UNITED STATES ARMY CORPS OF ENGINEERS

APPENDIX C - LIVINGSTON MANOR, NY

Economic Analysis

CENAP-PL-D

2/2/2016

Table of Contents

Addendum to the Economic Appendix

LIST OF EXHIBITS

Executive Summary

This document describes the procedures and results of the flood damage reduction analysis modeling for the project study area in the vicinity of Livingston Manor, Sullivan County, NY. Livingston Manor is in the Upper Delaware River Basin and is impacted by the flooding of three streams, the Willowemoc Creek, Little Beaver Kill, and Cattail Brook. The initial study focused on project alternatives along the Willowemoc creek. However, after the first analysis, it was found that the large majority of flood inundation economic damages were occurring along Little Beaver Kill Creek. This study includes modeling for the Willowemoc Creek and Little Beaver Kill. Data sources, processes utilized, assumptions, and results of the study are described in the following report. Despite the different periods in which the economic analysis took place, all price levels were indexed to January, 2016.

The Hydrologic Engineering Center's Flood Damage Reduction Analysis Software (HEC-FDA) was used for the economic modeling. HEC-FDA models were developed incorporating structure inventory database information. Structure locations were correlated with the river stationing established in the Hydrologic Engineering Center River Analysis Software (HEC-RAS) models in order to identify the stationing and damage reach assignments required for the HEC-FDA models. Four separate HEC-RAS models were developed for the Willowemoc Creek, Little Beaver Kill, Left Levee, and School Levee. The equivalent annual damage (EAD) for each established damage reach was calculated in the HEC-FDA models.

The EAD is the expected average dollar amount per year over a 50-year period of analysis of flood damage. The total of all four economic models results in expected annual damages of $977,000. Of the total $977,000, $617,000 are attributed to commercial damage and $360,000 are attributed to residential damage. The highest damages result in reaches LBK-R-400-A and LBK-R-450-B. These damage reaches are located in the center of Livingston Manor along Main Street and Pearl Street.

CENAP's final modeling effort utilized the updated HEC-FDA version 1.4. Modeling the tentatively selected plan (TSP), denoted as plan "J", along the Little Beaver Kill Creek (LBK) resulted in EAD of approximately $1,292,000 and total estimated annual damages reduced (i.e., average annual project benefits) of $727,000. The with-project condition yielded estimated annual commercial benefits of $566,000 and annual residential benefits of $161,000. Annual benefits for reaches LBK-R-400-A and LBK-R-450-B are estimated at $151,000 (63.45% reduction in damages) and $141,000 (60.26% reduction in damages), respectively. Plan J was estimated to have an initial cost of $7,696,948, with interest during construction (IDC) mounting to $180,397, and operations and maintenance (O&M) costs for the first 5 years after initial construction to be $10,000 each year. The total present worth of costs was calculated to be $7,922,979. Annualizing over the 50 year project life and utilizing a discount rate of 3.125%, the average annual costs (AAC) are estimated at $315,000. This yields a BCR of 2.31 with net benefits of $412,000.

1 Introduction

This document describes the procedures and results of the flood damage reduction analysis modeling developed for a flood damage reduction analysis model for the project study area in the vicinity of Livingston Manor, Sullivan County, NY. Livingston Manor is in the Upper Delaware River Basin and is impacted by the flooding of three streams, the Willowemoc Creek, Little Beaver Kill, and Cattail Brook. This study includes modeling for the Willowemoc Creek and Little Beaver Kill. Data sources, processes utilized, assumptions, and results of the study are described below. Refer to Exhibits A through E for supporting documentation.

2 Methodology and Findings

Flood damages are expressed in terms of expected annual damages, which are defined as the monetary value of physical damages and non-physical losses that can occur in any given year based on the magnitude and probability of losses from all possible events. The basis for determining existing damages is an examination of losses sustained in historical floods, supplemented by appraisals, application of depth-damage curves, and an inventory of capital investment within the floodplain.

Flood damages throughout the study area are classified as either physical or non-physical damages. Physical damages evaluated in this analysis account for a substantial proportion of flood damages, and include:

- Structural damages to buildings;
- Loss of contents of the buildings;

Potential additional non-physical damages were not included in the study results at this study phase.

2.1 Stream Station Assignment

A stream stationing value was assigned to each of the structures identified in the supplied data. The flood damage reduction analysis modeling requires that structures have a relative location that is consistent with the stationing used in the HEC-RAS hydraulic models for the Livingston Manor (NY) Study. The USACE provided hydraulic models for the Willowemoc Creek, Little Beaver Kill, School Levee, and Left Levee. Since the models utilize HEC-GeoRAS utilities (tools and utilities for processing geospatial data in ArcGIS), both the stream centerlines and the cross sections could be exported from the models as geo-referenced Geographic Information Systems (GIS) shape-files. Stream stationing was then determined at individual structures by measuring offsets from the corresponding hydraulic model cross sections in a GIS environment.

Structures were assigned a station value based on the location of the front door. Structures identified in the supplied data as demolished, accessory, missing, etc. were not assigned stream stationing and not included in the model. The stations for each structure were entered

into the HEC-FDA model along with additional required structure data obtained during field inventories.

2.2 HEC-FDA Model Livingston Manor, NY Study

Structure data was obtained during the field inventory for the Delaware River Structure Inventory Project. Structures were surveyed and depreciated replacement costs were calculated based on Marshall & Swift data. Structures were assigned a unique structure identification number.The following information was obtained during the structure inventory by Baker, Inc.:

Structure ID #	**Property Type**	**Condition**	**First Floor Elevation**
Street	**Style (Stories)**	**Exterior Walls**	**Zero Damage Elevation**
City	**Footprint**	**Roof**	**Benchmark Used**
Zip Code	**Square Footage**	**Garage**	**Tax Parcel Number**
Photo ID	**Quality**	**Basement**	**Map Sheet**
Owner	**Year Built**	**Structure Maps**	**Photos**

Table 1: Structure Data Categories

Database information for the Livingston Manor Central School structures (Structure ID LIV0001 and LIV0172) and the sewage plant structures (Structure ID LIV0171 and LIV0022) was clarified to better represent the conditions of these structures with regards to the parameters of the modeling. A facility that lies on the landward side of the covered bridge road has been determined to be part of the sewage plant. The building was given the assumed condition of the surveyed sewage plant building and a building area was measured from the aerial imagery. An elevation of 1409 feet NAVD88, determined for this landward facility by the USACE, was used as both the first floor and zero damage elevations. The sewage facility on the water side of the road was modeled with a ring levee at elevation 1407 feet NAVD88. This value was determined by the USACE to best represent the conditions at the site. The levee is modeled in HEC-FDA without uncertainty or risk from seepage, interior flooding, or geotechnical instability. Stage-damage functions for the sewage plant were altered to not allow damage at elevation 1407 feet NAVD88 or below.

The school auditorium structure was separated from the school structure within the HEC-FDA Model. Each is calculated separately as independent structures. USACE hydraulic modeling indicates that the auditorium floods at more frequent recurrence intervals than the main school even though the structures are connected by a throughway. The auditorium was attributed with an elevation provided by the USACE of 1419.7 feet NAVD88. Building area was calculated from aerial imagery.

Data for surveyed structures was entered into the Marshall & Swift Residential Estimator 7 and Commercial Estimator 7 Software Programs to obtain the depreciated replacement cost. Depreciated replacement cost was estimated by the Marshall & Swift Software using Method 1: M & S Depreciation Tables & Typical Life. This method is consistent with the methodologies applied during the data collection effort. The condition ratings and effective ages were later normalized using the methodology described in the draft

memorandum in Exhibit A. This draft memorandum describes the Life Cycle methodology used to determine the structure depreciated replacement cost estimates. This method is based on the M & S typical life cycle chart for a residential property and assumes that a structure can have a lower effective age regardless of an increasing chronological age if improvements typically made through the life cycle of a structure are completed. The Life Cycle chart (Exhibit A) illustrates the concept that structures with actual ages of up to 180 years old exhibit trends that allow the following determinations. A structure in 'Like New' condition can have an effective age ranging from approximately 5 to 15 years depending on what improvements have been completed. Similarly, a structure in 'Average' condition can have an effective age ranging from approximately 15 to 35 years, and a structure in 'Poor' condition can have an effective age ranging from approximately 35 to 50 years. By grouping the six M & S condition ratings into the three condition categories used in the life-cycle chart and assigning them the midpoint age from the range in each condition category; the following condition/effective age correlation can be made:

Like New – 10 years **(Good, Very Good, Excellent Condition)**
Average – 25 years **(Fair and Average Condition)**
Poor – 43 years **(Low Condition)**

Table 2: Structure Age Categories

By consolidating the effective age, the Life-Cycle Method normalizes extremes, reduces some subjectivity from the valuation, and may more appropriately account for the effects condition has on effective age. Although the condition rating remains a subjective variable, M & S attempts to reduce subjectivity by providing distinct definitions and examples of condition. This method could be applied to the study data without individual reassessment of each structure.

Structure and Content Stage Damage Curves were assigned to each residential structure using the USACE Institute of Water Resources Economic Guidance Memorandum 04-01 Generic Depth-Damage Relationships for Residential Structures (Exhibit B). Structure and Content Stage Damage Curves were assigned to each commercial structure using the USACE Institute of Water Resources Analysis of Nonresidential Content Value and Depth-Damage Data for Flood Damage Reduction Studies as a guide. Structure curves were assigned based on the total number of stories and whether or not the structure has a basement. Content of the structures was assumed to be a proportion of the replacement cost of the structure.

