participating municipalities. All structures would be demolished and removed from the site. Passive recreation could be an approved land use post removal of the structure. Utilities would essentially be disconnected from the structure but infrastructure such as power poles, water lines, sewer, etc. would remain in place.

Alternative 10, Alt 8 + Alt 1 + VD1: includes a combination of the 0.50 AEP floodplain buyout, channel modification (VC1), and detention basin (VD1).

Alternative 11, Alt 8 + Alt 1 + Alt 4: includes a combination of the 0.50 AEP floodplain buyout, channel modification (VC1), bridge modification (VB8), and detention basins VD1 and VD2.

Alternative 12, Alt 3 + Residual Risk 2-yr floodplain buyout: assumes the structural plan as the primary action that comes first; while the nonstructural action is secondary and protects the remaining structures not protected by the structural action. Alternative 12 includes alternative 3 (VD1+VD2+VD4), the structural plan with the highest mean net benefits, as the primary action; and the subsequently identifies

the residual risk structures for acquisition. Alternative 12 features a combination of three detention basins plus 39 residual risk structures for buyouts in the 0.50 AEP floodplain.

Alternative 13, Alt 1 + Residual Risk 2-yr floodplain buyout: selects structural plan alternative 1, which produces similar mean net benefits as alternative 3 but is less costly, as the primary action and then identifies the residual risk structures for acquisition. Alternative 13 features a combination of channel and bridge modification plus a buyout of the 0.50 AEP floodplain residual risk structures. The nonstructural action includes 79 structures.

To determine which structures were assigned for acquisition for Alternatives 8, 9, 10, and 11 the HEC-FDA FDA_StrucDetail.out output file for the FWOP condition was utilized. Specifically, any structure, excluding streets and vehicles, estimated by HEC-FDA to incur any amount of Total Damage during the FWOP 0.5 AEP flood event was assigned to be acquired with the implementation of Alternatives 8, 10 and 11. A similar process was undertaken for Alternative 9, where any structure incurring any amount of Total Damage during the 0.2 AEP flood event in the FWOP FDA_StrucDetail.out file was assigned for acquisition.

During the analysis of combination Alternatives 12 and 13, the FDA_StrucDetail.out file for the structural component of the alternative was referenced to designate the acquisition structures. Namely for Alternative 12, the Alternative 3 FDA_StrucDetail.out file was used, where the structures incurring Total Damages during the 0.5 AEP event were assigned for acquisition. To evaluate Alternative 13 the FDA_StrucDetail.out file corresponding with Alternative 1 was used to designate the structures assigned for acquisition.

1.4.1. Evaluation of Alternative Plans

Relevant data for each of the alternatives described above was entered into HEC-FDA and flood damages were calculated under the with-project conditions. The modeling results for each alternative are summarized as follows:

Alternatives 1 and 2 were removed from full consideration due to both alternatives reducing flood inundation depths only for the region of the study area within close vicinity of their implementation. The bridge and channel modifications are highly effective at generating benefits for the left bank residential structures from Murphys Lane upstream to 19th St. These two alternatives are especially effective at reducing flood inundation during the 0.4 and 0.01 AEP flood events. However, upstream and downstream of this localized area, spanning the majority of the study area, alternative 1 and alternative 2 have minimal reductions in overbank flood depths. Consequently, alternative 1 and 2 were screened from further consideration.

Alternative 8, 9, 10, 11, and 12 were screened from full consideration due to challenges in the NFS ability to implement acquisitions. Recent experience in executing buyouts in an adjacent watershed weren't well received by local residents. This has led the NFS to believe study area residents would be less than agreeable towards property acquisition. Of these plans Alternative 8 and 10 were estimated to have the highest mean net benefits, $700,000 and $648,000 respectively. Other more acceptable alternatives, with comparable mean net benefit estimates, were evaluated as part of the final array of alternatives.

Alternative 13 has a total first cost of $52.6 million and mean net benefits totaling $1.2 million. Alternative 13 is a combination alternative, entailing both structural and nonstructural actions.

The structural action involves channel and bridge modifications. The nonstructural action involves the acquisition of 79 structures that incur any flood inundation damages after the implementation of the alternative's structural action.

Alternative 4 is the NED and Recommended Plan. This alternative includes the implementation of two detention basins, VD1 and VD2. Preliminary H&H analysis of the 0.04 AEP event determined VD1 and VD2 individually were the most effective of the initially formulated detention basins at reducing

water surface profiles by zero to one foot for structures throughout the study area. With each detention basin reducing the 0.04 ACE flood water surface elevations by zero to one foot for approximately 1,800 structures. Conversely, these two basins were shown to be less effective at reducing stages between one and 3.5 feet for the 0.04 AEP event. With VD1 reducing stages within this range for less than ten structures and VD2 reducing such stages for zero structures. Furthermore, individually VD1 and VD2 were initially determined by H&H analysis to remove anywhere from 325 to 375 structures from the 0.04 ACE floodplain. See Appendix A: Engineering Valley Creek Flood Risk Management Study figures 4-24, 4-25, 4-26 for graphs depicting the referenced H&H analysis of the initially formulated detention basins.

When combined, VD1 and VD2 were found to have increased effectiveness at reducing 0.04 AEP stages between zero and one feet. Reducing named stages for a little under 4,000 structures, including building, streets, and automobiles. However, similarly to their individual performance, when combined VD1 and VD2 are less effective at reducing 0.04 AEP stages ranging one to 3.5 feet. Reducing such flood stages for less than ten structures. Alternative 4 has a total first cost of $29.3 million and generates nearly $1.2 million in net average annual benefits. This alternative is considered the NED Alternative.

1.5. Methodology

In order to develop plans to address water resource problems and opportunities within a study area, three conditions must be fully analyzed: the "existing" condition, the "future without project" condition, and the "future with project" condition.

In this analysis, the existing condition represents current floodplain conditions, which are the October 2019 (FY20) development and price levels. The future without project condition is the condition that would likely exist in the future without the implementation of a Federal project. This condition is evaluated for a 50-year period of analysis for urban flood risk management projects, and the results are expressed in terms of expected annual damages. The future without project condition (FWOP) is the time period starting 2023 and ending 2073. Note for this study the existing condition and future without project condition are identically characterized in the economical flood risk management analysis. Engineering data, including water surface profiles, and economic development assumptions are considered constant in all aspects from 2023 through to 2073. No firm plans for future economic development in the Valley Creek floodplain were discovered; while economic development undoubtedly will occur during the 50-year period of analysis, there is not enough information on or surety about specific planned developments to justify augmenting the structure inventory. The future with project condition (FWP) is the condition that would likely exist in the future with the implementation of a Federal project, using the same 50-year period as in the FWOP.

The primary benefit associated with a flood risk management project is the reduction in inundation damages to structures and their content. The difference in EAD to the study area properties between the FWOP and FWP represents flood damage reduction and is largely the basis of the project economic benefits.

Other economic and other significant outputs may accrue to the project as well, including recreation benefits, regional economic benefits, and other social effects. Other social effects, which often defy quantification in monetary terms, range from improvement in the quality of life within the study area to community impacts. This analysis attempts to recognize and, where possible, quantify the outputs of a Federal project in the study area.

1.5.1. Assumptions

This section of the analysis presents the assumptions used in computing average annual flood damages for the study area:

A. Real property will continue to be repaired to pre-flood conditions subsequent to each flood event.

B. The residential depth-percent damage relationships for structures and contents contained in Economic Guidance Memorandum #01-03, Generic Depth-Damage Relationships, 2000; and Economic Guidance Memorandum #04-01, Generic Depth-Damage Relationships for Residential Structures with Basements, 2003 are assumed to be representative of residential structures in the floodplain.

C. The depth-percent damage relationships for vehicles contained in Economic Guidance Memorandum #09-04, Generic Depth-Damage Relationships for Vehicles, 2009 are assumed to be representative of vehicles associated with residences in the floodplain.

D. Non-residential depth-percent damage relationships for structure and content are from expert elicitation found in the revised 2013 draft report; Nonresidential Flood Depth-Damage Function Derived from Expert Elicitation, April 2009; completed by the USACE Institute of Water Resources. Non- residential flood depth-damage functions (DDF) derived from expert elicitation are assumed to be representative of non-residential structures in the floodplain.

E. The Sewage Treatment DDF was provided to the PDT by USACE Mobile District, where the function was used as part of the economic analysis on an adjacent watershed. For the Valley Creek Study, the function was edited per conversations with the Jefferson County Deputy Director of Environmental Services Department to better reflect expert knowledge of historic flood inundation damages incurred by the Jefferson County Wastewater Treatment building.

F. The project's first costs and benefits will be annualized using the FY 2020 Federal discount rate of 2.75% assuming a period of analysis of 50 years.

G. The price level used in the economic analysis is FY 2020.

H. All project alternatives are evaluated for a 50-year period of analysis, spanning 2023 through 2073. Year 2023 is the base year.

1.5.2. Risk and Uncertainty Factors

Risk and uncertainty are inherent in water resources planning and design. These factors arise due to knowledge uncertainty and the innate natural variability of complex physical, social, and economic situations. The measured or estimated values of key planning and design variables are rarely known with certainty and can take on a range of possible values. Risk and uncertainty factors for specific variables are further described in Section 1.5.4, Modeling Variables.

1.5.3. Modeling Description

Risk-based economic analysis in flood-risk management projects is a technical task of balancing risk of design exceedance with flood damage reduced; trading off uncertainty of flood levels with design accommodations; and providing for safe, reasonably predictable project performance. Risk-based analysis is therefore a methodology that enables aspects of risk and uncertainty to be included in project formulation. The risk-based economic software product known as HEC-FDA version 1.4.2 (April 2016) was used in this analysis. This software is a product of the USACE and was created by the Corps' Hydrologic Engineering Center in Davis, California. HEC-FDA is a certified model used nationally within the Corps for flood damage analysis. It is a frequency-based model, relating expected flood damages to flood frequency and incorporating a multitude of variables.

