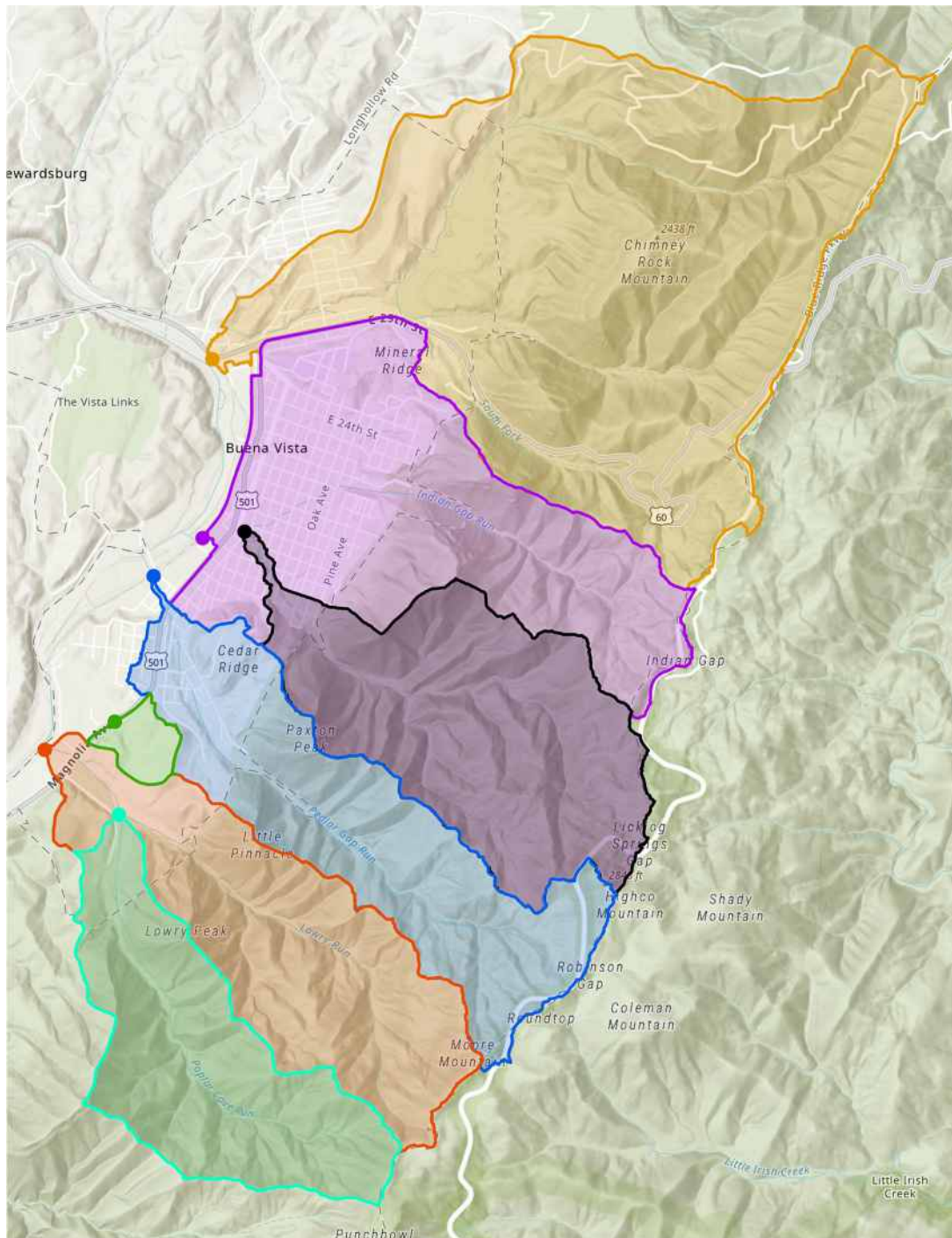


Buena Vista, Virginia

Stormwater Risk & Resilience Plan of Internal Streams

June, 2026



**Civil Consulting
Group, P.C.**
ENGINEERING
DESIGN & ANALYSIS

3688 Country Club Road · Troutville, VA 24175 · (540) 992-2242



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Executive Summary

Flood Risk is the probability of a flood occurring, combined with the consequences if it does occur. Flood Resilience is the ability to recover from a flood event.

Buena Vista has been ravaged by floods throughout its modern history, with the 1960s to 1990s seeing multiple catastrophic events resulting in tens of millions of dollars in damage and the permanent loss of many businesses. The James R. Olin Floodwall was completed in the 1990s to contain the Maury River, but it did nothing to prevent flooding from the City's five interior streams: Chalkmine Run, Indian Gap Run, Noel's Run, Pedlar Gap Run, and Lowry Run. The first four streams drain over 8,000 acres of steep terrain into Buena Vista's flatter downtown area and transport an endless supply of cobbles and debris, clogging everything in their paths. Lowry Run, located at the southern end of the City near Dickinson Lane, is largely undeveloped and drains 2,307 acres under Route 501 beside the City's water filtration plant.