Residential and commercial structures utilized a 1.0:0.5 structure to content ratio. This ratio is an assumed average ratio that has been established by the USACE. The models were also run with a residential structure to content ratio of 1.0:1.0 as a sensitivity analysis. EAD results are included in Exhibit C and D. These results were not calculated with any consideration of uncertainty or with risk analysis.

Once stage damage curves were assigned to each structure, four Structure Inventory Databases (SID) were initially created using HEC-FDA Version 1.2.5a from the USACE HEC website. Using the HEC-FDA Manual as a reference, required study structure data (Table 2) was imported into the HEC-FDA 1.2.5a program. The models were configured to accept hydrologic and hydraulic data to analyze existing without project and proposed with project conditions. The HEC-FDA studies were named: ***Willowemoc.sty, Little Beaver Kill.sty, LMLeftLevee.sty, School Levee.sty***

Damage reaches utilized in the HEC-FDA modeling were established by the USACE. Identification of damage reaches was influenced by flow change locations in the HEC-RAS model, tributaries, bridges, possible project locations, and structure locations. Reach designations were adjusted in order to provide sufficient coverage for the surveyed structures. Structure records in the database were then attributed with the name of the damage reach that they are associated with.

Hydrologic and hydraulic modeling data was then entered into the study after damage reaches were assigned by the following HEC-RAS models:

Model Name	**Flooding Source**
RJM_LM_CHAN_BEHIND_LOB_LEVEE_8SEP10	**Willowemoc Left Levee**
RJM_LM_CHAN_BEHIND_SCHOOL_8SEP10	**Willowemoc School Levee**
RJM-Willowemoc	**Willowemoc (Upper**
Section) RJM-Willowemoc	**Willowemoc (Lower**
Section) RJM-FIX-LBK-RUN-7-10JAN11	**Little Beaver Kill**

Table 3: Water Surface Profile HEC-RAS Models

These models were exported from HEC-RAS and imported to HEC-FDA as a Discharge-Probability table. This table contained all eight water surface profiles provided within the model. These profiles were the 0.50, 0.20, 0.10, 0.04, 0.02, 0.01, 0.004, and 0.002 annual chance exceedance (ACE) probability flood events. Models had to be modified for import into HEC- FDA. The modifications were needed in order for HEC-FDA to run properly. For example, flows must increase in a model as the event becomes less likely. In the provided models when the channel was not receiving water, an assumed value of one cfs was used. This needed to be increased with each less frequent event. None of the modifications impacted the flooding assessment in a noticeable manner.

Discharge-probability functions were then determined for each damage reach using HEC- FDA. HEC-FDA was utilized to perform a graphical process by which exceedance probability functions were determined. The Willowemoc Creek and its two Levee models were attributed with 86 years of record. The Little Beaver Kill model was attributed with 73 years of record. Record life has been attributed to support the possibility of an uncertainty analysis performed in the future. No uncertainty analysis has been performed for this study.

Stage-discharge functions with uncertainty were then determined for each reach. Functions were taken from the HEC-RAS import and determined at the index location for each reach. Index location is defined between the beginning and ending station values and where data is representative for the entire reach. Index locations were provided by the USACE. HEC-FDA computed stage-damage functions for each reach. The stage-damage functions determine the amount of damage based on stage.

Future discharge-probability functions and stage-discharge functions are assumed to be equal to the existing conditions for modeling purposes. HEC-FDA requires a future condition for processing of the model. The model is attributed and run with the discount rate. This rate discounts the expected annual damage to the beginning of the period of analysis or the base year. This process is used in performing an equivalent annual damage assessment. An equivalent annual damage assessment is not representative at this time because future conditions have not been determined.

Lastly, reach stage-damage functions were used to run an evaluation of the plan by analysis years and an EAD assessment was completed. The EAD is the predicted average dollar amount per year for fifty years of flood damage. The resulting EAD are provided in more detail in Exhibits C and D.

2.3 Risk & Uncertainty Analysis

Uncertainty parameters were defined for the all existing conditions and plan alternatives for the modeling efforts utilizing the HEC-FDA model for this economic analysis include:

- Error in first floor stage elevations
- Error in structure values
- Error in Content to structure values
- Standard Deviation in percent depth-damage functions;
- Standard Deviations for Exceedance Probability-Discharge functions and
- Standard Deviations for Stage-discharge functions

2.4 Other Social Effects, Regional Economic Development & Environmental Quality

The following tables display the other system of accounts. They include the account for Other Social Effects (OSE), the account for Regional Economic Development (RED), and the system for Environmental Quality (EQ). It was deemed that the National Economic Development (NED) account would be the most applicable system for analysis due to the minor impact of the other three. The environmental quality analysis is detailed further in the environmental section of Livingston Manor study. Tables __, show the summary of the PDT's professional judgments.

Other Social Effects (OSE)

Resource Categories	Action Plan	Alternative J (Tentatively Selected Plan)
Aesthetics	No Impact	Temporary adverse impacts on sight and smell due to construction activities (equipment, earth moving) would disappear upon end of construction period.
Displacement effects	No Impact	No permanent displacement of people, businesses, or farms.
Educational, cultural, and recreational opportunities	No impact	Permanent increase in availability of transportation routes during and after severe storm events. Increased level of protection prevents disruption of community services such as schools, hospitals, and utilities.
Emergency Preparedness	No Impact	Permanent increase in access to flexible reserves of water supplies, critical power supplies, scarce fuels, evacuation routes and emergency transport to health facilities during and after storm events.
Long-term productivity	No Impact	Negligible impact on long-term productivity of resources.
Security of life, health, and safety	No Impact	Significant mitigation of related health risks, such as loss-of-life, trauma, hypothermia, water & air pollution, water-borne diseases, vector-borne diseases (through ephemeral water-bodies), and food & water supply disruption.
Social Vulnerability	No Impact	Permanent reduction in flood hazard exposure for highly vulnerable populations identified in the Social Vulnerability Index, including senior citizens, minorities, and persons living in poverty.

* Social Vulnerability Index (SVI) is developed by the Agency for Toxic Substances and Disease Registry (ATSDR), a federal public health agency of the U.S. Department of Health and Human Services

Table 4: Summary of Other Social Effects Account

Regional Economic Development (RED)		
Resource Categories	**Action Plan**	**Alternative J (Tentatively Selected Plan)**
Employment distribution	No Impact	Temporary increase in construction-related jobs during construction. Permanent indirect positive impacts on employment opportunities for protected businesses, including opportunities for minority workers.
Fiscal condition of State and Local sponsor	No Impact	There is a possible permanent reduction in clean-up, emergency response, resource allocation, and other flood-related costs. Also, there might be a possible increase in tax base of workers and businesses.
Population distribution and composition	No Impact	Minimal temporary impact on population distribution or composition.
Real income	No Impact	Minimal temporary impact on real income.

Table 5: Summary of Regional Economic Development Account

Environmental Quality (EQ)	
Resource Categories	**Alternative J (Tentatively Selected Plan)**
Water Resources	Please see the environmental appendix.
Air Quality	Please see the environmental appendix.
Biological Resources	Please see the environmental appendix.
Cultural Resources	Please see the environmental appendix.
Land Use	Please see the environmental appendix.
HTRW	Please see the environmental appendix.
Noise	Please see the environmental appendix.

Table 6: Summary of Environmental Quality Account

3 Explanation of Initial Findings

The EAD Table 4 details the expected annual damage for each reach for the base year of 2015. These tables show the number of structures that are included in each reach. The commercial and residential damage reaches are plotted in Exhibit E.

The results in the EAD represent the damage that can be expected on an annual basis for the studied areas within the town of Livingston Manor. The following summarizes the commercial, residential, and total EAD for each of the four models with the initial assumption of structure to content ratios of 1.0:1.0 for commercial structures and 1.0:0.5 for residential structures.

Model	Commercial EAD	Residential EAD	Total EAD
Willowemoc	$39,150	$40,380	$79,530
Little Beaver Kill	$481,590	$211,170	$692,760
School Levee	$96,130	$2,810	$98,940
Left Levee	-	$30,320	$30,320

Table 7: Equivalent Annual Damage Summary

The total of the four models results in approximate total damages of $902,000 with $617,000 from commercial damage and $285,000 from residential damage. The highest damages are attributed to damage reaches LBK-R-400-A and LBK-R-450-B. These reaches are located in the center of Livingston Manor along Main Street and Pearl Street. As noted above, a sensitivity analysis was performed with residential structure to content ratios of 1.0:1.0. Damages assuming this residential content ratio result in an EAD of approximately $977,000. This parameter change results in an increase of approximately $75,000 in damages with the higher residential content ratio.

4 TSP "J": Little Beaver Kill Remodel

Little Beaver Kill creek was remodeled during the study effort to estimate flood damages and project benefits using HEC-FDA version 1.4. Both "without project" and "with-project" conditions were considered. The "with-project" condition under analysis consisted of bank stabilization and floodway expansion. Further planning scenario details considered for the remodeling effort may be found in the main report.

The original economic database was used for the modeling effort. The existing data was first converted to HEC-FDA version 1.4. Next, three structures were eliminated from the database because they were no longer in existence in the study area. All uncertainty parameters previously set for modeling efforts were used. A 50 year period of analysis was considered with the FY 16 discount rate of 3.125%.

CENAP H&H supplied new HEC-RAS modeling and delivered output files formatted as water surface profiles (WSP) for H&H input into the HEC-FDA model. Four WSPs were delivered: Two existing condition WSPs and two future WSPs. The change in future WSPs was considered minor by CENAP district H&H engineers relative to existing conditions. However, the minor

changes were still deemed sufficient by the PDT for purposes of calculating Equivalent Annual Damages for the 50 year period of analysis.