1.5.4. Modeling Variables

Uncertainty was quantified for errors in the underlying components of the stage-damage relationship: structure values for residential and nonresidential structures, vehicle values for residential structures, depth-percent damage relationship for both residential and nonresidential structures, content to structure

value ratios for residential and nonresidential structures, and first-floor elevations for all structures in the study area.

A. **Residential and Nonresidential Structural Values -** Structure values are crucial sources of uncertainty in the stage-damage relationship. Structure values play an important role in determining the dollar value of damage caused by a given depth of flooding in the structure itself, both to the structure itself and the contents of the structure. In this analysis, all of the existing structure values were obtained from the Jefferson County Tax Assessor's Office. Based on information collected by the tax assessor the retrieved value per structure, residential and nonresidential, in the study area was the replacement new value. This replacement new structure value represented the value to construct a new structure identical to the original building's construction characteristics and in the same location. Replacement new values are exclusive of land values. Replacement new structure values originally retrieved from county database were FY 19 price levels. The FY 19 residential and nonresidential structure values were escalated to FY 20 price levels using a Civil Works Construction Cost Index System composite index of all accounts factor of 1.0293, computed with an start date average annual factor for the year 2019 and end date average annual factor for the year 2020. Corps planning guidance requires structures to be valued in terms of depreciated replacement value. Also called current cash value, depreciated replacement value is the cost today to replace an asset (building, a piece of equipment, etc.) with another object of the same type, function, and condition. A depreciated replacement value was estimated through the application of a RSMeans depreciation percentage, based on a mix of a windshield survey and a Google Earth street view inspection of each structure's physical condition. Depreciation percentages applied to structures ranged from zero to 80 percent, with an average depreciation percentage of 38 percent. November 2018 PDT Economists conducted a windshield survey of structures within areas preliminarily assessed to incur repetitive losses. During the survey Economists noted the general condition of structures in the delineated repetitive loss areas. Structures not assessed during the 2018 windshield survey were visually inspected using Google Earth street view.

1. See Table 13: Valley Creek Structure First Floor, Structure Value, and CSRV Uncertainty Values for the uncertainty distributions applied to residential and non-residential structures value. All structures in the structure inventory were assigned normal distributions to capture the uncertainty about the structure value, with standard deviations ranging from 5 to 20 percent.

B. **Vehicle Inventory and Values -** Based on the 2016 American Community Survey's 5-year estimates for the Birmingham-Hoover, Alabama, metropolitan area, it was determined that the average household had 1.48 vehicles available. Economic Guidance Memorandum, 09-04, Generic Depth-Damage Relationships for Vehicles states that the average percentage of people who do not move vehicles to higher ground during flooding events is 49.5% during flood events with warning times of six hours or less. That is, 49.5% of vehicles remain in the area of flooding and are exposed to flood damages. According to the Edmunds 2018 Used Vehicle Market Report, the national average price of a used vehicle was $20,085. Since only 49.5% of vehicles remain susceptible to damage during a flood event, an FY 19 value of $14,714 (1.48*$20,085*0.495) was assigned to each residential structure. This value was escalated to FY 20 price levels using a Civil Works Construction Cost Index System composite index of all accounts factor of 1.0293, computed with an start date average annual factor for the year 2019 and end date average annual factor for the year 2020, calculating a FY 20 vehicle value of $15,145. Vehicle damages were only calculated for residential properties and not applied to nonresidential properties such as warehouses or offices.

1. Uncertainty surrounding the structure values assigned to the vehicles in the inventory was determined using a normal probability distribution function, with a standard deviation of 10%.

C. **Streets Value –** Streets values used were depreciated replacement construction costs per mile based on state transportation of department estimates, with consideration for two classes of streets, two

lane collector and four lane freeway.

The two-lane collector estimate was based on the average of two estimates from Florida Department of Transportation and Arkansas Department of Transportation (DoT). A Florida DoT estimated two lane collector cost of FY 16 $1,904,448 was depreciated by 65%, computing a price of FY 16 $1,237,891, and escalated to FY 20 $1,411,759 using the Roads, Railroads, & Bridges (CWCCIS 08) index factor of 1.1405, with a beginning date of December 2015 and ending date 13, 2020. An Arkansas DoT two lane collector estimate of FY 14 $2,100,000 was depreciated by 65%, computing an estimate FY 14 $1,365,000, and escalated to FY 20 $1,566,253 using the Roads, Railroads, & Bridges (CWCCIS 08) index factor of 1.1474. The Florida and Arkansas per mile construction cost estimates, FY 20 $1,411,759 and $1,566,253 respectively, were averaged computing the $1,489,066 two lane collector per mile construction cost used in the economic analysis.

The four-lane freeway FY 20 $6,563,347 estimate was calculated from Arkansas DoT FY 14 $8,800,000 value depreciated by 65% to FY 14 $5,720,000, and then escalated to FY 20 with the application of Roads, Railroads, & Bridges (CWCCIS 08) index factor of 1.1474.

1. Uncertainty surrounding the values assigned to streets in the inventory was determined using a normal probability distribution function, with a standard deviation of 30%. Flood damage potential for streets is minimal in comparison to the flood damages potential for structures.

D. **Residential Depth-Damage Curves -** The structure and content DDF relate flood damage as a percent of the value of the structure or contents at various depths of flooding above the first floor elevation. These functions are contained in Economic Guidance Memorandum #01-03, Generic Depth-Damage Relationships, 2000; and Economic Guidance Memorandum #04-01, Generic Depth-Damage Relationships for Residential Structures with Basements, 2003 are based on post-flood surveys administered through the Corps of Engineers' Institute for Water Resources. The functions show strong correlations between depth of flooding and percent of value in structure damage. The residential structures in the Valley Creek floodplain are represented by these curves. Moreover, both EGMs included a normal distribution function with an associated standard deviation of damage to account for uncertainty surrounding the damage percentage associated with each depth of flooding.

E. **Nonresidential Depth-Damage Curves -** The structure and content DDF relate flood damage as a percent of the value of the structure or contents at various depths of flooding above the first- floor elevation. The depth-damage function are shown in Table 12: Valley Creek Residential and Non-residential Depth Damage Functions. In 2008, the Federal Emergency Management Agency (FEMA) contracted to have an expert elicitation panel derive nonresidential content-to-structure value ratios and flood depth-damage functions for 21 of the most commonly affected categories of nonresidential properties. USACE Institute for Water Resources (IWR) fully participated in the planning, process, implementation, and analysis of the results. The functions show strong correlations between depth of flooding and percent of value in structure damage. The vast majority of the nonresidential structures in the Valley Creek floodplain are represented by these curves.

1. The Sewage Treatment DDF was sourced from the Mobile District Village Creek economic analysis. Subsequently, the function was edited for use in Valley Creek economic analysis.

Table 12. Valley Creek Estimated Property Damage percentage by Flood Depth in Feet.

Depth Damage Description	-8 ft	-6 ft	-4 ft	-2 ft	-1 ft	0	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	8 ft	10 ft	12 ft	14 ft	16 ft
Commercial Hospital	0	0	0	0	0	2%	12%	17%	22%	26%	30%	30%	32%	48%	52%	52%	52%
Commercial Airport	0	0	0	0	0	0	17%	17%	20%	23%	27%	28%	32%	40%	40%	43%	59%
Commercial Airport Hangers	0	0	0	0	0	0	17%	17%	20%	23%	27%	28%	32%	40%	40%	43%	59%
Commercial Church	0	0	0	0	0	0	10%	11%	11%	12%	12%	13%	14%	17%	24%	38%	52%
Commercial Manufacturing	0	0	0	0	0	5%	7%	9%	12%	28%	42%	48%	55%	58%	58%	58%	58%
Commercial Medical Office	0	0	0	0	0	0	1%	2%	2%	3%	4%	6%	11%	17%	25%	33%	42%
Commercial Motel	0	0	0	0	0	0	4%	7%	10%	12%	15%	18%	26%	37%	50%	61%	69%
Commercial Museum	0	0	0	0	0	0	17%	17%	20%	23%	27%	28%	32%	40%	40%	43%	59%
Commercial Office	0	0	0	0	0	0	12%	14%	17%	19%	23%	27%	35%	45%	55%	63%	71%
Commercial Restaurant	0	0	0	0	0	0	15%	18%	20%	23%	25%	27%	30%	37%	50%	64%	72%
Commercial Fast Food	0	0	0	0	0	0	15%	18%	20%	23%	25%	27%	30%	37%	50%	64%	72%
Commercial Retail, Mixed	0	0	0	0	0	0	%3	7%	7%	7%	9%	11%	17%	23%	30%	37%	44%
Commercial Service Station	0	0	0	0	0	0	0	1%	3%	5%	7%	10%	16%	23%	33%	49%	69%
Commercial Service/Shop	0	0	0	0	0	0	8%	9%	10%	12%	15%	17%	18%	20%	26%	33%	43%
Commercial Vacant Masonry	0	0	0	0	0	2%	12%	17%	22%	26%	30%	30%	32%	48%	52%	52%	52%
Commercial Vacant Metal	0	0	0	0	0	1%	12%	17%	20%	24%	26%	26%	30%	36%	36%	36%	36%
Commercial Vacant Wood/Steel	0	0	0	0	0	1%	18%	27%	31%	37%	45%	45%	48%	52%	55%	55%	55%
Commercial Warehouse	0	0	0	0	0	0	0	1%	1%	1%	3%	5%	12%	16%	26%	38%	51%
Public Library	0	0	0	0	0	0	1%	2%	2%	2%	3%	4%	8%	12%	20%	32%	50%
Public Post Office	0	0	0	0	0	0	8%	9%	10%	12%	15%	17%	18%	20%	26%	33%	43%
Public Power Utility	0	0	0	0	0	1%	6%	7%	30%	50%	100%	100%	100%	100%	100%	100%	100%
Public School	0	0	0	0	0	0	8%	12%	15%	15%	16%	17%	22%	28%	36%	45%	54%
Public Sewage Treatment	0	0	0	0	0	0	12%	16%	21%	27%	34%	42%	59%	77%	97%	97%	97%
Public Street	0	0	0	0	0	0	1%	2%	2%	3%	3%	4%	6%	8%	20%	25%	30%
Public Utility Company	0	0	0	0	0	0	0	0	10%	14%	18%	22%	30%	36%	40%	45%	50%

