

# Hazard Mitigation Loss Avoidance Study Northumberland County, Virginia

Unincorporated Community of Lottsburg - Elevations  
Flood Mitigation Assistance (FMA) 2014, 2016, and 2018  
Hazard Mitigation Grant Program (HMGP) 1905



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## Introduction

The Commonwealth of Virginia has a history and exposure to a wide array of natural hazards as demonstrated by 73 federal disaster declarations occurring since 1953 (Table 1).<sup>1</sup> As such, the Commonwealth has a long-established commitment to hazard mitigation in the encouragement, promotion, assistance with, and funding of the implementation of measures to reduce or eliminate long-term risk to people and property from natural hazards and their effects.

*Table 1: Federally Declared Disaster Declarations in Virginia and Northumberland County*

Incident Type	Virginia (#)	Northumberland (#)
Severe Storm	19	2
Flood	16	2
Hurricane	16	13
Fire	8	
Snowstorm	6	3
Biological	2	2
Drought	2	
Earthquake	1	
Freezing	1	1
Severe Ice Storm	1	1
Terrorist	1	
<b>Total</b>	<b>73</b>	<b>24</b>

Since 1990, more than \$200 million of Hazard Mitigation Assistance (HMA) funding has been allocated<sup>2</sup> to Virginia communities and agencies (Table 2).<sup>3</sup> Of those dollars \$1.2M has been spent on elevations and mitigation reconstruction projects in Northumberland County (Table 3).

To document and evaluate the impact of this funding, and update the *Commonwealth of Virginia Hazard Mitigation Plan*, VDEM determined that it is appropriate to examine a selection of completed mitigation projects and estimate the real-world losses avoided through those projects.

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<sup>1</sup> FEMA Open Data: <https://www.fema.gov/openfema-data-page/disaster-declarations-summaries-v2>

<sup>2</sup> Includes closed, obligated, and approved projects.

<sup>3</sup> FEMA Open Data: <https://www.fema.gov/openfema-data-page/hazard-mitigation-assistance-projects-v2>

Table 2: Hazard Mitigation Assistance (HMA) grants 1990 – 2022 Virginia

HMA Project Type - Virginia	\$ Amount	# Projects
Elevation of Private Structures - Coastal	\$51,382,872	58
Acquisition of Private Real Property (Structures and Land) - Riverine	\$34,982,356	96
Acquisition of Private Real Property (Structures and Land) - Coastal	\$24,779,435	27
Infrastructure Protective Measures	\$21,542,612	2
Management Costs	\$19,229,850	40
Elevation of Private Structures - Riverine	\$14,175,181	29
Multihazard Mitigation Plan	\$13,815,496	101
Generators	\$4,391,898	22
Acquisition of Public Real Property (Structures and Land) - Riverine	\$4,176,433	9
Acquisition of Public Real Property (Structures and Land) - Coastal	\$2,621,939	3
Stormwater Management - Diversions	\$2,538,191	3
Flood Control - Dam	\$2,510,440	1
Shoreline Stabilization (Riprap, etc.)	\$2,328,770	1
Stormwater Management - Culverts	\$2,203,414	3
Other Equipment Purchase and Installation	\$1,833,474	15
Miscellaneous	\$1,680,426	18
Other Non Construction (Regular Project Only)	\$1,358,447	12
Warning Systems (as a Component of a Planned, Adopted, and Exercised Risk Reduction Plan)	\$1,179,492	14
Retrofitting Public Structures - Wind	\$1,023,034	5
Public Awareness and Education (Brochures, Workshops, Videos, etc.)	\$965,089	22
Water and Sanitary Sewer System Protective Measures	\$734,432	7
Stormwater Management - Detention/Retention Basins	\$730,000	1
Dry Floodproofing Private Structures - Riverine (Commercial)	\$576,176	4
Advance Assistance (FMA and PDMC)	\$517,082	3
Landslide Stabilization - Structural	\$516,994	1
Mitigation Reconstruction	\$502,221	3
Feasibility, Engineering and Design Studies	\$461,076	6
Utility Protective Measures (Electric, Gas, etc.)	\$370,389	3
No Data	\$335,335	10
Relocation of Private Structures - Riverine	\$151,079	3
Advanced Assistance	\$125,000	1