To reduce recurring flood damage from interior streams, and to enhance resilience, several projects were undertaken in the 1980s and 90s ranging from elevating/relocating/demolishing 28 flood-prone homes, to channelizing streams, to installing many new culverts, some of which have liftable tops to aid in debris removal. It was well-known that these measures, while very helpful, would not eliminate frequent flooding.

Since 1999, several local and regional studies have been prepared, examining threats to Buena Vista's safety and economic vitality:

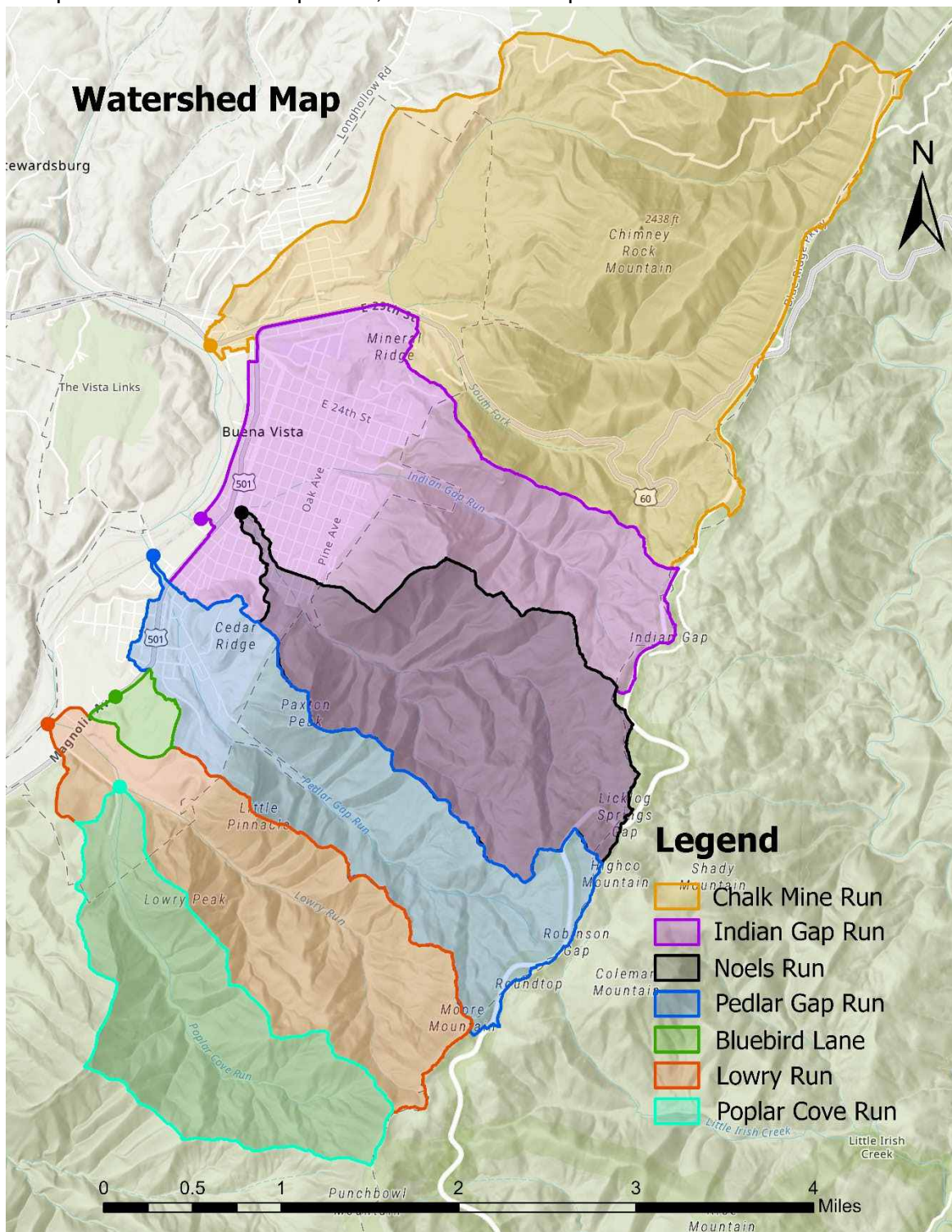
- 1999 Buena Vista Watershed, Final Plan – Environmental Impact Statement
- 2002 Central Shenandoah Valley Regional Flood Mitigation Plan
- 2020 Central Shenandoah Hazard Mitigation Plan
- 2020 Buena Vista Community Water System Risk and Resiliency Analysis and Emergency Response Plan
- 2022 Buena Vista, Lexington, and Rockbridge County Emergency Operations Plan

These documents are hereby incorporated via reference and are included in the Appendix.

The 2002 and 2020 Central Shenandoah studies are thorough in addressing overall risks and recommending resilience measures, while the 2020 Community Water plan looked solely at threat mitigation and resilience measures for potable water sources, treatment, and distribution.