Depth Damage Description	-8 ft	-6 ft	-4 ft	-2 ft	-1 ft	0	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	8 ft	10 ft	12 ft	14 ft	16 ft
Residential 15NB	0	0	0	0	3%	11%	19%	27%	33%	39%	45%	50%	58%	65%	69%	73%	75%
Residential 15WB	1%	1%	5%	12%	17%	22%	27%	33%	39%	45%	50%	56%	65%	73%	76%	78%	79%
Residential 1NB	0	0	0	0	3%	13%	23%	32%	40%	47%	53%	59%	67%	73%	77%	80%	81%
Residential 1STY Apartment	0	0	0	0	0	1%	8%	14%	18%	22%	25%	28%	30%	36%	45%	54%	60%
Residential 1WB	0	1%	5%	14%	19%	26%	32%	39%	46%	52%	59%	65%	74%	80%	81%	81%	81%
Residential 2NB	0	0	0	0	3%	9%	15%	21%	26%	31%	36%	41%	49%	56%	61%	66%	69%
Residential 2STY Apartment	0	0	0	0	0	1%	8%	14%	18%	22%	25%	28%	30%	36%	45%	54%	60%
Residential 2WB	2%	2%	5%	10%	14%	18%	22%	27%	32%	37%	42%	47%	56%	65%	71%	75%	76%
Residential Duplex	0	0	0	0	0	1%	8%	14%	18%	22%	25%	28%	30%	36%	45%	54%	60%
Residential Mobile Home	0	0	0	0	0	8%	44%	63%	73%	78%	80%	81%	82%	82%	82%	82%	82%
Residential Outbuilding	0	0	0	0	0	1%	18%	27%	31%	37%	45%	45%	48%	52%	55%	55%	55%
Residential SPL NB	0	0	0	0	6%	7%	9%	13%	17%	23%	29%	36%	49%	63%	74%	82%	84%
Residential SPL WB	0	3%	5%	10%	14%	19%	23%	28%	33%	39%	44%	49%	58%	65%	69%	69%	69%
Residential Vehicles	0	0	0	0	0	0	25%	43%	59%	72%	84%	93%	99%	100%	100%	100%	100%

F. **Residential Content-to-Structure-Value Ratio (CSVR) -** The CSVRs for residential structures included in this report were referenced from the EGM 01-03 and 04-01, which also included the residential DDFs. Moreover, both EGMs contained guidance to account for uncertainty associated with the residential CSVR, which implies the uncertainty in the CSVR should be inherent in the content depth-damage relationship as contained in both respective EGMs. Per the EGMs the CSVR for the majority of residential DDFs is 100%. Functions with differing CSRV of 35% are applied to mobile homes and multi-family residences such as: duplexes and apartment buildings.

G. **Nonresidential Content to Structure Value Ratio -** The nonresidential CSVR included in this report were derived from the same 2008 FEMA expert elicitation panel that constructed the nonresidential DDFs. Relevant nonresidential depth damage curves have a CSVR of 35%. Vacant structures and streets do not have CSVR assigned, due to the overarching structure not containing contents. Additionally, the commercial hospital DDF has a CSVR of 43.9%. Most of the CSVR have a normal distribution to account for the uncertainty surrounding the ratios. The commercial hospital occupancy CSVR uncertainty is characterized by a triangular distribution having a minimum, maximum, and most likely percentage of 35%, 50%, and 43.9% respectively. The residential and nonresidential CSVRs included in this report are detailed in Table 13: Valley Creek Structure First Floor, Structure Value, and CSVR Uncertainty Values

Table 13. Valley Creek Structure First Floor, Structure Value, and CSVR Uncertainty Values.

Depth Damage Description	First Floor Uncertainty Distribution Type	First Floor Uncertainty Std Dev	Structure Value Uncertainty	Structure Value Uncertainty Std Dev	CSVR Distribution Type	CSRV	CSVR Std Dev	
Commercial Hospital	Normal Distribution	0.7	Normal Distribution	20	*Triangle Distribution	43.9%	35	50
Commercial Airport	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Commercial Airport Hangers	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Commercial Church	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Commercial Manufacturing	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Commercial Medical Office	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Commercial Motel	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Commercial Museum	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Commercial Office	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Commercial Restaurant	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Commercial Fast Food	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Commercial Retail, Mixed	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Commercial Service Station	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Commercial Service/Shop	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Commercial Vacant Masonry	Normal Distribution	0.7	Normal Distribution	20	N/A			
Commercial Vacant Metal	Normal Distribution	0.7	Normal Distribution	20	N/A			
Commercial Vacant Wood/Steel	Normal Distribution	0.7	Normal Distribution	20	N/A			
Commercial Warehouse	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Public Library	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Public Post Office	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Public Power Utility	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Public School	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Public Sewage Treatment	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Public Street	Normal Distribution	0.3	Normal Distribution	30	N/A			
Public Utility Company	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	9.2	
Residential 15NB	Normal Distribution	0.7	Normal Distribution	20	Normal Distribution	100%		
Residential 15WB	Normal Distribution	0.7	Normal Distribution	20	Normal Distribution	100%		
Residential 1NB	Normal Distribution	0.7	Normal Distribution	20	Normal Distribution	100%		
Residential 1STY Apartment	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	15.8	
Residential 1WB	Normal Distribution	0.7	Normal Distribution	20	Normal Distribution	100%		
Residential 2NB	Normal Distribution	0.7	Normal Distribution	20	Normal Distribution	100%		
Residential 2STY Apartment	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	15.8	

Depth Damage Description	First Floor Uncertainty Distribution Type	First Floor Uncertainty Std Dev	Structure Value Uncertainty	Structure Value Uncertainty Std Dev	CSVR Distribution Type	CSRV	CSVR Std Dev	
Residential 2WB	Normal Distribution	0.7	Normal Distribution	20	Normal Distribution	100%		
Residential Duplex	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	15.8	
Residential Mobile Home	Normal Distribution	0.03	Normal Distribution	5	Normal Distribution	35%	15.8	
Residential Outbuilding	Normal Distribution	0.7	Normal Distribution	20	Normal Distribution	100%	50	
Residential SPL NB	Normal Distribution	0.7	Normal Distribution	20	Normal Distribution	100%		
Residential SPL WB	Normal Distribution	0.7	Normal Distribution	20	Normal Distribution	100%		
Residential Vehicles	Normal Distribution	0.5	Normal Distribution	10	N/A			

Note: *Triangle distribution is characterized by a minimum and maximum value. Normal Distributions are characterized by a standard deviation CSVR = Content-to-Structure-Value Ratio

First Floor Elevations – Topographical data was obtained from the Light Detection and Ranging (LIDAR) survey conducted in April and August 2013 for the study area and used to determine the ground elevations, in datum North American Vertical Datum 1988 (NAVD88), at the centroid of each parcel where the structure is most likely located. This is the same datum used in the H&H analysis. Google Maps street view visual inspections were conducted in 2018 to estimate the finished floor height above ground elevation per structure in the study area.

The finished floor height was estimated as the elevation at the bottom of each residential structure's front door, and nonresidential structure's main entryway. To estimate the elevation of the finished floor height, each step leading up the front door or main entryway was counted and assumed to equal eight inches. The number of steps was then summed, multiplied by eight, and divided by twelve (converting inches to feet) to estimate the finished floor height in feet.

The sum of the ground elevation, as determined by LIDAR, and the estimated finished floor height comprised the assigned first floor elevation per structure, is considered the lowest opening elevation. Vehicles were assigned to the ground elevation of the adjacent residential structures. Streets were assigned first floor elevations equal to the LIDAR elevation of the centroid structure location. During the visual inspection it was noted multiple residential structures had window well openings below the bottom elevation of the front door. For such structures the elevation to the bottom of the window well was estimated and considered the finished floor elevation.

First Floor Elevations Uncertainty – First floor elevation uncertainty factors were assigned a standard deviation, ranging from 0.03 to 0.7 feet, around a normal distribution. The first floor elevation uncertainty range was based on Table 6-5 of Engineering Manual No. 1110-2-1619, Risk-Based Analysis for Flood Damage Reduction Studies, 1996 which recommends an uncertainty associated with conventional level field survey estimations of 0.03 feet and aerial survey uncertainty up to 1.5 feet. Since Google Earth street view enables the close aerial examination of first floor elevations, a 0.7 feet upper limit uncertainty is reasonable per the EM recommendation. See Table 13: Valley Creek Structure First Floor, Structure Value, and CSVR Uncertainty Values for each depth-damage function uncertainty distribution type and assigned first floor elevation standard deviation.