The revised existing, or without project, conditions Equivalent Annual Damages was $1,292,000. The increase from the original model output can be accounted for by the revised CENAP H&H HEC-RAS modeling, as well as, HEC-FDA version 1.4's "less simple" method of accounting for uncertainty. The following table and figures provide a breakdown of damages, measured in thousands of dollars, by project reach:

Study:	Little Beaver Kill
Monetary Units:	$1,000's
Plan:	Without
Plan:	Without project condition
Discount Rate:	3.125%
Period of Analysis:	50
Version 1.4, Sep. 2014; Less Simple Method (0.010)	

Damage Reach Name	Total Without Project
LBK-L-100-A	$25.57
LBK-L-100-B	$0.00
LBK-L-150-A	$7.25
LBK-L-150-B	$0.00
LBK-L-150-C	$0.00
LBK-L-200-A	$25.70
LBK-L-200-B	$2.52
LBK-L-200-C	$0.00
LBK-L-300-A	$24.01
LBK-L-300-B	$9.79
LBK-L-400-A	$17.06
LBK-L-400-B	$38.70
LBK-L-500-A	$68.12
LBK-L-500-B	$3.22
LBK-R-100-A	$0.00
LBK-R-1000-A	$38.22
LBK-R-1000-B	$111.73
LBK-R-1050-A	$0.17
LBK-R-150-A	$120.76
LBK-R-200-A	$0.00
LBK-R-300-A	$48.19
LBK-R-300-B	$158.42
LBK-R-400-A	$237.97
LBK-R-400-B	$76.65
LBK-R-450-A	$16.98
LBK-R-450-B	$234.46
LBK-R-500-A	$0.00
LBK-R-600-A	$6.41
LBK-R-600-B	$7.28
LBK-R-700-A	$11.64
LBK-R-800-A	$1.45
LBK-R-850-A	$0.00
Total for stream: Little Beaver Kill	**$1,292.28**

Table 8: Summary of Existing Conditions Damages by Reach

Table 9: EAD Summary by Damage Reach

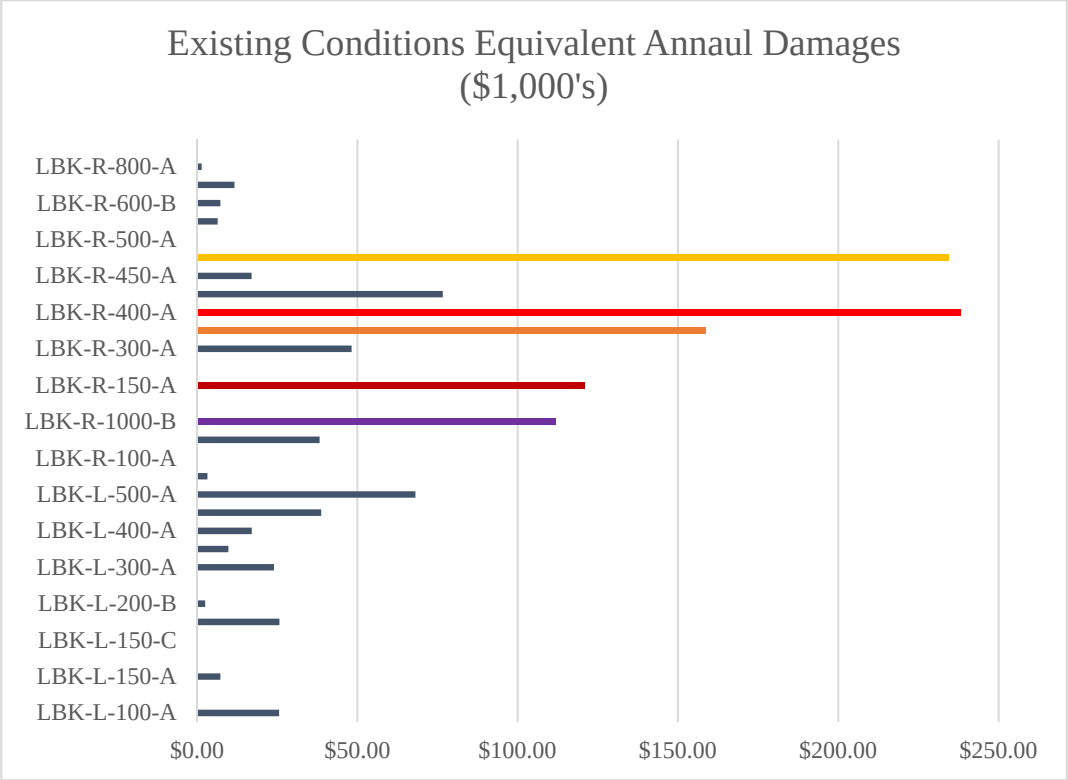


Figure 1: Existing Conditions EAD

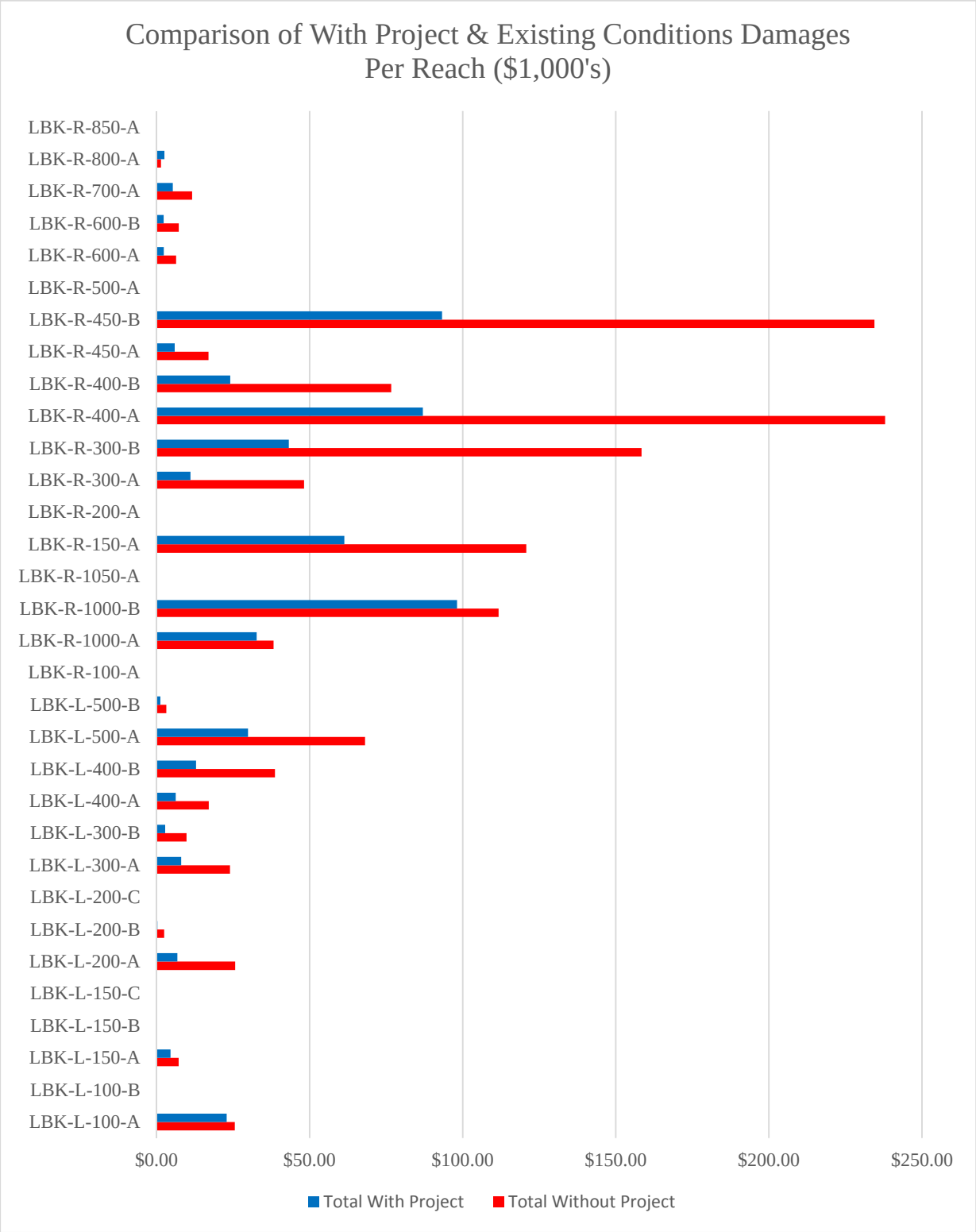


Figure 2: Comparison of Damages & Damages Reduced by Plan J

The with-project scenario was also analyzed. This scenario is the TSP, project "J." The average annual benefits (AAB) are the damages reduced by the proposed plan. AAB were estimated to be $727,000. The following table and graph illustrate the damages reduced in thousands of dollars per reach:

Report Equivalent Annual Damage Analysis Reduced and Distributed by Damage Reach.