In the mid-1990s, the Natural Resources Conservation Service (NRCS), a division of the USDA, began a multi-year study to quantify the interior flooding and associated financial costs, and to recommend infrastructure improvements to substantially reduce flood damage. It was published in 1999 as Buena Vista Watershed, Final Plan – Environmental Impact Statement. The study

included HEC-1 and HEC-2 numerical models that estimated the runoff rates, volumes, and flood depths for various return periods, with and without potential infrastructure enhancements.



The NRCS report excluded Lowry Run due to its lack of development, but was otherwise very thorough, recommending \$20.8 million (2025 dollars) in improvements to reduce damage from the 100-year storm event to its practicable lower limit. The recommendations included debris basins, channelization, and bridge/culvert replacements. The most significant impediments to flow were often railroad bridges over the streams near the floodwall, that tend to backup interior water into downtown. Without improving the bridges' hydraulic capacities, water will continue to flood parts of downtown despite other upstream improvements. The report and its recommendations were accepted by the federal government, but money was never appropriated and the City appears to have abandoned pursuit.

Of the flood mitigation projects recommended by NRCS, a few were later completed, all in the Chalkmine Run watershed, parallel to 29th Street (Route 60). Here, two debris basins were installed and three bridges were replaced. A recommended channelization between the Route 60 bridge and Rockbridge Avenue was designed in 2010, but was never fully permitted or constructed.

The best way to be flood-resilient is to minimize flooding in the first place. Therefore, it is essential that Buena Vista perform periodic inspections and maintenance on the existing debris basins, channels, bridges, and culverts in order to maximize their already limited capacities. This avoids exacerbating damage from storms and, hypothetically, turning a 5-year rainfall event into a 10-year flooding event. It has been several years since significant maintenance was performed and there is some question as to who is, or should be, responsible for maintaining the channels. Should it be the City, the landowners, or more likely, a combination of both?

Overall Recommendations

Buena Vista must be pro-active in maintaining its present system while enhancing it whenever opportunities arise. All the projects recommended in the 1999 NRCS study are still valid, though expensive, and should be long term goals. However, there are more pressing, but less costly things that Buena Vista must do to reduce risk and enhance resilience, all of which are explored within this report. Below is a summary of the recommendations.

1. **Replace the Woodland Avenue Culvert (capital project)**

The Woodland Avenue culvert on Pedlar Gap Run was installed in the 1970s and due to corrosion, has collapsed at its entrance and deformed along its 150-foot length. The City has just completed a temporary, emergency repair to its entrance, but the culvert must be replaced in the very near term to avoid total collapse. The culvert is hydraulically undersized and the 1999 NRCS report recommended replacing it with a large, single-span, precast structure, but did not give the size. Buena Vista should begin the process to analyze the flows, prepare the necessary design and construction documents, and bid the project to contractors. The analysis, design, and bid documents

are estimated to cost \$121,000 and construction is estimated at \$300,000 based upon 150 linear feet times \$2,000 per linear foot. Buena Vista should pursue CFPF grant funding for this critical project.

Summary

Hydrologic/Hydraulic Analysis, Structure Design, Bid Package, and Construction Administration	\$121,000
Construction of new structure (estimate based on limited info)	<u>\$300,000</u>
Total Budgetary Figure	\$421,000

2. Restore the Debris Basins on Chalkmine Run (capital project)

Buena Vista should restore the two debris basins on Chalkmine Run to their initial states. The original design documents and maintenance agreement from 2005 are provided in Appendices 8, 9, and 10 of this report. The cost for restoring the two basins is estimated at \$40,000 and is considered a capital project. This will reduce flood risk and enhance resiliency by diminishing the volume of cobbles and debris available to clog the channel and bridges between the entrance to the former Northwest Hardwoods and the Maury River.

3. Construct Remaining NRCS Recommended Debris Basins (capital project)

NRCS recommended constructing seven additional debris basins on three interior streams. The City should examine ownership of the recommended locations and explore costs associated with acquiring properties and constructing the debris basins. Based upon limited cost data from the NRCS report, the total cost of an average basin in 2025 is estimated at \$651,000 for a total cost of \$4.56 million. Buena Vista should rank potential locations based upon usefulness and cost, then pursue funding to acquire the land, then design and construct as many basins as possible.



Debris Basin on Chalkmine Run shortly after construction

4. Perform Deferred Maintenance

Buena Vista should perform Deferred Maintenance as summarized in the following table, with 1 being the highest priority. The tasks are explained within the body of the main report, and the costs are those expected if a contractor was hired to do the work, but it could be done in-house for less money. The regulations for working in a stream are complex, therefore we recommend the City submit a Joint Permit Application. The preparation cost for this is estimated at \$12,000. The permits are good for several years and readily renewed.