The structure inventory used in the economic analysis must comply with Section 308 of the Water Resources Development Act (WRDA) 1990, which requires that structures built after July 1991 with first-floor elevations below the 0.01 AEP flood stage cannot be included in the benefits analysis for a study. All the structures included within the structure inventory used for the economic analysis are compliant with this regulation.

1.5.5. Rough Order of Magnitude (ROM) Costs

Continuing the evaluation process, ROM first cost estimates were developed for each alternative as described above. The ROM costs were provided by the PDT Cost Engineer in FY 2020 prices. For comparison to benefits, which are average annual flood damages reduced, the ROM first costs were stated in average annual terms using the current Federal discount rate of 2.75% and a 50-year period of analysis. Interest during construction (IDC) was added to the ROM total project first costs, assuming a design and construction period of one year. Next annual operation and maintenance (O&M) costs per alternative were computed and included. The following Table 14: Initial Array of Alternatives First (FC) and Annual Costs (AC) displays the results of the costs calculation and was utilized to better inform the comparison and screening process of the initial array of alternatives. The structural, non-structural, and combination structural and non-structural alternatives ROM first cost estimates were annualized using the same discount rate, period of analysis, and anticipated IDC period. See Appendix D Cost Engineering section 5.2 Nonstructural Acquisition Costs for details on the cost estimate considerations associated with acquisitions. It should be noted that the first cost of $3,452,100 for the recreation component was included in the ROM first cost of Alternative 4.

Table 14. Initial Array of Alternatives First (FC) and Annual Costs (AC).

Alternative	FC Construction	FC Real Estate	FC PED	FC S&A	FC Escalation	FC Contingency	FC Total Project First Cost	AC Interest During Construction	AC O&M	Total Average AC
Structural Alternatives										
Alternative 1	$5,058	$25	$774	$310	$103	$2,186	$8,457	$349	$30	$356
Alternative 2	$5,933	$50	$908	$363	$121	$2,564	$9,940	$410	$45	$428
Alternative 3	$27,049	$4,009	$4,364	$1,746	$582	$12,321	$50,070	$2,065	$75	$2,006
Alternative 4	$16,444	$3,085	$2,741	$1,096	$365	$7,738	$31,469	$1,298	$50	$1,264
Alternative 5	$21,502	$3,110	$3,515	$1,406	$468	$9,924	$39,926	$1,647	$80	$1,620
Alternative 6	$22,377	$3,135	$3,649	$1,460	$486	$10,302	$41,409	$1,708	$95	$1,692
Alternative 7	$32,107	$4,034	$5,138	$2,055	$685	$14,507	$58,526	$2,414	$105	$2,362
Nonstructural Alternatives										
Alternative 8	$12,924	$32,143	$1,978	$791	$264	$5,585	$53,685	$2,214	$0	$2,071
Alternative 9	$29,176	$44,081	$4,466	$1,786	$595	$12,608	$92,713	$3,824	$0	$3,576
Structural + Nonstructural Alternatives										
Alternative 10	$23,771	$33,751	$3,744	$1,498	$499	$10,571	$73,833	$3,046	$55	$2,903
Alternative 11	$34,426	$35,252	$5,493	$2,197	$732	$15,509	$93,610	$3,861	$80	$3,690
Alternative 12	$32,030	$16,397	$5,126	$2,051	$683	$14,473	$70,761	$2,919	$75	$2,804
Alternative 13	$15,694	$26,476	$2,402	$961	$320	$6,782	$52,635	$2,171	$30	$2,060

Note: Period of Analysis: 50 years, October 2019 FY(20) price level, Values displayed in $1,000's, Interest Rate 2.75%

1.5.6. Results of the Analysis

The expected average annual benefits were compared to the average annual cost to develop net benefits and a benefit-to-cost ratio (BCR) for each alternative. The net benefits for each alternative were calculated by subtracting the average annual costs from the equivalent average annual benefits, and a BCR was derived by dividing average benefits by average annual costs. Net benefits were used for identification of the NED plan in accordance with the Federal objective. For comparative purposes, the following table summarizes the equivalent annual damages (benefits), average annual costs, total first cost, net benefits, and BCR for each alternative.

The annual mean net benefits indicate the efficiency of each alternative. The annual mean benefit (effectiveness) and annual mean net benefit (efficiency) were used for comparison of alternatives but ultimately the National Economic Development (NED) plan is the plan that reasonably maximizes the annual mean net benefits.

Table 15 presents the benefit-cost analysis results for the initial array of alternatives. Alternative 13 maximizes the annual mean net benefits (Table 15). This alternative includes channel modification and bridge modification at Murphys Lane. Nearly 80 structures are identified as residual risk structures to be acquired with moving assistance provided to those impacted families. Due to the requirement for 100% participation this and other large scale buyouts would be difficult to implement and potentially locally unacceptable.

Table 15. Valley Creek Economic Analysis Results per Alternative.

Alternative	Description	Total First Cost	Annual O&M	Annual Total Cost	Annual Mean Benefit	Annual Mean Net Benefit	Mean BCR
No Action	No Action Expected Annual Damages	N/A	N/A	N/A	$6,824	N/A	N/A
Structural Alternatives							
Alternative 1	VC1 + VB8	$8,457	$30	$356	$976	$619	2.74
Alternative 2	VC1 + VB8 + VB9	$9,940	$45	$428	$1,008	$579	2.35
Alternative 3	VD1 + VD2 + VD4	$50,070	$75	$ 2,006	$2,717	$711	1.35
Alternative 4	VD1 + VD2	$31,469	$50	$1,264	$1,701	$437	1.35
Alternative 5	Alt1 + Alt4	$39,926	$80	$1,620	$1,989	$369	1.23
Alternative 6	Alt2 + Alt4	$41,409	$95	$1,692	$2,030	$338	1.20
Alternative 7	Alt1 + Alt3	$58,526	$105	$ 2,362	$ 2,865	$503	1.21
Nonstructural Alternatives							
Alternative 8	Nonstructural 2-yr BO	$53,685	-	$2,071	$2,771	$700	1.34
Alternative 9	Nonstructural 5-yr BO	$92,713	-	$3,576	$4,106	$530	1.15
Structural + Nonstructural Alternatives							
Alternative 10	Alt8 + Alt1 + VD1	$73,833	$55	$2,903	$3,540	$638	1.22
Alternative 11	Alt8 + Alt1 + Alt4	$93,610	$80	$3,690	$3,907	$ 217	1.06
Alternative 12	Alt3 + Residual Risk 2-yr BO	$70,761	$75	$2,804	$3,094	$290	1.10

Alternative 13	Alt1 + Residual Risk 2-yr BO	$52,635	$30	$2,060	$3,266	$1,206	1.59

Note: October 2019 FY(20) price level, Period of Analysis: 50 years, Interest Rate 2.75%, Values displayed in $1,000's.

1.5.7. Screening Process

Alternative 3, the plan with the next highest annual mean net benefit, includes construction of three detention basins, VD1, VD2 and VD4, is effective and has slightly less first cost compared to the NED at approximately $50 million. Alternative 10 includes acquisition of approximately 100 frequently damaged structures by the 0.50 AEP. This plan is very effective but extremely costly, $21 million more than the NED at approximately $74 million. Alternative 1 is very similar to Alternative 3 in terms of net benefits but considerably less costly than Alternative 3 at approximately $8.5 million first cost. However, Alternatives 1 is also considerably less effective than Alternative 3 as the effects are localized to the neighborhoods near the channel and bridge modification of Murphys Lane.

Three plans with the next highest annual mean net benefits are Alternatives 8, 10, and 1. The annual mean net benefits of these plans are very similar and considered "indistinguishable" given the level of accuracy and refinement available during evaluation of the initial array. Alternative 8 with acquisition of approximately 100 frequently damaged structures by the 0.50 AEP. Though the annual mean net benefits are lower than the NED, it is a more effective plan but costs approximately $54 million total first cost. Again, an plans involving large scale buyouts with 100% required participation would be difficult to implement and potentially locally unacceptable.

Plans must meet the four criteria established in Principles & Guidelines: Effectiveness, completeness, efficiency, and acceptability. Large-scale buyouts require 100-percent participation. Homeowners or businesses within the buyout area who do not wish to participate would be subject to condemnation, resulting in extreme negative public sentiment and devastating impacts to the community. Therefore, any plans involving large-scale buyouts fail to meet the U.S. Water Resources Council Principles and Guidelines (P&G) standard of acceptability. Such plans were considered, however, to better understand the costs and benefits, even if such plans were purely hypothetical and would never be implemented. The "no action" alternative does not meet the four criteria but is shown for comparison and to illustrate the extent to which the various alternatives address the problems.

Alternative 1 benefits are very isolated at the downstream end of the study area and fails to contribute anything along the corridor lacking a comprehensive plan.

Main Report Table 5-4 summarizes the evaluation of the initial array of alternatives against the four criteria described previously: effectiveness, efficiency, completeness, and acceptability. The non-federal sponsors have expressed concern over the difficulty with implementing a large acquisition plan. A large-scale acquisition/buyout would have devastating effects on communities.

The sponsors have experience with implementing acquisition plans, most notably on an adjacent watershed (Village Creek) through Public 99-662 Section 401. Based on sponsor's experience and limited availability of decent, safe and sanitary housing, it is highly unlikely for an acquisition plan requiring 100% participation to be locally acceptable.

Alternatives 1, 3, and 7 produce reasonable net benefits and do not include a nonstructural acquisition plan. Array of alternatives for further consideration listed in order of annual mean net benefits from highest to lowest is Alternative 3, Alternative 1, and Alternative 7 with Alternative 13 retained for comparison.