Study:	Little Beaver Kill
Monetary Units:	$1,000's
Plan:	P3-LBK-FDA
Plan:	Widen Main St. Bridge
Discount Rate:	3.125%
Period of Analysis:	50

Version 1.4, Sep. 2014; Less Simple Method (0.010)

Damage Reach Name	Total Without Project	Total With Project	Damage Reduced	Prob Damg Reduced Exceeds 0.75	Prob Damg Reduced Exceeds 0.50	Prob Damg Reduced Exceeds 0.25
LBK-L-100-A	$25.57	$22.90	$2.68	$1.65	$3.01	$3.91
LBK-L-100-B	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
LBK-L-150-A	$7.25	$4.57	$2.68	$2.59	$2.76	$2.87
LBK-L-150-B	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
LBK-L-150-C	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
LBK-L-200-A	$25.70	$6.80	$18.90	$14.64	$19.45	$23.48
LBK-L-200-B	$2.52	$0.30	$2.22	$0.78	$1.60	$3.13
LBK-L-200-C	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
LBK-L-300-A	$24.01	$8.05	$15.96	$14.33	$16.25	$17.81
LBK-L-300-B	$9.79	$2.84	$6.95	$4.34	$6.86	$9.30
LBK-L-400-A	$17.06	$6.28	$10.78	$10.00	$10.98	$11.77
LBK-L-400-B	$38.70	$12.92	$25.78	$23.61	$26.35	$28.47
LBK-L-500-A	$68.12	$29.88	$38.24	$37.93	$38.58	$38.71
LBK-L-500-B	$3.22	$1.26	$1.96	$1.83	$1.99	$2.12
LBK-R-100-A	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
LBK-R-1000-A	$38.22	$32.70	$5.52	$5.51	$5.55	$5.56
LBK-R-1000-B	$111.73	$98.17	$13.56	$13.21	$13.68	$13.73
LBK-R-1050-A	$0.17	$0.13	$0.04	$0.02	$0.04	$0.05
LBK-R-150-A	$120.76	$61.33	$59.43	$50.64	$61.97	$70.57
LBK-R-200-A	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
LBK-R-300-A	$48.19	$11.08	$37.10	$33.04	$37.97	$42.05
LBK-R-300-B	$158.42	$43.20	$115.22	$98.76	$118.71	$135.27
LBK-R-400-A	$237.97	$86.99	$150.99	$148.85	$151.91	$152.54
LBK-R-400-B	$76.65	$24.09	$52.57	$47.26	$53.73	$58.93
LBK-R-450-A	$16.98	$5.94	$11.04	$10.15	$11.30	$12.16
LBK-R-450-B	$234.46	$93.24	$141.22	$138.84	$143.13	$145.55
LBK-R-500-A	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
LBK-R-600-A	$6.41	$2.38	$4.03	$3.67	$4.13	$4.47
LBK-R-600-B	$7.28	$2.32	$4.96	$3.85	$5.08	$6.10
LBK-R-700-A	$11.64	$5.34	$6.29	$5.12	$6.14	$7.37
LBK-R-800-A	$1.45	$2.58	-$1.13	-$1.78	-$1.02	-$0.40
LBK-R-850-A	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total for stream: Little Beaver Kill	**$1,292.28**	**$565.27**	**$727.01**	**$668.83**	**$740.16**	**$795.55**

Table 10: Plan J Damages Reduced Summary by Reach

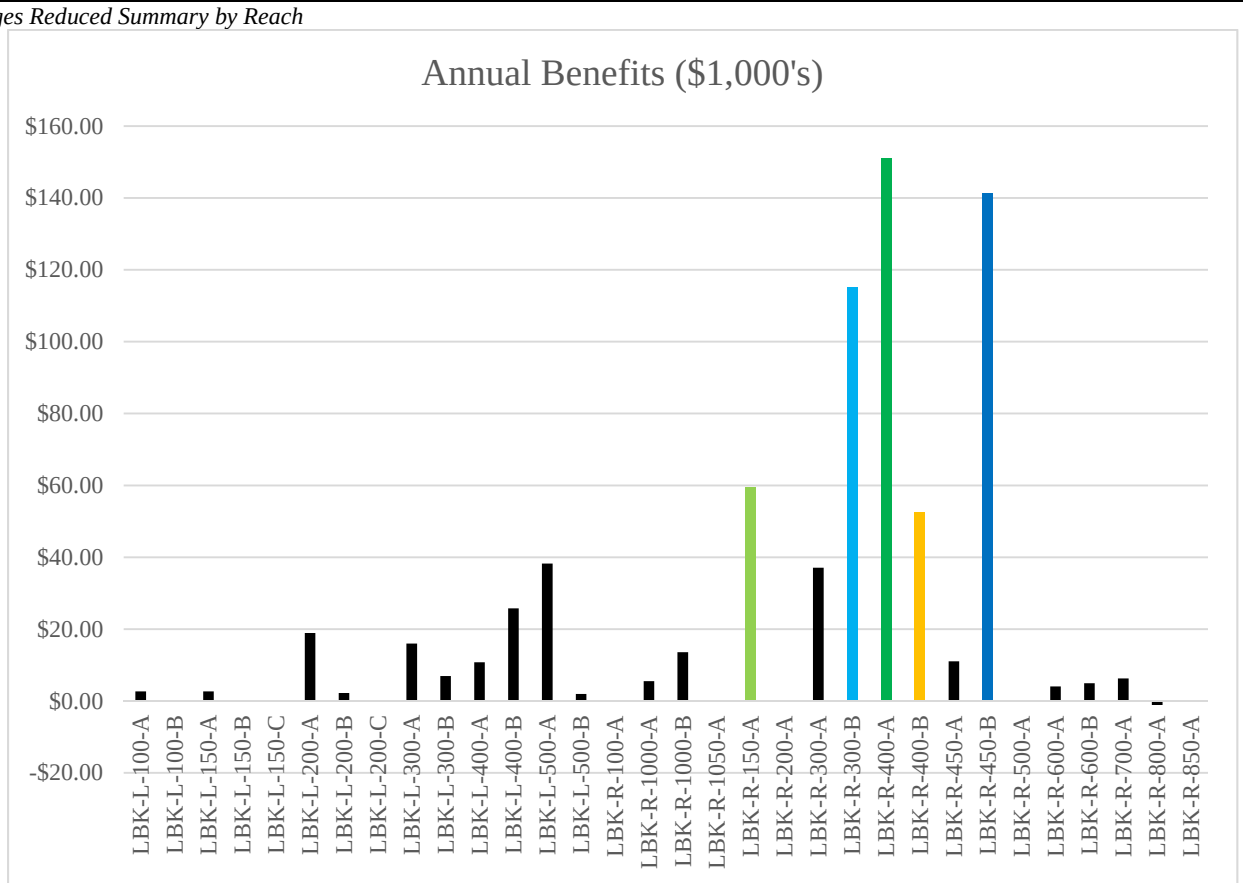


Figure 3: Summary of Benefits by Reach for Plan J

5 Engineering Performance

Project engineering performance is computed as the exceedance probability for a target stage measured in feet. Flood risk is defined as the probability of one or more exceedances of the target stage previously set.

The target stage is determined by interpolation from the stage-damage relationship using a specified fraction of a damage for a specified exceedance probability. This damage is determined from the damage-exceedance probability function obtained by combining traditional estimates of the contributing relationships for the without-project (existing) condition.

The exceedance probability for this stage is specified as both a “median” and “expected” value. The median value is obtained from the stage-exceedance probability curve calculated by the traditional method. The expected value is obtained by averaging the target stage over all the Monte Carlo simulations.

The following equation accounts for flooding risk:

$$R = 1 - (1 - p)^N$$

Where the risk of flooding one or more times in a year is designated as variable "N," and variable "p" is the probability of exceeding the target stage. The expected value "R" is reported as the average over all Monte Carlo simulations.

To define indices that describe the performance of plan “J”, the target stage, measured in feet NAVD 88, was interpolated for each plan damage reach. For reference, the median annual exceedance probability that corresponds to the stage top is determined with direct reference to the stage-discharge (ratings curves) and discharge-frequency relationships generated from the WSP (water surface profiles) input into the HEC-FDA. The following tables describe the engineering performance of the without and TSP project conditions for 2015 & 2065.

Report Project Performance by Reaches.
Study: Little Beaver Kill
Plan: P3-LBK-FDA
Description: Widen Main St. Bridge
Year: 2015
Version 1.4, Sep. 2014; Less Simple Method (0.010)