Because this is deferred maintenance that can be completed in a specific time, and since Buena Vista lacks adequate in-house personnel to complete the task, the City should pursue a CFPF grant to hire two workers for two years. Performing deferred maintenance is crucial to reducing the frequency and severity of flooding.

The maintenance cost estimates below assume that a contractor is hired to complete the tasks. As noted, hiring two workers for two years would likely reduce the total cost.

Deferred Maintenance Summary Based Upon Priority

Priority 1-highest 3-lowest	Watershed	Total Cost
1	Indian Gap Run	\$38,750
1	Noel's Run	\$130,000
1	Pedlar Gap Run	\$60,000
1	Chalkmine Run	\$0
Priority 1 Total		\$228,750
Priority	Watershed	Total Cost
2	Indian Gap Run	\$95,500
2	Noel's Run	\$13,500
2	Pedlar Gap Run	\$15,000
2	Chalkmine Run	\$83,750
Priority 2 Total		\$207,750
Priority	Watershed	Total Cost
3	Indian Gap Run	\$110,000
3	Noel's Run	\$0
3	Pedlar Gap Run	\$98,500
3	Chalkmine Run	\$293,750
Priority 3 Total		\$502,250
Total of All Maintenance Priorities		\$938,750

5. Establish Maintenance Responsibilities

The City should collaborate with the Department of Environmental Quality to review its flood management ordinances and permitting and enforcement procedures for compliance with current regulations and adherence to best practices.

The City must also determine who is responsible for maintaining the creek channels: the City, the property owner, or no one? Several other questions must be answered:

- a. Was an easement placed on the concrete portion of Indian Gap Run when it was constructed?
- b. Are there any maintenance easements on the other channels?
- c. It is assumed that the City would be responsible for maintaining the elements within the rights-of-way which would capture all the culverts, bridges, and short sections of the channels.
 1. The City should determine with certainty whether it is responsible for property damage due to flooding if the City has not been maintaining the channels and crossings.
 2. How would this affect the City's insurance?
- d. The City should determine whether it can pass an ordinance requiring property owners to maintain their channels and how it would be handled if the channel is the property line. What liability would the owners have if their section unmaintained of channel is determined to have exacerbated a flood?
- e. The City should consider a separate fee related only to maintaining interior channels and perhaps the City's closed pipe system. This would provide an earmarked source of revenue where none presently exists.
 1. The 2020 Central Shenandoah Planning District Commission (CSPDC) report entitled Central Shenandoah Hazard Mitigation Plan contains the results of a regional survey (pages 329-346) in which 75% of respondents said they would be willing to spend between \$1000 and \$5000 to better protect their homes and families from floods. This was a total cost, not an annual cost.

6. Ongoing Maintenance Recommendations

- a. After performing the deferred maintenance/cleanup, the necessary effort for ongoing maintenance will be better understood. Buena Vista should establish a schedule to maintain two streams per year. This will ensure that each stream receives attention every other year.
- b. After each significant rainfall, inspect all culverts and bridges from the roadways for debris and potential blockages. Encourage citizens to call if they see blockages. Perform emergency maintenance as needed to keep them clear.

- c. Once yearly, inspect all channels and structures from within the channels.
- d. Incorporate asset management into the GIS database to track details, photos, and maintenance histories of all stormdrain elements. This should ultimately include the five streams, their major tributaries, and their appurtenances, as well as the City's entire stormwater piped collection/conveyance system. Adding this information to the GIS system will ensure that it is not lost due to personnel changes.
- e. It is understood that cobbles will build-up over time and effectively reduce channel depths. This may be observable by comparing multi-year high resolution contour data such as that available through VGIN (VA Geographic Information Network). Buena Vista should consult with VGIN to confirm this approach, and if valid, Buena Vista should purchase the necessary data from VGIN every time it is updated. Keeping the channels and banks free of excess vegetation will facilitate the most accurate Lidar mapping.

7. Additional Recommendations

There are several other things that Buena Vista should do to increase its stormwater resilience:

- a. Make 'betterment' improvements to channels, culverts, and bridges when other work is done. The bottlenecks causing much of the flooding are the bridges and culverts in the lower reaches of the system. Whenever any hydraulic structures are rehabilitated or replaced, they should be upsized to increase stormwater capacity. Some will argue that there is no point in spending extra money when so many other impediments to flow will remain unchanged. However, there will likely never be an opportunity to simultaneously replace all the bottlenecks as recommended in the 1999 NRCS study. Therefore, the only way to ameliorate the problems will be one element at a time. To facilitate this, the City must maintain constant contact with the railroad, VDOT and other in-stream structure owners to ensure that they do not implement a project affecting the creeks without the City having an opportunity to increase capacity. Buena Vista should determine if it can require this in its ordinance.
- b. In order for the City to quantify the benefits of the "betterment" described above, and to justify certain capital improvements, hydraulic models are necessary. Significant searching has shown that no one at the federal or local level retained copies of the HEC-1 and HEC-2 models from the 1990s, nor did the company that prepared them. Creating new models on short notice because a bridge or culvert must be replaced is likely untenable, so an opportunity may be lost. The solution is to recreate the models in the near term so they are on-hand.