1.5.8. Refined Array of Alternatives

Refined alternatives from evaluation and comparison to the refined array are listed in order of annual mean net benefits from highest to lowest. Alternative 3, initially identified as the TSP, was the locally preferred plan which cost less than Alternative 13, the plan with the highest net benefit. Table 16 lists the refined array of alternatives.

Table 16. Refined Array of Alternatives.

Alternative	Description	Annual Mean Net Benefit
Alternative 13	Channel and Bridge Modification plus residual risk 2-yr floodplain buyout (~79 structures)	$1,206
Alternative 3	Detention Basins VD1, VD2, VD4	$711
Alternative 1	Channel and Bridge Modification VC1, VB8	$619
Alternative 7	Channel and Bridge Modification plus Detention Basins VD1, VD2, VD4	$503

Note: October 2019 FY(20) price level, Period of Analysis: 50 years, Interest Rate 2.75%, Values displayed in $1,000's.

1.5.9. Final Array of Alternatives

An error was discovered during the review process which affected only those alternatives including VD2, causing induced damages to be counted when none existed. Alternatives 1 and 7 were screened since channel and bridge modification was found to not be incrementally justified. Costs increased for Alternative 13 due to updated real estate costs. Costs decreased for alternatives 3 and 4 due to refinement of the haul distance for excess materials. The error was corrected prior to the ADM and resulted in the following corrected figures and demonstrating Alternative 4 to be the NED plan. Alternative 4 was endorsed by the vertical team during the ADM and is therefore considered the Recommended Plan.

Table 17. Final Array of Alternatives.

Alternative	Description	Total First Cost	Total Investment Cost	Annual O&M	Total Annual Cost	Annual Mean Benefit	Annual Mean Net Benefit	BC Ratio
No Action	FWOP Expected Annual Damages		N/A	N/A	N/A	($6,284)	N/A	N/A
Alternative 3	VD1+VD2+VD4	$45,065	$46,924	$75	$1,783	$2,717	$904	1.50
Alternative 4	VD1+VD2 (Corrected)	$29,035	$30,233	$50	$1,150	$2,203	$1,033	1.88
Alternative 13 Original NED	Alt 1 + Residual Risk 2-yr Buyout	$59,346	$61,794	$30	$2,319	$3,266	$947	1.41

Notes: Total First Cost only includes construction costs
Total Investment Costs include IDC
No Action Annual Mean Benefit are negative benefits. As they are an estimate of damages occurring.
October 2019 (FY20) price level, FY20 Federal Interest rate of 2.75%, 50-year period of analysis, Values displayed in $1,000s.

1.6. Recommended Plan

Tables 18, 19, and 20 display the number of structures damaged by probability event, total damages by probability event, and reduced damages by probability event, respectively, for the Recommended Plan Alternative 4 considering only FRM. Table 18 presents the single event damages without uncertainty, and includes damages incurred by buildings, streets, and automobiles within the project study area specified AEP event.

Cost and benefit values detailed in prior sections of this appendix were displayed at the FY 20 price level. It should be noted subsequent sections of this document will present cost and benefit values at a different price level, FY 22. This is the current price level at the drafting of the later sections of this document. Cost estimates were updated by NWK Cost Engineering. Benefit values for the Recommended Plan were updated using the CWCCIS, Account 19 (Buildings, Grounds, and Utilities) index factor of 1.055, with an index factor start date of October 2020 and end date of October 2021. The average annual costs and benefits were annualized using a FY 22 interest rate of 2.25 percent over a 50-year period of analysis.

Table 18. Number of Structures Damaged by Probability Event, Single Event Numbers.

Alternative	AEP 0.5	AEP 0.2	AEP 0.1	AEP 0.04	AEP 0.02	AEP 0.01	AEP 0.004	AEP 0.002
FWOP	208	680	1,151	2,015	2,517	3,033	3,546	4,061
Alternative 4	121	410	851	1,615	2,216	2,804	3,387	3,987

*AEP = Exceedance Probability Event.
Includes Buildings, Streets, and Automobiles

Table 19. FWOP and Alternative 4 Total Damages by Probability Event, Single Event Damages.

Alternative	AEP 0.5	AEP 0.2	AEP 0.1	AEP 0.04	AEP 0.02	AEP 0.01	AEP 0.004	AEP 0.002
FWOP								
Residential	$655	$3,319	$6,560	$14,641	$20,182	$25,870	$32,512	$40,843
Commercial	$970	$3,429	$5,399	$7,536	$8,749	$10,153	$11,948	$13,892
Public	-	-	$2	$259	$463	$616	$1,451	$27,339
Streets	$157	$482	$841	$1,429	$1,829	$2,227	$2,744	$3,409
Vehicles	$124	$644	$1,547	$4,090	$6,043	$7,885	$10,134	$13,016
FWOP Total	$1,908	$7,876	$14,351	$27,958	$37,268	$46,753	$58,792	$98,502
Recommended Plan Alternative 4								
Residential	$300	$1,746	$4,350	$10,362	$16,622	$23,095	$30,889	$40,978
Commercial	$158	$2,146	$3,758	$6,035	$7,136	$8,434	$10,016	$12,261
Public	-	-	$2	$72	$368	$562	$1,084	$11,655
Streets	$103	$325	$607	$1,155	$1,579	$2,047	$2,570	$3,394
Vehicles	$61	$368	$946	$2,657	$4,763	$6,914	$9,419	$12,742
Alternative 4 Total	$624	$4,587	$9,665	$20,283	$30,471	$41,053	$53,980	$81,032

*AEP = Exceedance Probability Event.

Notes: October 2021 FY(22) price level, Period of Analysis: 50 years, Values displayed in $1,000's, Interest Rate 2.25%

Table 20. Alternative 4 Total Damages Reduced by Probability Event, Single Event Damages.

Alternative	AEP* 0.5	AEP 0.2	AEP 0.1	AEP 0.04	AEP 0.02	AEP 0.01	AEP 0.004	AEP 0.002
Residential	$355	$1,573	$2,210	$4,279	$3,560	$2,775	$1,623	$(135)
Commercial	$812	$1,283	$1,641	$1,501	$1,613	$1,719	$1,932	$1,631
Public	-	-	$(0)	$187	$95	$54	$367	$15,684
Streets	$54	$157	$234	$274	$250	$180	$174	$15
Vehicles	$63	$276	$601	$1,433	$1,280	$971	$715	$274
Alternative 4 Total Damages Reduced	$1,284	$3,289	$4,686	$7,674	$6,798	$5,699	$4,811	$17,469

*AEP = Exceedance Probability Event.
Notes: October 2021 FY(22) price level, Period of Analysis: 50 years, Values displayed in $1,000's, Interest Rate 2.25%

1.6.1. Total Project Costs Considering Only FRM

Following the selection of the Recommended Plan the ROM first costs estimates were refined for Alternative 4, considering only FRM, and are summarized by account in Table 21. The total project first cost for the Recommended Plan FRM components, in 1 October 2021 FY 22 dollars, is $27,130,000.

Table 21. Recommended Plan Alternative 4 Total Project First Costs Considering Only FRM.

Account	Item Description	Cost
01	Lands & Damages	$2,485
02	Relocations	$1,643
06	Fish & Wildlife Mitigation	$347
15	Floodway Control & Diversion Structure	$16,900
30	Planning, Engineering & Design	$3,597
31	Construction Management	$2,158
	Total Project First Cost	$27,130

Note: October 2021 FY(22) price level, Values displayed in $1,000.

1.6.2. Annual Cost Considering Only FRM

The total annual cost for the recommended plan considering only FRM, in 1 October 2021 FY 22 prices and at the 2.25 percent interest rate over a 50-year period of analysis, is $1,014,000. Included in the annual cost calculations is an estimated interest during construction (IDC) of approximately $1,644,000.

The IDC costs are considered costs incurred during the construction period increased by adding compound interest at the applicable compound discount rate from the date the expenditures are

incurred to the beginning of the period of analysis, using uniform, middle-of-period payments. The construction period is assumed to span 69 months, starting August 2022 and ending April 2028. Planning, Engineering, and Design (PED) and PED contingency actions are expected to be expended equally during the first 19 months, construction period months one through 19, followed by the expenditure over the next month of Real Estate actions, construction period month 20. During the remaining 49 months of construction, sequential construction period months 21 through 69; construction, construction supervision and administration (S&A), and construction contingency costs are assumed to be equally incurred per month. See the Valley Creek Integrated Report section 7.8.2 Implementation Schedule for further details on the project's PED and construction schedule.

Table 22. Recommended Plan Alternative 4 Annual Costs Considering Only FRM.

Item Description	Cost
Total Project First Cost	$27,130
Interest During Construction	$1,644
Total Investment Cost	$28,774
Interest & Amortization Factor	0.03352
Annual Costs subtotal	$964
Annual OMRR&R	$50
Total Annual Cost	$1,014

Note: October 2021 FY(22) price level, Period of Analysis: 50 years, Values are displayed in $1,000's, Interest Rate 2.25%

Table 23. Alternative 4 Interest During Construction.