All units: Feet		Target Stage Annual Exceedance Probability		Long Term Risk (years)			Conditional Non-Exceedance Probability by Events					
Reach Name	**Target Stage**	**Median**	**Expected**	**10**	**30**	**50**	**10%**	**4%**	**2%**	**1%**	**0.40%**	**0.20%**
LBK-L-100-A	1418.59	0.1514	0.1521	0.808	0.9929	0.9997	0.1576	0.0147	0.0039	0.0034	0	0
LBK-L-100-B	1415	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-L-150-A	1421.59	0.0438	0.0464	0.3783	0.7597	0.9071	0.9593	0.4515	0.2041	0.0932	0.0213	0.0061
LBK-L-150-B	1417	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-L-150-C	1417	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-L-200-A	1423.65	0.0148	0.0186	0.1711	0.4306	0.6088	0.9998	0.884	0.6077	0.3657	0.147	0.0606
LBK-L-200-B	1426.54	0.0029	0.0052	0.0512	0.1457	0.2309	0.9998	0.9983	0.9559	0.8297	0.591	0.395
LBK-L-200-C	1417	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-L-300-A	1421.62	0.1069	0.1084	0.6825	0.968	0.9968	0.4387	0.0727	0.0182	0.0109	0.0018	0
LBK-L-300-B	1425.64	0.0094	0.0129	0.1217	0.3224	0.4772	0.9997	0.9578	0.7624	0.5214	0.2526	0.1235
LBK-L-400-A	1421.65	0.1327	0.1339	0.7624	0.9866	0.9992	0.2464	0.0275	0.0069	0.0051	0	0
LBK-L-400-B	1422.57	0.0765	0.0786	0.5589	0.9142	0.9833	0.7245	0.1807	0.0583	0.0275	0.0047	0
LBK-L-500-A	1420.1	0.3304	0.3291	0.9815	1	1	0	0	0	0	0	0
LBK-L-500-B	1422.07	0.1156	0.1169	0.7114	0.976	0.998	0.3647	0.055	0.0132	0.0089	0	0
LBK-R-100-A	1415	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-R-1000-A	1439.6	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-R-1000-B	1439.6	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-R-1050-A	1446.5	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-R-150-A	1423.13	0.0197	0.0233	0.2096	0.5062	0.6916	0.9989	0.8103	0.5027	0.2775	0.0977	0.0364
LBK-R-200-A	1417	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-R-300-A	1421.73	0.0462	0.049	0.3951	0.7787	0.919	0.947	0.4198	0.1857	0.0816	0.0174	0.0048
LBK-R-300-B	1423.52	0.0217	0.0252	0.2254	0.5352	0.7211	0.9985	0.7758	0.4632	0.2489	0.0837	0.0296
LBK-R-400-A	1419.97	0.2743	0.2735	0.9591	0.9999	1	0.0042	0	0	0	0	0
LBK-R-400-B	1422.1	0.0945	0.0962	0.6363	0.9519	0.9936	0.552	0.1082	0.029	0.0156	0.0024	0
LBK-R-450-A	1421.04	0.1852	0.186	0.8723	0.9979	1	0.0602	0.0041	0.0011	0	0	0
LBK-R-450-B	1420.68	0.2218	0.2223	0.919	0.9995	1	0.0207	0.0012	0	0	0	0
LBK-R-500-A	1419.5	0.4424	0.4311	0.9964	1	1	0	0	0	0	0	0
LBK-R-600-A	1422.31	0.109	0.1105	0.6898	0.9702	0.9971	0.4196	0.0685	0.0161	0.0105	0	0
LBK-R-600-B	1423.71	0.0423	0.0454	0.3719	0.7522	0.9022	0.9638	0.4638	0.2121	0.0955	0.0213	0.0058
LBK-R-700-A	1422.12	0.1304	0.1314	0.7555	0.9854	0.9991	0.2637	0.0321	0.008	0.0058	0	0
LBK-R-800-A	1428	0.0692	0.072	0.5262	0.8936	0.9761	0.7923	0.2194	0.0786	0.0342	0.0058	0.0016
LBK-R-850-A	1429	0.999	0.999	1	1	1	0	0	0	0	0	0

Table 11: Plan J Engineering Performance, 2015

Report Project Performance by Reaches.
Study: Little Beaver Kill
Plan: P3-LBK-FDA
Description: Widen Main St. Bridge
Year: 2065
Version 1.4, Sep. 2014; Less Simple Method (0.010)

All units: Feet		Target Stage Annual Exceedance Probability		Long Term Risk (years)			Conditional Non-Exceedance Probability by Events					
Reach Name	**Target Stage**	**Median**	**Expected**	**10**	**30**	**50**	**10%**	**4%**	**2%**	**1%**	**0.40%**	**0.20%**
LBK-L-100-A	1418.76	0.1472	0.1479	0.7982	0.9918	0.9997	0.1769	0.0173	0.0046	0.0038	0	0
LBK-L-100-B	1416	0.4298	0.4212	0.9958	1	1	0	0	0	0	0	0
LBK-L-150-A	1421.08	0.0615	0.0638	0.4825	0.8614	0.9629	0.8545	0.2746	0.1082	0.0466	0.0092	0.0024
LBK-L-150-B	1419	0.2011	0.2021	0.8954	0.9989	1	0.0382	0.0025	0	0	0	0
LBK-L-150-C	1419	0.2011	0.2021	0.8954	0.9989	1	0.0382	0.0025	0	0	0	0
LBK-L-200-A	1423.61	0.016	0.0198	0.1814	0.4515	0.6324	0.9997	0.8656	0.5778	0.3401	0.1314	0.053
LBK-L-200-B	1426.51	0.0032	0.0056	0.0549	0.1558	0.2459	0.9998	0.9977	0.9491	0.8127	0.5656	0.3704
LBK-L-200-C	1419	0.2011	0.2021	0.8954	0.9989	1	0.0382	0.0025	0	0	0	0
LBK-L-300-A	1421.62	0.1122	0.1137	0.7008	0.9732	0.9976	0.3932	0.0601	0.0151	0.0094	0	0
LBK-L-300-B	1425.65	0.01	0.0136	0.1276	0.336	0.4946	0.9997	0.951	0.7435	0.4999	0.2352	0.113
LBK-L-400-A	1421.66	0.1399	0.1407	0.7804	0.9894	0.9995	0.2104	0.0224	0.0056	0.0045	0	0
LBK-L-400-B	1422.57	0.0818	0.0838	0.5832	0.9276	0.9874	0.6734	0.1552	0.0471	0.023	0.0038	0
LBK-L-500-A	1420.5	0.2842	0.2833	0.9643	1	1	0.0032	0	0	0	0	0
LBK-L-500-B	1422.07	0.1221	0.1232	0.7314	0.9806	0.9986	0.3176	0.0436	0.0106	0.0073	0	0
LBK-R-100-A	1416	0.4298	0.4212	0.9958	1	1	0	0	0	0	0	0
LBK-R-1000-A	1440.8	0.2548	0.254	0.9466	0.9998	1	0.0071	0	0	0	0	0
LBK-R-1000-B	1440.8	0.2548	0.254	0.9466	0.9998	1	0.0071	0	0	0	0	0
LBK-R-1050-A	1453.01	0.0046	0.0075	0.0723	0.2017	0.313	0.9997	0.993	0.9087	0.7295	0.457	0.272
LBK-R-150-A	1422.34	0.0309	0.0341	0.2933	0.647	0.8237	0.9911	0.6252	0.3232	0.1593	0.0433	0.0137
LBK-R-200-A	1419	0.2011	0.2021	0.8954	0.9989	1	0.0382	0.0025	0	0	0	0
LBK-R-300-A	1421.75	0.0483	0.0511	0.408	0.7925	0.9273	0.9366	0.3959	0.1731	0.0747	0.0156	0.0041
LBK-R-300-B	1422.97	0.0282	0.0315	0.274	0.6174	0.7984	0.9941	0.6666	0.3569	0.1814	0.0522	0.0172
LBK-R-400-A	1420.5	0.2261	0.2255	0.9223	0.9995	1	0.0185	0.0006	0	0	0	0
LBK-R-400-B	1422.11	0.1007	0.1021	0.6594	0.9605	0.9954	0.4997	0.0909	0.0236	0.0135	0.0021	0
LBK-R-450-A	1421.07	0.192	0.1927	0.8824	0.9984	1	0.051	0.0035	0.0009	0	0	0
LBK-R-450-B	1420.68	0.2333	0.2337	0.9302	0.9997	1	0.0145	0.0008	0	0	0	0
LBK-R-500-A	1420.5	0.2843	0.2847	0.9649	1	1	0.003	0	0	0	0	0
LBK-R-600-A	1422.31	0.1154	0.1168	0.7112	0.9759	0.998	0.3676	0.0536	0.0126	0.0085	0	0
LBK-R-600-B	1423.72	0.0449	0.048	0.3885	0.7714	0.9145	0.9531	0.4323	0.1932	0.0856	0.0185	0.0049
LBK-R-700-A	1421.79	0.1676	0.1682	0.8414	0.996	0.9999	0.1034	0.0079	0.0025	0.0025	0	0
LBK-R-800-A	1428.01	0.085	0.0874	0.5992	0.9356	0.9897	0.6392	0.1423	0.0405	0.0199	0.0028	0
LBK-R-850-A	1431	0.999	0.999	1	1	1	0	0	0	0	0	0

Table 12: Plan J Engineering Performance, 2065

Report Project Performance by Reaches.
Study: Little Beaver Kill
Plan: Without
Description: Without project condition
Year: 2015
Version 1.4, Sep. 2014; Less Simple Method (0.010)