The availability of high-resolution, 1' contour data and other modern resources make it much easier and cost-effective to create in-house floodplain models that could be used to quantify the effects of improvements to channels, culverts, and bridges. Buena Vista should have the models recreated for the three internal watersheds with significant development. A partial model of Chalkmine Run is available from the 2010 channel improvements plan that was never implemented, and Lowry Run is undeveloped. The City could apply for a CFPF grant to do all three models. If unsuccessful, the City should either continue trying, pare the application back to one model, or budget its own money to do one model every year (or every other year), until they are complete. Each model should have the existing conditions, plus whatever recommendations can be gleaned from the NRCS study. Recall that the NRCS report does not always give dimensions or adequately explain the physical properties of all their recommended improvements. Once created, the models are easily altered to estimate the effects of changes.

Modern models also make it much easier to analyze the flooding effects of climate-induced increases in rainfall, as well as to model nature-based solutions for channel improvements. A budgetary estimate is \$100,000 per model which would be \$300,000 total. There would be economies of scale for doing all three simultaneously. The costs would include hydrologic runoff modeling in HEC-HMS and flood modeling in HEC-RAS.

- b. The peak runoff rates vary greatly depending upon what model or data is used. For instance, FEMA used stream gauge data for their runoff rates whereas NRCS used TR-55, a model that accounts for drainage shed area, slope, soils, and land cover. NRCS believes the stream gauge data in this area is too limited to reliably estimate peak runoff rates. For instance, for a 100-year storm on Chalkmine Run, FEMA used 1,920 cubic feet per second, whereas NRCS estimated 7,336 cubic feet per second. The difference has a profound impact on estimated flooding. NRCS had the storm data and flood photos from the 1990s to consider when it prepared its model, whereas FEMA's model was created circa 1977.

If Buena Vista is going to work with VDOT, Norfolk Southern, and other entities on enhancing capacity, then there must be consistent flow rates for each drainage shed that everyone uses. We recommend that the City utilize the rates from the 1999 NRCS study for this purpose.

- c. Study and implement the recommendations in the Debris Management Plan in Appendix 22.

- d. The City should promote and educate the public about the National Flood Insurance program in an effort to increase the number of properties covered.
- e. The City should evaluate implementation of the Community Rating System (CRS) to potentially reduce NFIP policy premiums.
- f. The City should conduct detailed study and mapping of its existing gray (traditional hard infrastructure such as pipes, inlets, channels) and green stormwater management (grass swales, rain gardens, etc.) collection and conveyance systems to identify and address localized flooding, erosion and sediment control, and water quality concerns.
- g. The City should engage the Virginia Department of Emergency Management for technical assistance in procurement of contractors for debris management. Also, they should consider strategic reuse of collected debris, such as rocks, limbs, etc. for other flood hazard, stabilization, or other environmental projects, such as fill material, armoring riverine banks, etc.

8. Funding Mechanisms

Aside from the previously discussed CFPF grants, the City will need other funding mechanisms.

- a. Search for other grants related to infrastructure resilience.
- b. Consider a stormwater fee that would be used to maintain and improve the streams and pipes within the stormwater system. These are generally assessed over the entire locality based upon a parcel's impervious area.
- c. Consider passing an ordinance requiring property owners to maintain their own stream channels and embankments, thus relieving the City of the cost. The City must have the political will to enforce such a requirement.

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Introduction

Floods have devastated Buena Vista multiple times over the past 100 years. Earlier floods resulted from the Maury River overtopping its banks, but through the twentieth century, historic stream beds became more constricted by development, impervious areas increased, and many bridges and culverts were constructed. As a result, flooding in the 1980's and 1990's wrought havoc along the developed interior streams: Chalkmine Run, Indian Gap Run, Noel's Run, and Pedlar Gap Run. Together, they direct stormwater runoff from over 8,000 acres into the low-lying areas of the City. Lowry Run was also decimated, but there is no development along its banks. The upper parts of the drainage sheds are very steep, with an endless supply of cobbles that wash down, clogging channels, culverts, and bridges. Recognizing this risk, the Corps of Engineers constructed multiple new culverts, while a second project funded by the Virginia Department of Housing and Community Development (DHCD) converted most of Indian Gap Run into a trapezoidal concrete channel. These projects were very helpful, but not sufficient to eliminate the flooding, mostly because the streams' capacities are limited in their lower reaches by undersized bridges, culverts, and channel sizes.

In the mid-1990s, the Natural Resources Conservation Service (NRCS), a division of the USDA, began a multi-year study to model the interior flooding and associated financial costs. Published in 1999 as Buena Vista Watershed, Final Plan – Environmental Impact Statement, it also evaluated the infrastructure improvements and costs necessary to substantially reduce flood damage. This exhaustive report is a wealth of knowledge and its utility cannot be overstated.