Construction Period (months)	Cost Expenditures	Cost ($1)	Interest Factor	Interest During Construction ($1)
1	PED	$189,337	0.13543328	$25,642.510
2	PED	$189,337	0.13332989	$25,244.260
3	PED	$189,337	0.1312304	$24,846.749
4	PED	$189,337	0.12913479	$24,449.974
5	PED	$189,337	0.12704307	$24,053.934
6	PED	$189,337	0.12495523	$23,658.628
7	PED	$189,337	0.12287125	$23,264.054
8	PED	$189,337	0.12079113	$22,870.211

Construction Period (months)	Cost Expenditures	Cost ($1)	Interest Factor	Interest During Construction ($1)
9	PED	$189,337	0.11871486	$22,477.097
10	PED	$189,337	0.11664244	$22,084.712
11	PED	$189,337	0.11457387	$21,693.054
12	PED	$189,337	0.11250912	$21,302.121
13	PED	$189,337	0.1104482	$20,911.913
14	PED	$189,337	0.10839109	$20,522.427
15	PED	$189,337	0.1063378	$20,133.663
16	PED	$189,337	0.10428831	$19,745.619
17	PED	$189,337	0.10224261	$19,358.294
18	PED	$189,337	0.10020071	$18,971.686
19	PED	$189,337	0.09816259	$18,585.795
20	Real Estate	$2,484,500	0.09612824	$238,830.619
21	Construction, S&A, and Contingency	$429,547	0.09409767	$40,419.364
22	Construction, S&A, and Contingency	$429,547	0.09207085	$39,548.752
23	Construction, S&A, and Contingency	$429,547	0.09004779	$38,679.753
24	Construction, S&A, and Contingency	$429,547	0.08802848	$37,812.363
25	Construction, S&A, and Contingency	$429,547	0.08601291	$36,946.580
26	Construction, S&A, and Contingency	$429,547	0.08400107	$36,082.401
27	Construction, S&A, and Contingency	$429,547	0.08199296	$35,219.823

Construction Period (months)	Cost Expenditures	Cost ($1)	Interest Factor	Interest During Construction ($1)
28	Construction, S&A, and Contingency	$429,547	0.07998856	$34,358.843
29	Construction, S&A, and Contingency	$429,547	0.07798789	$33,499.458
30	Construction, S&A, and Contingency	$429,547	0.07599091	$32,641.665
31	Construction, S&A, and Contingency	$429,547	0.07399764	$31,785.460
32	Construction, S&A, and Contingency	$429,547	0.07200806	$30,930.842
33	Construction, S&A, and Contingency	$429,547	0.07002217	$30,077.808
34	Construction, S&A, and Contingency	$429,547	0.06803995	$29,226.353
35	Construction, S&A, and Contingency	$429,547	0.06606141	$28,376.476
36	Construction, S&A, and Contingency	$429,547	0.06408653	$27,528.173
37	Construction, S&A, and Contingency	$429,547	0.06211531	$26,681.442
38	Construction, S&A, and Contingency	$429,547	0.06014774	$25,836.279
39	Construction, S&A, and Contingency	$429,547	0.05818382	$24,992.682
40	Construction, S&A, and Contingency	$429,547	0.05622353	$24,150.647
41	Construction, S&A, and Contingency	$429,547	0.05426688	$23,310.173
42	Construction, S&A, and Contingency	$429,547	0.05231385	$22,471.255
43	Construction, S&A, and Contingency	$429,547	0.05036444	$21,633.892
44	Construction, S&A, and Contingency	$429,547	0.04841864	$20,798.079
45	Construction, S&A, and Contingency	$429,547	0.04647645	$19,963.816
46	Construction, S&A, and Contingency	$429,547	0.04453785	$19,131.097

Construction Period (months)	Cost Expenditures	Cost ($1)	Interest Factor	Interest During Construction ($1)
47	Construction, S&A, and Contingency	$429,547	0.04260284	$18,299.921
48	Construction, S&A, and Contingency	$429,547	0.04067142	$17,470.285
49	Construction, S&A, and Contingency	$429,547	0.03874358	$16,642.186
50	Construction, S&A, and Contingency	$ 429,547	0.03681931	$15,815.621
51	Construction, S&A, and Contingency	$429,547	0.0348986	$14,990.587
52	Construction, S&A, and Contingency	$429,547	0.03298145	$14,167.082
53	Construction, S&A, and Contingency	$429,547	0.03106785	$13,345.102
54	Construction, S&A, and Contingency	$429,547	0.0291578	$12,524.645
55	Construction, S&A, and Contingency	$429,547	0.02725129	$11,705.707
56	Construction, S&A, and Contingency	$429,547	0.02534831	$10,888.287
57	Construction, S&A, and Contingency	$429,547	0.02344885	$10,072.381
58	Construction, S&A, and Contingency	$429,547	0.02155291	$9,257.986
59	Construction, S&A, and Contingency	$429,547	0.019660484	$ 8,445.101
60	Construction, S&A, and Contingency	$429,547	0.017771563	$7,633.721
61	Construction, S&A, and Contingency	$429,547	0.015886142	$6,823.844
62	Construction, S&A, and Contingency	$429,547	0.014004213	$6,015.467
63	Construction, S&A, and Contingency	$429,547	0.012125771	$5,208.588
64	Construction, S&A, and Contingency	$429,547	0.010250809	$4,403.204
65	Construction, S&A, and Contingency	$429,547	0.00837932	$3,599.311

Construction Period (months)	Cost Expenditures	Cost ($1)	Interest Factor	Interest During Construction ($1)
66	Construction, S&A, and Contingency	$429,547	0.006511298	$2,796.908
67	Construction, S&A, and Contingency	$429,547	0.004646736	$1,995.991
68	Construction, S&A, and Contingency	$429,547	0.002785629	$1,196.558
69	Construction, S&A, and Contingency	$429,547	0.000927969	$398.606
Total	---	$27,129,700	---	$1,644,447.9

Note: October 2021 FY(22) price level, Period of Analysis: 50 years, Interest Rate 2.25%.

1.6.3. Risk and Uncertainty

Risk-informed planning should incorporate transparency in the estimation of benefits. A single value displayed for benefits has associated uncertainties. The mean, average, benefits usually does not equal to the 50 percent quartile, median. Which is the result of the distribution not being symmetrical due to uncertainties. Therefore, to better inform, while taking risk and uncertainty into account, the Recommended Plan benefits are displayed as a range in Table 24: Alternative 4 Probabilistic Distribution of Benefits, Net Benefits, and BCR.

Annual benefits for the Valley Creek Recommended Plan are $2,324,000 in 1 October 2021 prices, at the Federal interest rate of 2.25 percent. There is a 25 percent chance the true benefits total would exceed $2,722,000, a 50 percent chance they would exceed $2,250,000, and a 75 percent chance they would exceed $1,917,000.

Table 24. Alternative 4 Probabilistic Distribution of Benefits, Net Benefits, and BCR.

Annual Total Cost	EAD Reduced (Benefits)				Net Benefits				BCR				Probability Benefits Exceed Cost and BCR >1
	Mean Benefit	Probability Benefits Exceed Indicted Values			Mean Net Benefit	Probability Benefits Exceed Indicted Values			Mean BCR	Probability Benefits Exceed Indicted Values			
		0.75	0.50	0.25		0.75	0.50	0.25		0.75	0.50	0.25	
$1,014	$2,324	$1,917	$2,250	$2,722	$1,130	$903	$1,236	$1,708	2.3	1.9	2.2	2.7	Greater than 75 percent

Note: October 2021 FY(22) price level, Period of Analysis: 50 years, Values are displayed in $1,000's, Interest Rate 2.25%

1.6.4. Induced Damages

The feasibility study tasks included investigation of the potential for the NED plan to raise stages upstream or downstream of the project area. The investigation concluded that the project would not raise stages for the 1 percent flood event over future without-project conditions.

1.6.5. Project Performance

The estimated performance of a flood-risk management project in reducing the chances of occurrence of damaging floods is known as assurance. Assurance can be expressed as a range of statistics, and HEC-FDA, in addition to estimating economic damage and damages reduced, also provides a range of assurance estimates as an output. Tables 25 and 26, summarize the assurance statistics for the FWOP condition and alternative 4 respectively.

The target stage annual exceedance probability is the probability that a target stage will be exceeded in a given year. The study area without project expected target stage annual exceedance probability is the lowest in the middle of the study area. Specifically, in damage reaches Bess_WWTP_RB, 0.68 percent; Bess_Huey_GarUpper_RB, 1.24 percent; and Bess_Huey_GarDown_RB, 1.82 percent. Conversely, the without project expected annual probably that the specified reach target stage will be exceedance is the highest, at 99.9 percent, in reaches: Bess_Huey_GarUpper_LB, Bess_WWTP_Down, Bess_WWTP_LB, and Brighton_Besssemer. It should be noted the reaches with the highest future without project expected target stage annual exceedance probabilities are also the reaches with the fewest number of residential and non-residential structures, in addition to being the reaches delineating the study area lowest total investment values. These statistics account for the entire range of possible floods that would be large enough to result in economic damage and thus encompasses a broad range of smaller, moderate, and larger events. The abovementioned future without project reaches with the highest and lowest expected target stage annual exceedance probability are also observed with the implementation of alternative 4.

The long-term risk calculations displayed in Tables 25 and 26 below indicate the estimated chances of a damaging flood occurring over specified multi-year time periods, specifically for the time periods of 10 years, 25 years, and 50 years. Like the AEP, these statistics account for floods with a broad range of possible magnitudes. On average over the long-run under the FWOP, there is a range from 6.56 to 100 percent chance that a damaging flood would occur over a 10-year period in the study area. For longer time periods, such as the 30 and 50-year periods, it is anywhere from 18.42 percent in the Bess_WWTP_RB reach to essentially 100 percent. This is a long- term average and does not necessarily mean that a damaging flood will occur in the next 10 years. Under the implementation of alternative 4 the likelihood that the specified target stage will be exceeded during a 10, 30, and 50-year time windows closely mirror the FWOP estimates but are slightly lower. Under alternative 4 the likelihood that the target stage will be exceeded in a 10-year time window is the lowest in the Bess_WWTP_RB reach and estimated as 5.58 percent.

Table 25. Future Without Project Performance HEC-FDA Estimates.