<b>HMA Project Type - Virginia</b>	<b>\$ Amount</b>	<b># Projects</b>
Developing, Implementing and Enforcing Codes, Standards, Ordinances and Regulations	\$118,712	1
Technical Assistance - Outreach/Training	\$116,666	2
FMA or CRS Plan	\$54,800	1
Dry Floodproofing Private Structures - Coastal (Commercial)	\$45,860	1
Stormwater Management - Flapgates/Floodgates	\$27,000	1
Planning Related Activities	\$12,120	1
Technical Assistance - Application Development/Review	\$0	1
<b>Grand Total</b>	<b>\$214,113,791</b>	<b>531</b>

*Table 3: Hazard Mitigation Assistance (HMA) grants 1990 – 2022 Northumberland County*

<b>HMA Project Type – Northumberland County</b>	<b>\$ Amount</b>	<b># Projects</b>
Elevation of Private Structures - Coastal	\$979,424	5
Mitigation Reconstruction	\$216,771	1
<b>Grand Total</b>	<b>\$1,196,195</b>	<b>6</b>

This report presents the study in the following sections: 1) Study Summary, 2) Project Summary, 3) Study Methodology, and 4) Loss Avoidance Calculations.

## Study Summary

The study area is located in the Village of Lewisetta in Lottsburg Magisterial District, Northumberland County which is part of the Northern Neck Planning District Commission (NNPDC). The NNPDC has identified, through a Hazard Identification and Risk Assessment (HIRA) process, 13 natural hazards most likely to impact the district's communities. Coastal and riverine flooding were assessed as the third and fourth highest risks, respectively, to mitigate.<sup>4</sup> The projects selected for the study include five private property elevations located adjacent to the Potomac River. This area has an extensive history of coastal and riverine flooding. It has also experienced post-mitigation flooding necessary for a study such as this one, to determine what losses would have occurred had those structures remained unmitigated when later flooding occurred.

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**Study Area** – Northumberland County, Lottsburg, Village of Lewisetta

**Hazard Type** – Coastal Flooding

**Project Type** – Elevation

**Total Project Cost** – \$979,424

**Total Losses Avoided** – \$582,960

**Return on Investment (ROI) | Benefit-Cost Ratio** – 0.60

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Damages from this single post-mitigation event do not yield cost effectiveness. However, considering the history and assumption of continued flooding to these properties, it is assumed the return on investment will be experienced over the course of the project useful life of 30 years. Overall, benefit cost analysis yields a BCR of 1.77 using a 7% discount rate, and a 2.76 BCR using a 3% discount rate.

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<sup>4</sup> Northern Neck Planning District Commission Hazard Mitigation Plan Update Draft 2023 at <https://www.northernneck.us/regional-northern-neck-hazard-mitigation-plan/>



Figure 1: Location of mitigated properties

## Project Summary

The five project structures included in this LAS were elevated between 2015 & 2021.

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**Grant:** Hazard Mitigation Assistance

**Subgrant(s):** Flood Mitigation Assistance (FMA) 2014, 2016, and 2018; Hazard Mitigation Grant Program (HMGP) DR-1905-VA<sup>5</sup>

**Project Number** – N/A

**Applicant** – Northumberland County

**Hazard Mitigation Plan** – Northern Neck Hazard Mitigation Plan<sup>6</sup>

**Flood Zone Designation** – AE

**Flood Insurance Study** - 51133CV000C<sup>7</sup>

**Project Type** – Elevation of 5 residential properties

**Project Useful Life** – 30 Years<sup>8</sup>

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### *Pre-Mitigation Problem Description*

The Village of Lewisetta, Lottsburg is located in Northumberland County on the Northern Neck of Virginia. The Northern Neck is bounded by the Potomac River to the north and east, the Chesapeake Bay to the east, and the Rappahannock River to the east and south. The buildings are secondary residences located in the 100-year floodplain and have experienced repetitive flooding.

According to the Northern Neck Hazard Mitigation Plan, the county has experienced 14 coastal and 8 riverine significant flood events (1996–2022) incurring over \$23M in property damage.