The multiple 1969 to 1996 flood events coincided with regional and national trends from the last quarter of the twentieth century, such as offshoring and the alignment of Interstates 64 and 81, to hollow-out both small businesses downtown, and larger manufacturers. This prompted many of Buena Vista's larger employers to leave town, creating a downward spiral which has only begun leveling-out since approximately 2010.

The tables on the following page contain damage summaries for each of the four developed watersheds which are based upon actual damage estimates from the 1996 flood and interpolated/extrapolated to standard return periods of 5, 25, and 100 years. The costs were escalated from the mid-1990s to 2025 using by a factor of 3.0 based upon published data. The original spreadsheets and other very important information are contained in Appendix 15.

In 2024, the City was awarded a grant from DCR's Community Flood Preparedness Fund (CFPF) to examine flooding from interior streams and to prepare a risk and resilience plan. Flood Risk is a combination of the probability (likelihood) of a flood occurring and the consequences (potential impact) if it does occur. Flood Resilience has traditionally meant the ability to recover from a flood event, but lately, the definition has expanded to include minimizing flood damage. This report examines both risk and resilience together, and provides recommendations for new

projects, maintenance of existing in-stream appurtenances, and other ways to reduce flooding risk. The former informs the latter and there is some necessary overlap. Both elements provide programmatic and project-based recommendations for the City to implement in coming years. A Debris Management Plan is also provided in Appendix 22.

Purpose

The purpose of this report is to revisit the extensive analysis and recommended projects from the 1999 NRCS study and to distill them into realistic and achievable goals for maintenance and construction projects that Buena Vista can integrate into its Comprehensive and Capital Improvements Plans.

Table IP-1

Damage Summary by Subwatershed and Storm Event

Multiplier from 1999 to 2025 3.00

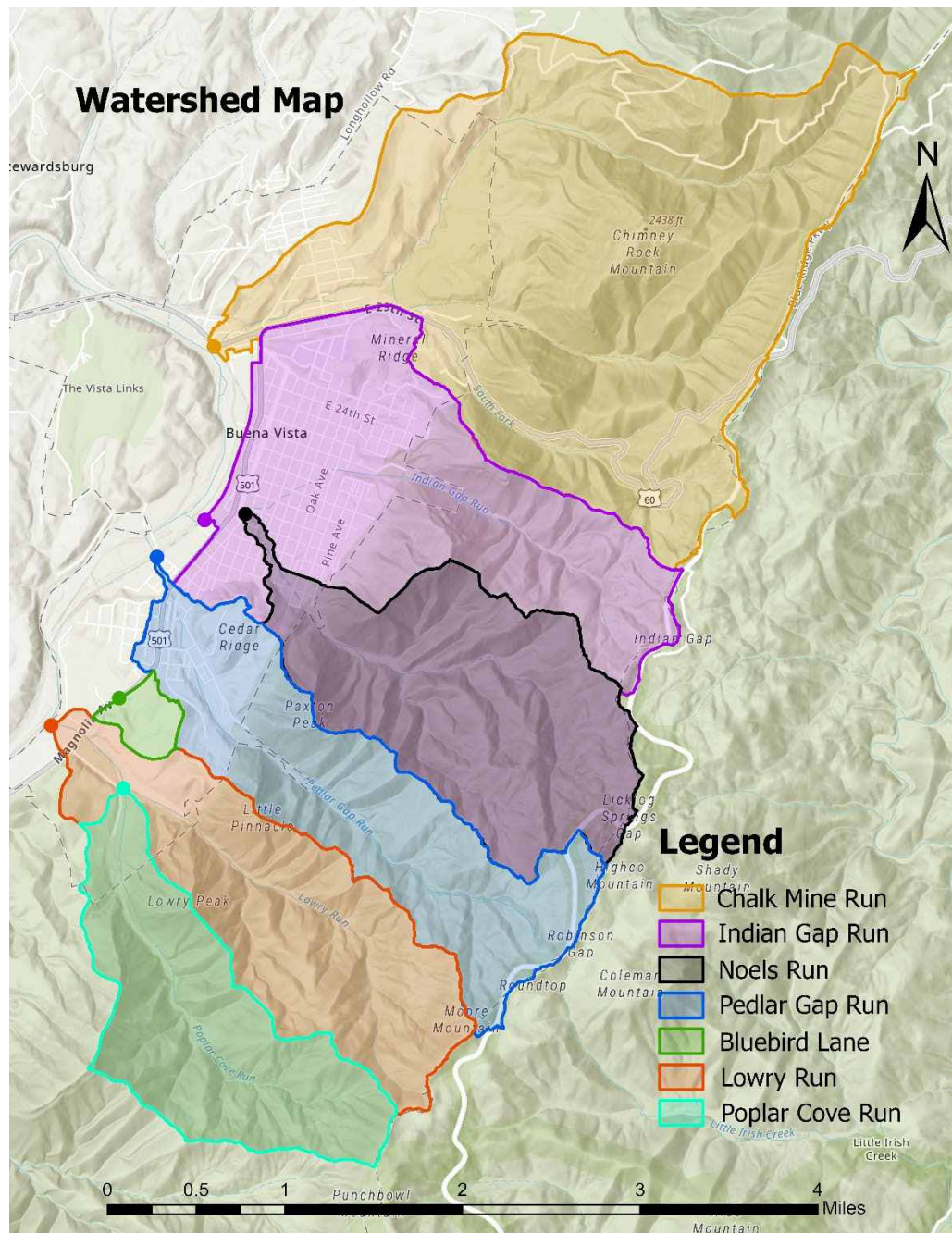
Structure Damages				Content Damage			
	2025	2025	2025		2025	2025	2025
	5 yr, 20%	25 yr, 4%	100 yr, 1%		5 yr, 20%	25 yr, 4%	100 yr, 1%
Chalkmine Run	\$83,667	\$314,976	\$709,737	Chalkmine Run	\$43,092	\$166,179	\$368,166
Indian Gap Run	\$185,478	\$4,095,303	\$12,252,927	Indian Gap Run	\$141,237	\$1,968,753	\$6,048,180
Noel's Run	\$0	\$3,001,989	\$4,156,119	Noel's Run	\$0	\$957,081	\$1,431,501
Pedlar Gap Run	<u>\$208,806</u>	<u>\$1,151,928</u>	<u>\$1,472,430</u>	Pedlar Gap Run	<u>\$113,316</u>	<u>\$632,961</u>	<u>\$792,672</u>
Totals	\$477,951	\$8,564,196	\$18,591,213	Totals	\$297,645	\$3,724,974	\$8,640,519