Damage Reach Name	Target Stage (feet)	Target Stage Annual Exceedance Probability		Long-Term Risk Probability			Conditional Non-Exceedance Probability by Events					
		Median	Expected	10 years	30 years	50 years	10%	4%	2%	1%	0.40%	0.20%
HCL	450.04	0.0198	0.0314	0.2734	0.6165	0.7975	0.967	0.734	0.503	0.3376	0.1335	0.0308
HCTrib	468.65	0.1835	0.1836	0.8685	0.9977	1	0.173	0.005	0.001	0.0012	0	0
HCU	459.51	0.901	0.8969	1	1	1	0	0	0	0	0	0
Bess_Hueytown_Lower	413.54	0.0758	0.0779	0.5557	0.9123	0.9827	0.699	0.199	0.093	0.0935	0.0369	0.016
Bess_Huey_Down	452.25	0.244	0.2423	0.9376	0.9998	1	0.083	0	0	0	0	0
Bess_Huey_GarDown_LB	459.45	0.0663	0.0673	0.5017	0.8762	0.9693	0.809	0.276	0.069	0.002	0	0
Bess_Huey_GarDown_RB	463.85	0.0045	0.0182	0.1675	0.423	0.6001	0.999	0.826	0.661	0.5755	0.4325	0.1397
Bess_Huey_GarUpper_LB	456	0.999	0.999	1	1	1	0	0	0	0	0	0
Bess_Huey_GarUpper_RB	465.45	0.0041	0.0124	0.1169	0.3114	0.463	0.999	0.905	0.777	0.6973	0.4883	0.1715
Bess_Huey_Upper	466.11	0.1301	0.1349	0.7651	0.987	0.9993	0.267	0.004	0.001	0.0009	0	0
Bess_WWTP_Down	422	0.999	0.999	1	1	1	0	0	0	0	0	0
Bess_WWTP_LB	427	0.999	0.999	1	1	1	0	0	0	0	0	0
Bess_WWTP_RB	440.59	0.0053	0.0068	0.0656	0.1842	0.2878	0.999	0.994	0.942	0.7917	0.4427	0.362
Bess_WWTP_Upper	446.19	0.2113	0.212	0.9077	0.9992	1	0.119	0	0	0.0001	0.0001	0.0001

Damage Reach Name	Target Stage (feet)	Target Stage Annual Exceedance Probability		Long-Term Risk Probability			Conditional Non-Exceedance Probability by Events					
		Median	Expected	10 years	30 years	50 years	10%	4%	2%	1%	0.40%	0.20%
Birmingham	529.63	0.5092	0.5137	0.9993	1	1	0	0	0	0	0	0
Brighton_Bessemer	474	0.999	0.999	1	1	1	0	0	0	0	0	0
Midfield	493.98	0.6196	0.5766	0.9998	1	1	0.001	0	0	0	0	0
Upper_Bessemer	468.5	0.1651	0.1624	0.83	0.9951	0.9999	0.234	0.006	0	0	0	0

Note: October 2020 FY(21) price level, Period of Analysis: 50 years, Values displayed in $1,000's, Interest Rate 2.5%

Table 26. Alternative 4 Recommended Plan Project Performance HEC-FDA Estimates.

Damage Reach Name	Target Stage (feet)	Target Stage Annual Exceedance Probability		Long-Term Risk Probability			Conditional Non-Exceedance Probability by Events					
		Median	Expected	10 years	30 years	50 years	10%	4%	2%	1%	0.40%	0.20%
HCL	450.04	0.0215	0.0331	0.2855	0.6352	0.8138	0.963	0.7106	0.4848	0.3269	0.1148	0.0231
HCTrib	468.65	0.1528	0.152	0.8076	0.9929	0.9997	0.2645	0.0117	0	0	0	0
HCU	459.51	0.9016	0.8975	1	1	1	0	0	0	0	0	0
Bess_Hueytown_Lower	413.54	0.0777	0.08	0.5656	0.918	0.9845	0.6865	0.1755	0.0795	0.0776	0.0353	0.0143
Bess_Huey_Down	452.25	0.1502	0.1473	0.7969	0.9916	0.9997	0.3207	0.0196	0.0051	0.0049	0.0026	0
Bess_Huey_GarDown_LB	459.45	0.061	0.0611	0.4679	0.8493	0.9573	0.861	0.3004	0.1585	0.0613	0.0439	0.0159
Bess_Huey_GarDown_RB	463.85	0.0045	0.0159	0.1481	0.3817	0.5512	0.9996	0.8879	0.7036	0.5378	0.4732	0.3078
Bess_Huey_GarUpper_LB	456	0.999	0.999	1	1	1	0	0	0	0	0	0
Bess_Huey_GarUpper_RB	465.45	0.0038	0.0112	0.1062	0.2859	0.4296	0.9998	0.9493	0.7933	0.6276	0.514	0.2969
Bess_Huey_Upper	466.11	0.1105	0.1181	0.7154	0.977	0.9981	0.3931	0.0038	0.0009	0.0007	0.0006	0
Bess_WWTP_Down	422	0.999	0.999	1	1	1	0	0	0	0	0	0
Bess_WWTP_LB	427	0.999	0.999	1	1	1	0	0	0	0	0	0
Bess_WWTP_RB	440.59	0.0045	0.0057	0.0558	0.1583	0.2496	0.9996	0.9976	0.9625	0.8245	0.489	0.4194
Bess_WWTP_Upper	446.19	0.2113	0.2115	0.9071	0.9992	1	0.1271	0	0	0	0	0
Birmingham	529.63	0.3453	0.3458	0.9856	1	1	0	0	0	0	0	0
Brighton_Bessemer	474	0.999	0.999	1	1	1	0	0	0	0	0	0
Midfield	493.98	0.4377	0.4169	0.9955	1	1	0.0093	0	0	0	0	0
Upper_Bessemer	468.5	0.1435	0.1422	0.7842	0.99	0.9995	0.2983	0.0184	0.0037	0	0	0

Note: October 2020 FY(21) price level, Period of Analysis: 50 years, Values displayed in $1,000's, Interest Rate 2.5%

1.6.6. Benefit-Cost Results for Recommended Plan Considering Only Flood Risk Management

Please note the cost and benefits detailed below in this section of the document are for FRM only, i.e. there is no consideration for recreational features in the below values.

Mean benefits divided by the total annual costs produces an alternative's BCR. From this, the probability of maintaining a BCR greater than one is of interest. As seen in Table 27 Alternative 4 has an average BCR of 2.3. The BCR is displayed as a range in Table 24, with there being a 50 percent chance Alternative 4 BCR is between 1.9 and 2.7. Costs used in calculation of BCR were the refined Alternative 4 cost estimates shown in Table 21: Recommended Plan Alternative 4 Total Project First Costs, and not the screening level first cost estimate.

Table 27. Recommended Plan Alternative 4 FRM Benefit-Cost Data.

Total Project First Costs	$27,130
FWOP Annual Damages	$7,199
Annual Residual Damages	$4,875
Annual Benefits	$2,324
Annual Costs	$1,014
Benefit-Cost Ratio	2.3
Net Benefits	$1,310

Note: October 2021 FY(22) price level, Period of Analysis: 50 years, Values displayed in $1,000's, Interest Rate 2.25%

1.6.7. Benefit-Cost Results for Recommended Plan Considering Flood Risk Management and Recreation

A recreation evaluation was performed on the Recommended Plan. The recreation evaluation involves an analysis of the National Economic Development (NED) benefits from recreation opportunities created from the proposed recreation facilities. Details on the recreation evaluation can be found in Appendix J Recreation. The estimate first cost of recreational features, including contingency, is $181,000 and the total estimated first cost of the Recommended Plan including recreational features is $27,311,000. The cost and benefits detailed below take into consideration the FRM and recreation features of the recommended plan. Including both FRM and recreation features, the BCR increases to 2.7.

Table 28. Recommended Plan Alternative 4 FRM and Recreation Benefit-Cost Data.

Total Annual Cost			NED Benefit			Mean Net Benefits			BCR	
FRM	REC	FRM + REC	FRM (Mean)	REC	FRM + REC	FRM	REC	FRM + REC	FRM	FRM + REC
$1,014	$8.2	$1,023	$2,324	$404	$2,728	$1,310	$396	$1,705	2.3	2.7

Note: October 2021 FY(22) price level, 50 year Period of Analysis, Values displayed in $1,000's, FY22 Federal Interest Rate 2.25% unless stated otherwise

Section II: Other Social Effects

A set of difficult to quantify impacts from a water resource projects is lumped into the Other Social Effects (OSE) account. These impacts can range widely but typically include considerations of public safety, including potential for life loss, and environmental justice. The OSE account describes plan effects on social aspects such as community impacts, health and safety factors, displacement, energy conservation and others (USACE ER 1005-2-100; IWR Report 2013-R-03, Applying Other Social Effects in Alternatives Analysis). This OSE evaluation includes a description of the risks to life loss, community well-being and social connectedness, and social benefits associated with recreational amenities associated with the alternatives.

Between FWOP and with-project conditions, there are no significant changes in flood-wave velocity within downstream or adjacent project areas of Valley Creek, for any analyzed frequency. The only changes are negligible reductions in channel and overbank velocities with implementation of the recommended plan. In general, velocities within the stream channel range from 3 to 16 ft/s. This range represents all analyzed frequencies as well as FWOP and with-project conditions. Velocities in overbank areas are much lower, approaching 6 ft/s in the highest velocity zones.

In regard to breach scenarios, there are no observed changes in comparison to non-breach scenarios, with the exception of minor increases at the breach location. However, these areas of increase are within the order of a few feet in width and depth, and do not affect any infrastructure.