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<sup>5</sup> DR-1905-VA was declared April 27, 2010 - Severe Winter Storms & Snowstorms

<sup>6</sup> 2022 2<sup>nd</sup> Draft version at <https://www.northernneck.us/regional-northern-neck-hazard-mitigation-plan/>

<sup>7</sup> Flood Insurance Study Northumberland County, Virginia, 51167CV000A, December 30, 2021

<sup>8</sup> FEMA Benefit-Cost Analysis *BCA Reference Guide*, June 2009 at <https://www.fema.gov/grants/guidance-tools/benefit-cost-analysis>





Figure 2: Mitigated properties pre-mitigation photos

### Post-Mitigation Event

A coastal flood event occurred in October 2021, causing the evacuation of the Village of Lewisetta.

*“A strong low pressure system that deepened offshore of the northeast US coast during the night of October 27 (and especially by October 28th) was responsible for sending long-period swell our way that served to increase water levels in areas adjacent to the Chesapeake Bay (especially the mid and upper bay). This is evidenced by the two large, successive flood tides that were observed at Cape Henry (which is near the mouth of the bay). Water levels were already above moderate flood thresholds in many locations adjacent to the bay by the early morning hours of the 29th. Then, another strong low pressure system slowly approached from the west-southwest during the day on the 29th, while its associated occluded front approached from the SSW. Moderate to strong easterly winds were observed during the day on the 29th (ahead of the front), with gusts of 40-50 mph in spots near the coast. These strong easterly winds served to increase tidal anomalies further, reaching 4ft (or more) above normal in spots near the mid/upper bay by the*

afternoon of the 29th (where major flooding was already occurring in multiple locations). However, the worst of the flooding was observed across the mid/upper bay during the evening high tide cycle on the 29th, as winds were veering to the SSW in the wake of the occluded front. Despite the fact that astronomical tides were relatively low, water levels during the evening high tide on 10/29 at Cambridge, Bishop's Head, and Crisfield, Maryland were the highest observed since Hurricane Sandy in 2012 (at Crisfield) and Hurricane Isabel in 2003 (at Cambridge and likely Bishop's Head). **In fact, water levels were so high that the entire village of Lewisetta, Virginia had to be evacuated. In Cambridge, MD, shelters had to be opened for residents impacted by the extremely high water levels.**<sup>9</sup>



Figure 3: Mitigated properties post-mitigation photos

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<sup>9</sup> National Weather Service at <https://storymaps.arcgis.com/stories/f84a1640e8934b44a37da1191b0cb05e;>  
[https://www.weather.gov/akq/Oct28-30\\_2021\\_coastalflooding](https://www.weather.gov/akq/Oct28-30_2021_coastalflooding)



*Figure 4: Photo of flooding during post-mitigation event October 2021*

## **Study Methodology**

A loss avoidance study (LAS) provides a justification for existing and future mitigation projects and activities. The ability to assess the economic performance of mitigation projects over time is important to encourage future funding and continued support of mitigation projects, activities, and programs. An LAS requires that the project(s) studied be completed prior to the event(s) analyzed, as losses avoided through the mitigation measure are determined by comparing the damage that would have been caused by the event had the projects not be implemented.

The following list provides examples of standard data inputs for conducting an LAS:

- Cost of the mitigation measure
- First floor elevations (pre-mitigation)
- First floor elevations (post-mitigation – Elevations only)
- Base Flood Elevations
- Stillwater elevations
- Building type
- Number of stories
- Foundation type
- Square footage of the structures
- Building replacement value
- Number of residents, and number employed
- Depth of flooding in project area (post-mitigation event)

## Assumptions

- All buildings have an active NFIP Policy.
- Building replacement value is based on generic R.S. Means values for an average construction class for 1 or 2 story structures at \$128 and \$133 per square foot respectively.<sup>10</sup>
- Contents replacement value is based on FEMA BCA 6.0 Toolkit default of 100% for residential properties.
- Depth damage function values are based on FEMA BCA 6.0 Toolkit to determine avoided building, contents, and displacement costs during the post-mitigation event.
- For elevated properties there is a social benefit assuming on average a 2 plus person household with at least one person working.
- Flood depth at property location were estimated using historic flood depths and water levels at Lewisetta, VA - Station ID: 8635750.<sup>11</sup>

## Loss Avoidance Calculations

To complete this study, the following calculations were performed to estimate losses avoided through mitigation from the October 2021 post-mitigation coastal flooding event:

- Building depth-damage
- Building contents depth-damage
- Displacement costs
- Social benefits
- Benefit cost ratio