All units: Feet		Target Stage Annual Exceedance Probability		Long Term Risk (years)			Conditional Non-Exceedance Probability by Events					
Reach Name	**Target Stage**	**Median**	**Expected**	**10**	**30**	**50**	**10%**	**4%**	**2%**	**1%**	**0.40%**	**0.20%**
LBK-L-100-A	1418.59	0.1396	0.1401	0.7789	0.9892	0.9995	0.1673	0.0083	0.0015	0	0	0
LBK-L-100-B	1415	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-L-150-A	1421.59	0.0795	0.0808	0.5693	0.9201	0.9852	0.7337	0.1225	0.0264	0.0103	0	0
LBK-L-150-B	1417	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-L-150-C	1417	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-L-200-A	1423.65	0.0516	0.0532	0.4212	0.8061	0.935	0.9568	0.3379	0.1119	0.0352	0.0042	0
LBK-L-200-B	1426.54	0.0128	0.0155	0.1445	0.3738	0.5416	0.9994	0.9514	0.6938	0.399	0.1321	0.0436
LBK-L-200-C	1417	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-L-300-A	1421.62	0.2295	0.229	0.9257	0.9996	1	0.0053	0	0	0	0	0
LBK-L-300-B	1425.64	0.0351	0.037	0.314	0.6771	0.848	0.9948	0.5771	0.2363	0.0889	0.0132	0.0026
LBK-L-400-A	1421.65	0.2487	0.248	0.9422	0.9998	1	0.0027	0	0	0	0	0
LBK-L-400-B	1422.57	0.1662	0.1658	0.8368	0.9956	0.9999	0.0641	0.002	0	0	0	0
LBK-L-500-A	1420.1	0.4835	0.467	0.9981	1	1	0	0	0	0	0	0
LBK-L-500-B	1422.07	0.2174	0.2169	0.9132	0.9993	1	0.0091	0	0	0	0	0
LBK-R-100-A	1415	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-R-1000-A	1439.6	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-R-1000-B	1439.6	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-R-1050-A	1446.5	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-R-150-A	1423.13	0.0575	0.0591	0.4562	0.8392	0.9524	0.9249	0.2737	0.086	0.0261	0.0029	0
LBK-R-200-A	1417	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-R-300-A	1421.73	0.1816	0.1812	0.8645	0.9975	1	0.0378	0.0008	0	0	0	0
LBK-R-300-B	1423.52	0.0865	0.0876	0.6002	0.9361	0.9898	0.6544	0.0943	0.0183	0.0075	0	0
LBK-R-400-A	1419.97	0.4543	0.4434	0.9971	1	1	0	0	0	0	0	0
LBK-R-400-B	1422.1	0.1996	0.1991	0.8914	0.9987	1	0.0192	0	0	0	0	0
LBK-R-450-A	1421.04	0.3181	0.3173	0.978	1	1	0	0	0	0	0	0
LBK-R-450-B	1420.68	0.3667	0.3653	0.9894	1	1	0	0	0	0	0	0
LBK-R-500-A	1419.5	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-R-600-A	1422.31	0.2065	0.2061	0.9005	0.999	1	0.0142	0	0	0	0	0
LBK-R-600-B	1423.71	0.1037	0.1048	0.6694	0.9639	0.996	0.4614	0.0472	0.0072	0.0032	0	0
LBK-R-700-A	1422.12	0.2427	0.242	0.9374	0.9998	1	0.0032	0	0	0	0	0
LBK-R-800-A	1428	0.0104	0.0129	0.1214	0.3218	0.4765	0.9997	0.9735	0.7693	0.4858	0.1813	0.0656
LBK-R-850-A	1429	0.999	0.999	1	1	1	0	0	0	0	0	0

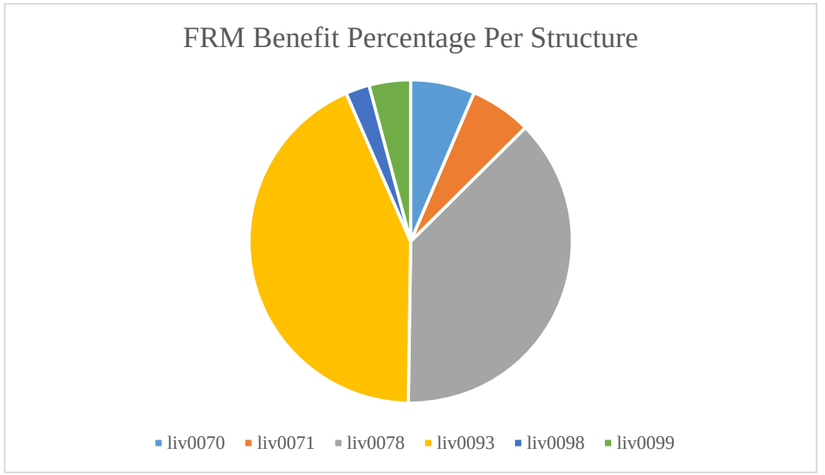
Table 13: Existing Conditions Engineering Performance, 2015

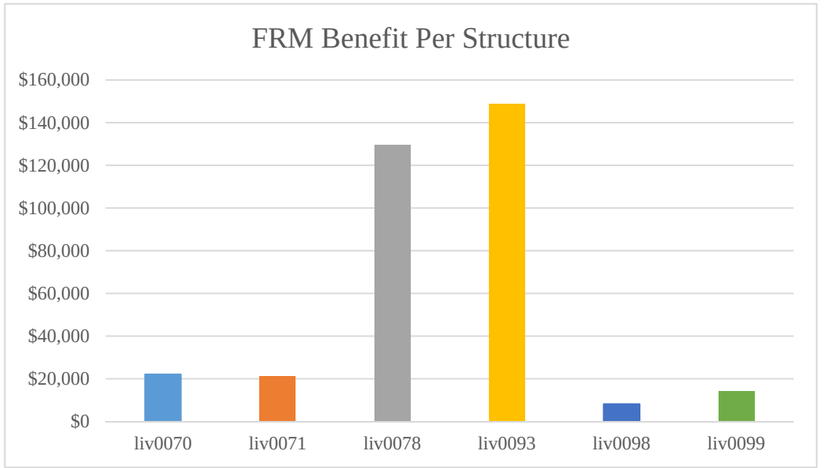
Report Project Performance by Reaches.
Study: Little Beaver Kill
Plan: Without
Description: Without project condition
Year: 2065
Version 1.4, Sep. 2014; Less Simple Method (0.010)

All units: Feet		Target Stage Annual Exceedance Probability		Long Term Risk (years)			Conditional Non-Exceedance Probability by Events					
Reach Name	**Target Stage**	**Median**	**Expected**	**10**	**30**	**50**	**10%**	**4%**	**2%**	**1%**	**0.40%**	**0.20%**
LBK-L-100-A	1418.76	0.2129	0.2125	0.9082	0.9992	1	0.0105	0	0	0	0	0
LBK-L-100-B	1416	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-L-150-A	1421.08	0.252	0.2513	0.9447	0.9998	1	0.0024	0	0	0	0	0
LBK-L-150-B	1419	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-L-150-C	1419	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-L-200-A	1423.61	0.1193	0.1201	0.7217	0.9784	0.9983	0.3062	0.023	0.0035	0.0022	0	0
LBK-L-200-B	1426.51	0.017	0.0195	0.1785	0.4457	0.626	0.9992	0.9206	0.5659	0.3135	0.0859	0.022
LBK-L-200-C	1419	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-L-300-A	1421.62	0.3675	0.3661	0.9895	1	1	0	0	0	0	0	0
LBK-L-300-B	1425.65	0.0769	0.0784	0.5578	0.9135	0.9831	0.7617	0.1337	0.0287	0.0109	0	0
LBK-L-400-A	1421.66	0.3942	0.3917	0.9931	1	1	0	0	0	0	0	0
LBK-L-400-B	1422.57	0.2909	0.2902	0.9676	1	1	0	0	0	0	0	0
LBK-L-500-A	1420.5	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-L-500-B	1422.07	0.3556	0.3545	0.9874	1	1	0	0	0	0	0	0
LBK-R-100-A	1416	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-R-1000-A	1440.8	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-R-1000-B	1440.8	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-R-1050-A	1453.01	0.0116	0.0144	0.1349	0.3527	0.5156	0.9997	0.9624	0.7288	0.4359	0.1545	0.0526
LBK-R-150-A	1422.34	0.1675	0.1678	0.8406	0.996	0.9999	0.0624	0.0025	0	0	0	0
LBK-R-200-A	1419	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-R-300-A	1421.75	0.3145	0.3137	0.9768	1	1	0	0	0	0	0	0
LBK-R-300-B	1422.97	0.2114	0.211	0.9065	0.9992	1	0.0116	0	0	0	0	0
LBK-R-400-A	1420.5	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-R-400-B	1422.11	0.3297	0.3288	0.9814	1	1	0	0	0	0	0	0
LBK-R-450-A	1421.07	0.4749	0.4592	0.9979	1	1	0	0	0	0	0	0
LBK-R-450-B	1420.68	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-R-500-A	1420.5	0.999	0.999	1	1	1	0	0	0	0	0	0
LBK-R-600-A	1422.31	0.3271	0.3263	0.9807	1	1	0	0	0	0	0	0
LBK-R-600-B	1423.72	0.205	0.2054	0.8996	0.999	1	0.0147	0	0	0	0	0
LBK-R-700-A	1421.79	0.4007	0.3985	0.9938	1	1	0	0	0	0	0	0
LBK-R-800-A	1428.01	0.0214	0.0238	0.2142	0.5148	0.7004	0.9996	0.8279	0.4632	0.2128	0.05	0.0124
LBK-R-850-A	1431	0.999	0.999	1	1	1	0	0	0	0	0	0

Table 14: Existing Conditions Engineering Performance, 2065

. Strucutre id	FRM benefit	FRM Evac. Benefit Freq.
liv0070	$22,100	6%
liv0071	$21,140	6%
liv0078	$129,610	38%
liv0093	$148,670	43%
liv0098	$8,210	2%
liv0099	$14,280	4%
Sum	**$344,010**	**100%**





6 Floodplain Evacuation Analysis

In early 2012 an initial appraisal of structures for Floodplain Evacuation Analysis was conducted. The analysis was conducted in accordance with CECW-PD, 22 January 2001, and Public Law 91-646. Eleven structures were Identified from the Livingston Manor, NY inventory for further analysis.

In early 2016, CENAP-PL-D updated the analysis and Identified six structures for further consideration. Those structures are found in the table above, along with each structure's Flood Risk Management (FRM) benefit provided to the Tentatively Selected Plan (TSP) under the Livingston Manor, NY Section 205 study.

To summarize the analysis, if all structures are removed from the floodplain, than the TSP will be heavily affected. The BCR drops from 2.31 to 1.20. Net benefits decrease from $412,000 to $65,000. However, if liv0070, liv0071, liv0098 & liv0099 are bought-out and removed from the floodplain, than the BCR only drops to 2.08. It should be noted that net benefits for the TSP would still decrease by $65,730 if this was considered.