An evaluation on the risks of life loss from flooding was conducted with USACE HEC-LifeSim. The risk to loss of life associated with the Recommended Plan compared to the FWOP is very similar. Analysis indicates that most frequent flood events (0.05 AEP through 0.04 AEP) with minimal or ample warning time have a median life loss risk of zero, although there are slight increases in life loss during larger events. Implementation of the recommended plan does not significantly increase or decrease the risk to loss of life compared to the FWOP. The opportunity now exists to accomplish one of the main objectives of the study, removing people from harm's way while also ensuring that this is accomplished by optimizing and balancing as many types of benefits as possible within the four accounts.

In general, as detailed in Section 5.1 of the Engineering Appendix, water surface elevations are reduced in all downstream inhabited areas along Valley Creek. Some increases to overall water surface elevations (and flood depths) were observed in the floodplain areas immediately south of the basin locations (referred to as "backflow areas"). These were not considered significant from a life safety standpoint as the observed increases are considered within the limits of hydraulic, hydrologic and topographic uncertainty. Section 5.2.2.1 of the Engineering Appendix details changes to water surface elevations (and flood depths) resulting from implementation of the recommended plan.

Table 29. Life Loss Analysis for the Future Without Project Condition.

Annual Exceedance Probability	Structures Inundated	Minimal Warning				Ample Warning			
		Population at Risk		Median Life Loss		Population at Risk		Median Life Loss	
		Day	Night	Day	Night	Day	Night	Day	Night
0.50 AEP	273	505	882	0	0	505	882	0	0
0.20 AEP	755	1,320	2,228	0	0	1,320	2,228	0	0
0.10 AEP	1,109	1,879	3,096	0	0	1,879	3,096	0	0
0.04 AEP	1,556	2,773	4,166	0	0	2,773	4,166	0	0
0.02 AEP	1,890	3,261	4,910	1	2	3,261	4,910	1	1
0.01 AEP	2,194	3,773	5,666	4	4	3,773	5,666	0	0
0.005 AEP	2,505	4,384	6,551	3	5	4,384	6,551	1	1
0.002 AEP	2,966	5,247	7,571	12	19	5,247	7,571	3	4

Table 30. Life Loss Analysis for the Recommended Plan.

Annual Exceedance Probability	Structures Inundated	Minimal Warning				Ample Warning			
		Population at Risk		Median Life Loss		Population at Risk		Median Life Loss	
		Day	Night	Day	Night	Day	Night	Day	Night
0.50 AEP	126	200	345	0	0	200	344	0	0
0.20 AEP	471	192	225	0	0	192	225	0	0
0.10 AEP	834	1,439	2,404	0	0	1,439	2,400	0	0
0.04 AEP	1,326	2,146	3,556	0	0	2,146	3,551	0	0
0.02 AEP	1,710	3,016	4,502	0	0	3,016	4,499	0	0
0.01 AEP	2,057	3,576	5,327	3	4	3,576	5,324	0	0
0.005 AEP	2,400	4,198	6,200	7	9	4,198	6,197	1	1
0.002 AEP	2,876	5,096	7,330	18	23	5,095	7,328	3	4

Section III: Regional Economic Development Background

The Valley Creek flood risk management project evaluates a number of alternatives. For this analysis, the regional economic development (RED) effects of constructing the Recommended Plan based on the first costs (supervision, administration, planning, engineering, design and construction costs) to construct the project are provided using the USACE Regional Economic System (RECONS). The economic impact area was identified as Jefferson County, the county in which the project is located. The RED effects for the state of Alabama are also provided using RECONS.

1.7. Methodology

The RED analysis assesses how construction spending associated with the alternatives would affect regional economic conditions. The RED analysis estimates the direct, indirect, and induced effects to local regions as measured through jobs, gross regional product, labor income, and sales. “Sales” is the sum total of transactions that take place as a result of the construction project, including both value added and intermediate goods purchased in the economy. “Labor Income” includes all forms of employment income, including employee compensation (wages and benefits) and proprietor (self-employment) income. “Gross Regional Product (GRP)” is the value-added of all produced units in the region or the value of all goods and services produced in the study area. “Jobs” is the estimated worker-years of labor required to build the project. In RECONS, employment is presented as full-time equivalent jobs.

These regional economic effects are also expressed in monetary values or other numeric units (i.e., number of jobs) and are classified as either a direct or secondary (indirect and induced) effects. Direct effects represent the impacts of construction spending, including supervision and administration, planning, and engineering. Indirect effects represent the impacts caused by the iteration of industries purchasing goods and services to support the directly affected industries. These are industries in the supply chain of the construction sector, such as materials manufacturing, trucking, fuel, and others.

Induced effects represent the economic impacts from the directly and indirectly affected workers spending their income in the local or regional economy. For example, the additional income may be spent on clothing, groceries, dining out, and other items in the area. Secondary effects are described as the multiplier or rollover effects and include the indirect and induced effects in the defined economic impact areas.

This Regional Economic Development (RED) analysis employs input-output economic analysis, which measures the interdependence among industries, institutions, and households in an economy. RECONS was developed by the Institute for Water Resources (IWR), Michigan State University, and the Louis Berger Group. RECONS uses industry multipliers derived from the commercially available input-output

model IMPLAN® to estimate the effects of the construction activity on USACE projects on a regional economy. The model provides annual economic impacts at a fixed point in time.

The inputs for the RECONS model are expenditures that are entered by work activity or industry sector, each with its own unique production function. The Flood Risk Management production function of "Flood Risk Management Construction" was selected to gauge the impacts of the Recommended Plan. The Recommended Plan, with a project first cost of $25,484,000 was entered into RECONS under the work activity flood risk management construction to generate results for the construction, beginning in 2024, of two detention basins. The baseline data used by RECONS to represent the regional economy of Jefferson County and the State of Alabama are annual averages from the Bureau of the Census, the Bureau of Labor Statistics, and the Bureau of Economic Analysis for the year 2020. The model results are expressed in 2021 dollars.

1.8. Results

Please note that figures in this section are presented in FY21 dollars. The construction first cost for the Recommended Plan is estimated to be $25.484 million. Of this first cost total, $19.924 million would be captured within Jefferson County, while $21.045 million would be captured within the state of Alabama, as shown in Table 31. The expenditures made by the USACE associated with the Recommended Plan are expected to support 268.5 full-time equivalent jobs and $20.366 million in labor income in Jefferson County. On-going operations and maintenance activities and expenditures would result in minimal effects on regional economic conditions.

Table 31. Regional Economic Effects of the Recommended Plan.

Effects/Impact Areas	Region (Jefferson County)	State of Alabama
First Cost ($000)	$25,484	$25,484
Direct Impact		
Output ($000)	$19,924	$21,045
Jobs*	178	194.4
Labor Income ($000)	$14,524	$15,168
GRP or Value Added ($000)	$12,257	$13,109
Secondary Impact		
Output ($000)	$16,856	$18,099
Jobs*	90.5	92.1
Labor Income ($000)	$5,842	$6,350
GRP or Value Added ($000)	$9,848	$10,667
Total Impact (Direct and Secondary)		
Output ($000)	$36,780	$39,144
Jobs*	268.5	286.5
Labor Income ($000)	$20,366	$21,518
GRP or Value Added ($000)	$22,105	$23,776

*Jobs are presented in full-time equivalence (FTE) and are short term resulting from construction spending.

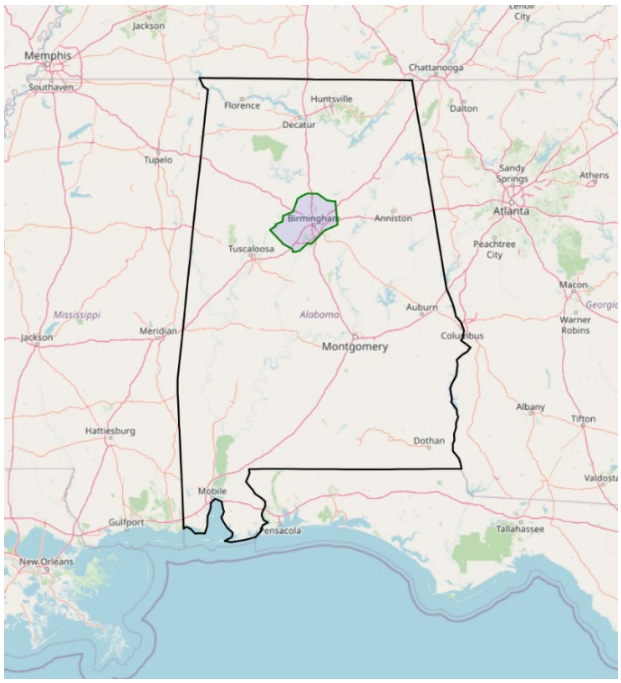

Figure 6. Jefferson, Alabama Map.

Section IV: Conclusion

The analysis of the Valley Creek basin federal flood risk management project in northern Alabama demonstrates a federal interest in the Recommended plan, Alternative 4. The Recommended Plan is the NED plan and consists of two overbank, off-channel, detention basins. Specifically, VD1 and VD2 are in the northern region of the project study area.

Considering only FRM components of the Recommended Plan, the estimated first cost in FY 22 dollars is $27,130,000. This plan exhibits economic justification with a mean benefit-cost ratio of 2.3 at the current FY 22 federal interest rate of 2.25 percent. With net annual benefits of $1,310,000, the project represents a strong contribution to national economic outputs.

When FRM and recreational features are both taken into consideration, the estimated first cost in FY 22 dollars is $27,311,000. This plan provides $1,705,000 in net annual benefits and a BCR of 2.7 at the current FY 22 federal interest rate of 2.25 percent, providing an even stronger contribution to national economic outputs.