Private Clean-Up/Debris Removal				Lost Business Income			
	2025	2025	2025		2025	2025	2025
	5 yr, 20%	25 yr, 4%	100 yr, 1%		5 yr, 20%	25 yr, 4%	100 yr, 1%
Chalkmine Run	\$1,584	\$37,614	\$92,517	Chalkmine Run	\$2,787	\$39,453	\$249,096
Indian Gap Run	\$6,768	\$176,916	\$591,594	Indian Gap Run	\$26,430	\$1,165,110	\$2,399,511
Noel's Run	\$0	\$3,192	\$8,412	Noel's Run	\$0	\$9,042	\$22,602
Pedlar Gap Run	<u>\$1,440</u>	<u>\$32,892</u>	<u>\$192,675</u>	Pedlar Gap Run	<u>\$0</u>	<u>\$83,982</u>	<u>\$727,278</u>
Totals	\$9,792	\$250,614	\$885,198	Totals	\$29,217	\$1,297,587	\$3,398,487

Public Infrastructure and Debris Removal				Public Administration Costs to BV & Other Agencies			
	2025	2025	2025		2025	2025	2025
	5 yr, 20%	25 yr, 4%	100 yr, 1%		5 yr, 20%	25 yr, 4%	100 yr, 1%
Chalkmine Run	\$31,269	\$560,271	\$1,216,239	Chalkmine Run	\$4,902	\$18,486	\$41,331
Indian Gap Run	\$22,779	\$408,189	\$886,101	Indian Gap Run	\$10,866	\$240,372	\$713,526
Noel's Run	\$61,299	\$1,098,399	\$2,384,409	Noel's Run	\$0	\$176,199	\$242,022
Pedlar Gap Run	\$71,958	\$1,289,370	\$2,798,976	Pedlar Gap Run	<u>\$12,231</u>	<u>\$67,611</u>	<u>\$85,743</u>
City-Wide or Other	<u>\$28,440</u>	<u>\$509,628</u>	<u>\$1,106,304</u>	Totals	\$27,999	\$502,668	\$1,082,622
Totals	\$215,745	\$3,865,857	\$8,392,029				

Grand Totals for All Damage Categories			
	2025	2025	2025
	5 yr, 20%	25 yr, 4%	100 yr, 1%
Chalkmine Run	\$167,301	\$1,136,979	\$2,677,086
Indian Gap Run	\$393,558	\$8,054,643	\$22,891,839
Noel's Run	\$61,299	\$5,245,902	\$8,245,065
Pedlar Gap Run	\$407,751	\$3,258,744	\$6,069,774
City-Wide or Other	<u>\$28,440</u>	<u>\$509,628</u>	<u>\$1,106,304</u>
Totals	\$1,058,349	\$18,205,896	\$40,990,068

The breakdowns in the table above came from the final page of the 99 page “1997 Building Inventory and Damage Estimates” from Appendix 15. Note that the final 1999 NRCS report utilized similar, but not identical versions of these tables in which the costs were not itemized by type, e.g. Structure Damage, Content Damage, etc. The table above is presented to aid in understanding how the damage is distributed. These damages were based upon actual interviews and data whereas the 2020 Central Shenandoah Hazard Mitigation Plan provided more generic damage estimates.