The two structures highlighted in the table above, liv0078 & liv0093, make up 81% of the total FRM benefits provided by the structures being considered for buyouts. Together, they also make up approximately 38% of the total TSP benefit pool.

The following tables summarize the data collected and
Provide further details of the analysis.

The table below displays the data that was collected on each of the six structures in the Livingston Manor Section 205 in accordance with CECW-PD, 22 January 2001. The data was taken from the HEC-FDA *Struc_Details.out* file and post processed in "R." The category "Structure Name" displays the individual structure ID assigned to each structure in the study. The category "Reach Name" indicates the study damage reach to which each structure is assigned. Eight annual chance exceedance (ACE) events are utilized in the HEC-FDA model. The 8 ACE probabilities are: {0.5, 0.2, 0.1, 0.04, 0.02, 0.01, 0.004, 0.002}. The first table displays the EAD at each ACE to the structures during the Existing Conditions plan. The second table displays the average annual damages received at each ACE for the TSP alternative. The "Total Value" category represents the depreciated replacement value assigned per structure.

Existing Conditions

Structure Name	Reach Name	Total Value	Total Damage at 0.5 Probability	Total Damage at 0.2 Probability	Total Damage at 0.1 Probability	Total Damage at 0.04 Probability	Total Damage at 0.02 Probability	Total Damage at 0.01 Probability	Total Damage at 0.004 Probability	Total Damage at 0.002 Probability
liv0070	LBK-R-300-B	$270.68	$0.00	$43.94	$96.27	$120.01	$127.48	$131.08	$143.20	$147.90
liv0071	LBK-R-300-B	$277.62	$0.00	$38.85	$104.64	$131.12	$137.53	$139.36	$151.55	$155.64
liv0078	LBK-R-400-A	$1,227.20	$222.20	$507.32	$626.29	$684.28	$707.10	$721.99	$755.67	$768.76
liv0093	LBK-R-450-B	$1,560.62	$122.51	$569.96	$741.59	$831.60	$863.75	$884.92	$941.00	$958.63
liv0098	LBK-R-450-B	$167.90	$0.00	$25.38	$37.68	$46.55	$50.18	$52.62	$59.59	$62.63
liv0099	LBK-R-450-B	$287.22	$0.00	$44.71	$65.61	$80.72	$86.86	$91.04	$102.82	$107.99

Plan P3-LBK-FDA

Structure Name	Reach Name	Total Value	Total Damage at 0.5 Probability	Total Damage at 0.2 Probability	Total Damage at 0.1 Probability	Total Damage at 0.04 Probability	Total Damage at 0.02 Probability	Total Damage at 0.01 Probability	Total Damage at 0.004 Probability	Total Damage at 0.002 Probability
liv0070	LBK-R-300-B	$270.68	$0.00	$0.00	$0.00	$10.92	$68.16	$97.97	$124.15	$136.74
liv0071	LBK-R-300-B	$277.62	$0.00	$0.00	$0.00	$35.47	$81.27	$108.36	$133.99	$144.37
liv0078	LBK-R-400-A	$1,227.20	$0.00	$184.78	$359.54	$492.24	$581.68	$642.53	$703.79	$739.12
liv0093	LBK-R-450-B	$1,560.62	$0.00	$130.71	$395.31	$561.49	$683.08	$777.34	$860.47	$910.68
liv0098	LBK-R-450-B	$167.90	$0.00	$0.00	$14.17	$25.08	$33.42	$40.83	$49.96	$55.75
liv0099	LBK-R-450-B	$287.22	$0.00	$0.00	$25.51	$44.11	$58.34	$70.95	$86.44	$96.27

* All dollars in 1,000s

Table 15: Floodplain Evacuation Data Summary

The following tables display the FRM benefit that must be removed from the TSP if all the available structures are considered for buyout. "Total FRM Benefit" is calculated as the difference between categories "EAD" & "AAD." Both of these categories are derived from the sum of the weighted damages to ACE frequency intervals.

All Structure IDs that are eligible for buyout considered

Damages for potential buyout structures for LM plan Existing Conditions

ACE	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Total Damage at each ACE	$344.71	$1,230.16	$1,672.08	$1,894.28	$1,972.90	$2,021.01	$2,153.84	$2,201.55
Average Damage by ACE	$787.43	$1,451.12	$1,783.18	$1,933.59	$1,996.96	$2,087.42	$2,177.69	
ACE Frequency Interval	0.3	0.1	0.06	0.02	0.01	0.006	0.002	
Weighted Damages	$236.23	$145.11	$106.99	$38.67	$19.97	$12.52	$4.36	
EAD	**$563.85**							

* all dollars in 1,000s

Damages for potential buyout structures for LM plan P3-LBK-FDA

ACE	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Total Damage at each ACE	$0.00	$315.49	$794.54	$1,169.30	$1,505.96	$1,737.98	$1,958.80	$2,082.92
Average Damage by ACE	$157.74	$555.01	$981.92	$1,337.63	$1,621.97	$1,848.39	$2,020.86	
ACE Frequency Interval	0.3	0.1	0.06	0.02	0.01	0.006	0.002	
Weighted Damages	$47.32	$55.50	$58.92	$26.75	$16.22	$11.09	$4.04	
AAD	**$219.84**							

* all dollars in 1,000s

Total FRM Benefit **$344.01**

Table 16: Total Economic Benefit of All Potential Buyouts

The following tables display the FRM benefit that must be removed from the TSP if structure ID: liv0070 is considered for buyout. "Total FRM Benefit" is calculated as the difference between categories "EAD" & "AAD." Both of these categories are derived from the sum of the weighted damages to ACE frequency intervals.

Structure ID: liv0070

Damages for potential buyout structures for LM plan Existing Conditions

ACE	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Total Damage at each ACE	$0.00	$43.94	$96.27	$120.01	$127.48	$131.08	$143.20	$147.90

Average Damage by ACE	$21.97	$70.11	$108.14	$123.75	$129.28	$137.14	$145.55
ACE Frequency Interval	0.3	0.1	0.06	0.02	0.01	0.006	0.002
Weighted Damages	$6.59	$7.01	$6.49	$2.47	$1.29	$0.82	$0.29
EAD	**$24.97**						

* all dollars in 1,000s

Damages for potential buyout structures for LM plan P3-LBK-FDA

ACE	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Total Damage at each ACE	$0.00	$0.00	$0.00	$10.92	$68.16	$97.97	$124.15	$136.74

Average Damage by ACE	$0.00	$0.00	$5.46	$39.54	$83.06	$111.06	$130.44
ACE Frequency Interval	0.3	0.1	0.06	0.02	0.01	0.006	0.002
Weighted Damages	$0.00	$0.00	$0.33	$0.79	$0.83	$0.67	$0.26
AAD	**$2.88**						

* all dollars in 1,000s

Total FRM Benefit **$22.10**

Table 17: Economic Benefit of Structure liv0070

The following tables display the FRM benefit that must be removed from the TSP if structure ID: liv0071 is considered for buyout. "Total FRM Benefit" is calculated as the difference between categories "EAD" & "AAD." Both of these categories are derived from the sum of the weighted damages to ACE frequency intervals.

Structure ID: liv0071

Damages for potential buyout structures for LM plan Existing Conditions

ACE	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Total Damage at each ACE	$0.00	$38.85	$104.64	$131.12	$137.53	$139.36	$151.55	$155.64

Average Damage by ACE	$19.43	$71.74	$117.88	$134.33	$138.45	$145.46	$153.60
ACE Frequency Interval	0.3	0.1	0.06	0.02	0.01	0.006	0.002
Weighted Damages	$5.83	$7.17	$7.07	$2.69	$1.38	$0.87	$0.31
AAD	**$25.33**						

* all dollars in 1,000s

Damages for potential buyout structures for LM plan P3-LBK-FDA

ACE	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Total Damage at each ACE	$0.00	$0.00	$0.00	$35.47	$81.27	$108.36	$133.99	$144.37

Average Damage by ACE	$0.00	$0.00	$17.73	$58.37	$94.82	$121.18	$139.18
ACE Frequency Interval	0.3	0.1	0.06	0.02	0.01	0.006	0.002
Weighted Damages	$0.00	$0.00	$1.06	$1.17	$0.95	$0.73	$0.28
AAD	**$4.18**						

* all dollars in 1,000s

Total FRM Benefit **$21.14**

Table 18: Economic Benefit of Structure liv0071

The following tables display the FRM benefit that must be removed from the TSP if structure ID: liv0078 is considered for buyout. "Total FRM Benefit" is calculated as the difference between categories "EAD" & "AAD." Both of these categories are derived from the sum of the weighted damages to ACE frequency intervals.

Structure ID: liv0078

Damages for potential buyout structures for LM plan Existing Conditions

ACE	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Total Damage at each ACE	$222.20	$507.32	$626.29	$684.28	$707.10	$721.99	$755.67	$768.76

Average Damage by ACE	$364.76	$566.81	$655.29	$695.69	$714.55	$738.83	$762.22
ACE Frequency Interval	0.3	0.1	0.06	0.02	0.01	0.006	0.002
Weighted Damages	$109.43	$56.68	$39.32	$13.91	$7.15	$4.43	$1.52
AAD	**$232.44**						

* all dollars in 1,000s

Damages for potential buyout structures for LM plan P3-LBK-FDA

ACE	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Total Damage at each ACE	$0.00	$184.78	$359.54	$492.24	$581.68	$642.53	$703.79	$739.12

Average Damage by ACE	$92.39	$272.16	$425.89	$536.96	$612.11	$673.16	$721.45
ACE Frequency Interval	0.3	0.1	0.06	0.02	0.01	0.006	0.002
Weighted Damages	$27.72	$27.22	$25.55	$10.74	$6.12	$4.04	$1.44
AAD	**$102.83**						

* all dollars in 1,000s

Total FRM Benefit **$129.61**

Table 19: Economic Benefit of Structure liv0078

The following tables display the FRM benefit that must be removed from the TSP if structure ID: liv0093 is considered for buyout. "Total FRM Benefit" is calculated as the difference between categories "EAD" & "AAD." Both of these categories are derived from the sum of the weighted damages to ACE frequency intervals.