*Table 4: Example of stillwater elevations*

Recurrence Interval	Stillwater Elevation
10	3.4
50	4.6
100	5.1
500	6.1

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<sup>10</sup> Hazus 6.0 Inventory Technical Manual at

[https://www.fema.gov/sites/default/files/documents/fema\\_hazus-inventory-technical-manual-6.pdf](https://www.fema.gov/sites/default/files/documents/fema_hazus-inventory-technical-manual-6.pdf)

<sup>11</sup> Water Levels at Lewisetta, VA - Station ID: 8635750 at

<https://tidesandcurrents.noaa.gov/stationhome.html?id=8635750>

Table 5: Example depth damage curve - Building

Depth Damage Curve - Building		
Flood depth (ft)	Percent (%)	Damage Value (\$)
-2	0.5	2,110.52
-1	0.5	2,110.52
0	1.0	4,221.04
1	12.5	52,763.04
2	20.4	86,109.28
3	25.9	109,325.01
4	31.7	133,807.06
5	33.5	141,404.94
6	37.5	158,289.12
7	39.4	166,309.10
8	42.2	178,128.02
9	45.1	190,369.04
10	46.6	196,700.61
11	46.6	196,700.61
12	46.6	196,700.61
13	46.6	196,700.61
14	46.6	196,700.61
15	46.6	196,700.61
16	46.6	196,700.61

Table 6: Example depth damage curve - Contents

Depth Damage Curve - Contents		
Flood depth (ft)	Percent (%)	Damage Value (\$)
-2	0.0	-
-1	0.0	-
0	0.0	-
1	22.0	11,143.55
2	30.0	15,195.75
3	39.0	19,754.48
4	45.0	22,793.63
5	48.0	24,313.20
6	52.0	26,339.30
7	56.0	28,365.41
8	59.0	29,884.98
9	61.0	30,898.03

Depth Damage Curve - Contents		
Flood depth (ft)	Percent (%)	Damage Value (\$)
10	63.0	31,911.08
11	63.0	31,911.08
12	63.0	31,911.08
13	63.0	31,911.08
14	63.0	31,911.08
15	63.0	31,911.08
16	63.0	31,911.08

Table 7: Example depth damage curve - Displacement

Depth Damage Curve - Displacement		
Flood depth (ft)	Days	Damage Value (\$)
-2	0	-
-1	0	-
0	0	-
1	45	12,748.37
2	90	25,496.75
3	135	38,245.13
4	180	63,741.89
5	255	79,677.36
6	270	95,612.84
7	315	111,548.31
8	360	101,987.03
9	405	114,735.41
10	450	127,483.79
11	450	127,483.79
12	450	127,483.79
13	450	127,483.79
14	450	127,483.79
15	450	127,483.79
16	450	127,483.79

### Losses Avoided

Losses avoided and the benefit-cost ratio are reported below. Table 8 reports the property ID, total project cost, estimated depth of flooding from the October 2021 storm event, value of damage to the building and contents, displacement costs and benefit cost ratio. Expected annual social benefits are an estimated \$13,622 per structure.

Table 8: Losses avoided

ID	Total Project Costs	Flood Depth	Building Damage Value	Contents Damage Value	Displacement Damage Value	Total Damage Losses Avoided	Benefit-Cost Ratio
1	\$210,882	2	\$59,759	\$33,101	\$18,180	\$111,040	0.53
2	\$188,920	0	\$30,201	\$21,393	\$0	\$51,593	0.27
3	\$209,000	2	\$60,864	\$43,085	\$25,452	\$129,401	0.62
4	\$168,222	3	\$71,753	\$37,396	\$27,270	\$136,419	0.81
5	\$202,400	1	\$94,118	\$51,298	\$9,090	\$154,506	0.76
	<b>\$979,424</b>		<b>\$316,695</b>	<b>\$186,273</b>	<b>\$79,992</b>	<b>\$582,960</b>	<b>0.60</b>

Damages from this single post-mitigation event do not yield cost effectiveness. However, considering the history and assumption of continued flooding to these properties, it is assumed the return on investment will be experienced over the course of the project useful life of 30 years. Overall, benefit cost analysis yields a BCR of 1.77 using a 7% discount rate, and a 2.76 BCR using a 3% discount rate.

Note: The only individual property not yielding an overall cost effective BCR is 108 Island Lane.