Structure ID: liv0093

Damages for potential buyout structures for LM plan Existing Conditions

ACE	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Total Damage at each ACE	$122.51	$569.96	$741.59	$831.60	$863.75	$884.92	$941.00	$958.63

Average Damage by ACE	$346.23	$655.77	$786.59	$847.67	$874.33	$912.96	$949.82
ACE Frequency Interval	0.3	0.1	0.06	0.02	0.01	0.006	0.002
Weighted Damages	$103.87	$65.58	$47.20	$16.95	$8.74	$5.48	$1.90
AAD	**$249.72**						

* all dollars in 1,000s

Damages for potential buyout structures for LM plan P3-LBK-FDA

ACE	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Total Damage at each ACE	$0.00	$130.71	$395.31	$561.49	$683.08	$777.34	$860.47	$910.68

Average Damage by ACE	$65.36	$263.01	$478.40	$622.29	$730.21	$818.91	$885.58
ACE Frequency Interval	0.3	0.1	0.06	0.02	0.01	0.006	0.002
Weighted Damages	$19.61	$26.30	$28.70	$12.45	$7.30	$4.91	$1.77
AAD	**$101.04**						

* all dollars in 1,000s

Total FRM Benefit **$148.67**

Table 20: Economic Benefit of Structure liv0093

The following tables display the FRM benefit that must be removed from the TSP if structure ID: liv0098 is considered for buyout. "Total FRM Benefit" is calculated as the difference between categories "EAD" & "AAD." Both of these categories are derived from the sum of the weighted damages to ACE frequency intervals.

Structure ID: liv0098

Damages for potential buyout structures for LM plan Existing Conditions

ACE	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Total Damage at each ACE	$0.00	$25.38	$37.68	$46.55	$50.18	$52.62	$59.59	$62.63

Average Damage by ACE	$12.69	$31.53	$42.11	$48.36	$51.40	$56.11	$61.11
ACE Frequency Interval	0.3	0.1	0.06	0.02	0.01	0.006	0.002
Weighted Damages	$3.81	$3.15	$2.53	$0.97	$0.51	$0.34	$0.12
AAD	**$11.43**						

* all dollars in 1,000s

Damages for potential buyout structures for LM plan P3-LBK-FDA

ACE	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Total Damage at each ACE	$0.00	$0.00	$14.17	$25.08	$33.42	$40.83	$49.96	$55.75

Average Damage by ACE	$0.00	$7.09	$19.63	$29.25	$37.12	$45.39	$52.85
ACE Frequency Interval	0.3	0.1	0.06	0.02	0.01	0.006	0.002
Weighted Damages	$0.00	$0.71	$1.18	$0.58	$0.37	$0.27	$0.11
AAD	**$3.22**						

* all dollars in 1,000s

Total FRM Benefit **$8.21**

Table 21: Economic Benefit of Structure liv0098

The following tables display the FRM benefit that must be removed from the TSP if structure ID: liv0099 is considered for buyout. "Total FRM Benefit" is calculated as the difference between categories "EAD" & "AAD." Both of these categories are derived from the sum of the weighted damages to ACE frequency intervals.

Structure ID: liv0099

Damages for potential buyout structures for LM plan Existing Conditions

ACE	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Total Damage at each ACE	$0.00	$44.71	$65.61	$80.72	$86.86	$91.04	$102.82	$107.99

Average Damage by ACE	$22.35	$55.16	$73.17	$83.79	$88.95	$96.93	$105.41
ACE Frequency Interval	0.3	0.1	0.06	0.02	0.01	0.006	0.002
Weighted Damages	$6.71	$5.52	$4.39	$1.68	$0.89	$0.58	$0.21
AAD	**$19.97**						

* all dollars in 1,000s

Damages for potential buyout structures for LM plan P3-LBK-FDA

ACE	0.5	0.2	0.1	0.04	0.02	0.01	0.004	0.002
Total Damage at each ACE	$0.00	$0.00	$25.51	$44.11	$58.34	$70.95	$86.44	$96.27

Average Damage by ACE	$0.00	$12.76	$34.81	$51.23	$64.64	$78.69	$91.35
ACE Frequency Interval	0.3	0.1	0.06	0.02	0.01	0.006	0.002
Weighted Damages	$0.00	$1.28	$2.09	$1.02	$0.65	$0.47	$0.18
AAD	**$5.69**						

* all dollars in 1,000s

Total FRM Benefit **$14.28**

Table 22: Economic Benefit of Structure liv0099

7 Summary of Results of Economic Analysis

The initial project cost of construction was developed by the USACE Philadelphia District and estimated to be –with contingency included – $7,696,948. Project construction was estimated to be 9 months. The Federal discount rate utilized for the interest during construction (IDC) calculation was 3.125%, making IDC approximately $180,397. After construction, a federal maintenance cost of $10,000 per year for the first 5 years of project life was added to the cost list. The present worth factor was multiplied by each present worth year to find the present worth of cost for that respective year. The total present worth of cost is the sum of all 50 present worth of cost years and is equal to $7,922,979. Next the capital recovery factor, utilizing the 3.125% discount rate and a project life of 50 years, is multiplied by the total present worth of costs to find the average-annual cost (AAC), rounded to $315,000.

The HEC-FDA model outputs the flood risk management (FRM) benefit as the damages reduced by a project alternative. Therefore, the average annual benefit (AAB) for project J is estimated to be $727,000.

The benefit-to-cost-ratio (BCR) is calculated as the proportion of AAB to AAC. The net benefits for a project are the difference between the AAB and the AAC of a project alternative. The BCR for project J is 2.31, and it provides net benefits of $412,000. Table 23 displays the overall summary of the project.

Because project J's BCR is greater than 1, and it provides positive net benefits to the community and society at large, it is deemed in the national interest of the United States to authorize construction of alternative plan J.

LIVINGSTON MANOR, NY
50 YR PERIOD OF ANALYSIS

ECONOMIC ANALYSIS
AAC, AAB, BCR, NET BENEFITS
PRESENT WORTH ANALYSIS

Base Year:	2019 est
FY 16 Discount Rate:	3.125%
Price Level:	Jan-16

TYPE	YEAR	PW YEAR	COST	PW FACTOR	PW COST
INITIAL		0	$7,696,948	1.000000	$7,696,948
IDC		0	$180,397	1.000000	$180,397
	2019	1	$10,000	0.969697	$9,697
	2020	2	$10,000	0.940312	$9,403
	2021	3	$10,000	0.911818	$9,118
	2022	4	$10,000	0.884187	$8,842
	2023	5	$10,000	0.857394	$8,574
	2024	6	$0	0.831412	$0
	2025	7	$0	0.806218	$0
	2026	8	$0	0.781787	$0
	2027	9	$0	0.758096	$0
	2028	10	$0	0.735124	$0
	2029	11	$0	0.712847	$0
	2030	12	$0	0.691246	$0
	2031	13	$0	0.670299	$0
	2032	14	$0	0.649987	$0
	2033	15	$0	0.630290	$0
	2034	16	$0	0.611191	$0
	2035	17	$0	0.592670	$0
	2036	18	$0	0.574710	$0
	2037	19	$0	0.557294	$0
	2038	20	$0	0.540407	$0
	2039	21	$0	0.524031	$0
	2040	22	$0	0.508151	$0
	2041	23	$0	0.492753	$0
	2042	24	$0	0.477821	$0
	2043	25	$0	0.463341	$0
	2044	26	$0	0.449301	$0
	2045	27	$0	0.435685	$0
	2046	28	$0	0.422483	$0
	2047	29	$0	0.409680	$0
	2048	30	$0	0.397266	$0
	2049	31	$0	0.385227	$0
	2050	32	$0	0.373554	$0
	2051	33	$0	0.362234	$0
	2052	34	$0	0.351257	$0
	2053	35	$0	0.340613	$0
	2054	36	$0	0.330291	$0
	2055	37	$0	0.320283	$0
	2056	38	$0	0.310577	$0
	2057	39	$0	0.301166	$0
	2058	40	$0	0.292039	$0
	2059	41	$0	0.283190	$0
	2060	42	$0	0.274608	$0
	2061	43	$0	0.266287	$0
	2062	44	$0	0.258218	$0
	2063	45	$0	0.250393	$0
	2064	46	$0	0.242805	$0
	2065	47	$0	0.235447	$0
	2066	48	$0	0.228313	$0
	2067	49	$0	0.221394	$0
	2068	50	$0	0.214685	$0

TOTAL PRESENT WORTH COSTS	$7,927,345		$7,922,979
CRF (50, 3.125%)			0.039790
		Average Annual Costs:	$315,255
		Rounded to:	$315,000
AVERAGE ANNUAL BENEFITS			$727,000
AVERAGE ANNUAL COSTS			$315,000
BCR			**2.31**
NET BENEFITS			**$412,000**

Table 23: Summary of Economic Analys