Approach

This report will examine numerous aspects of Buena Vista's demographics and its intersection with flooding:

- 1 City Data
- 2 Population trends and income
- 3 Major flooding events
- 4 Previous studies
- 5 Effects of climate change
- 6 Past flood mitigation projects
- 7 Floodplain management and Repetitive loss properties
- 8 Works of unknown origin
- 9 Overview of the 1999 NRCS Environmental Impact Statement
- 10 Costs of damage from storms of various return periods
- 11 Drainage Sheds, Problem Areas, and Recommended Projects from the 1999 NRCS Study
- 12 Debris Management (References Appendix 22)
- 13 Repetitive loss properties
- 14 Conclusions
- 15 Recommendations

1.0 LOCATION

The City of Buena Vista lies southeast of the Intersection of Interstates 81 and 64 in Rockbridge County Virginia. It is located 188 miles southwest of Washington, D.C. and 130 miles west of Richmond, VA in the Blue Ridge Mountains region.

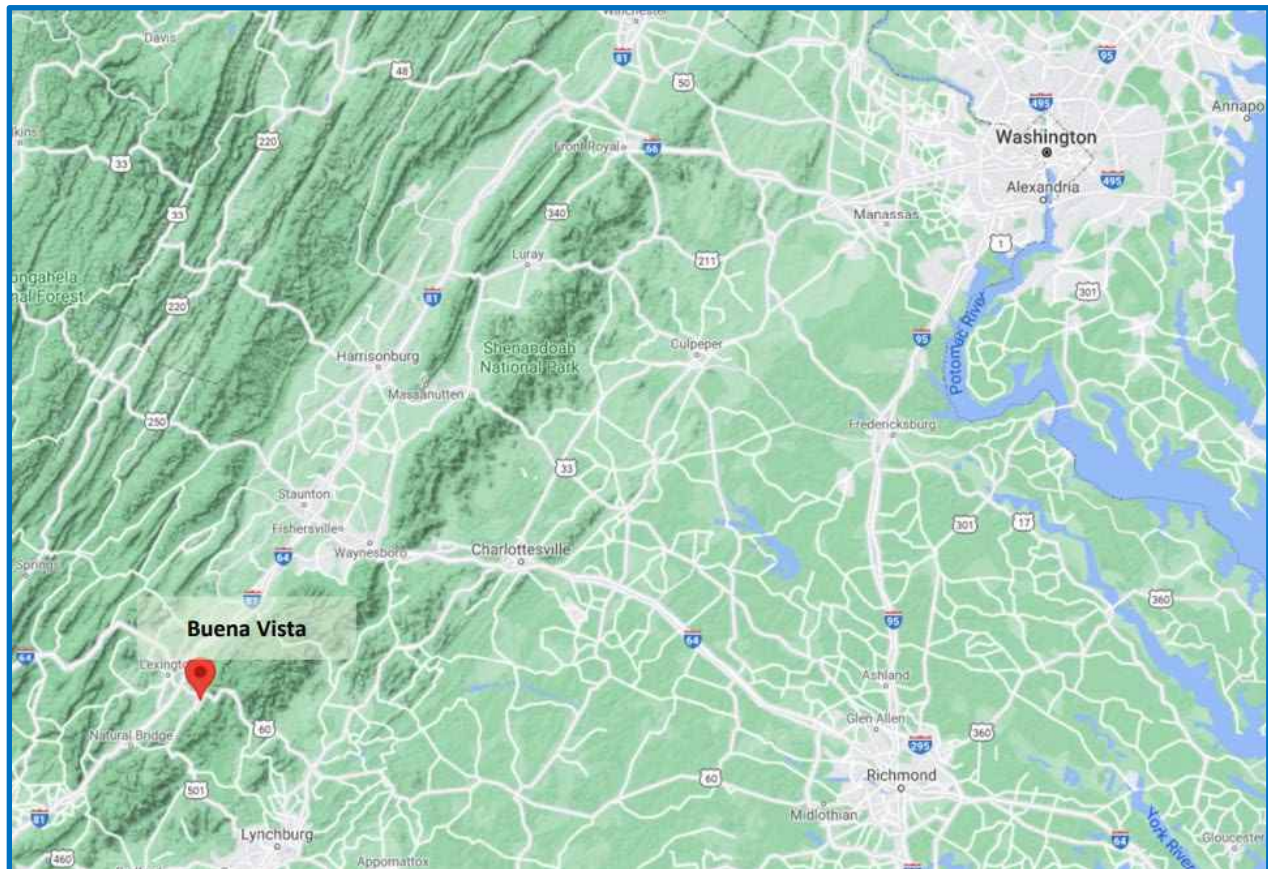


Figure 1-1

City of Buena Vista Location Map

As shown below in **Figure 1-2**, the City of Buena Vista encompasses a total area of approximately 4,200 acres.

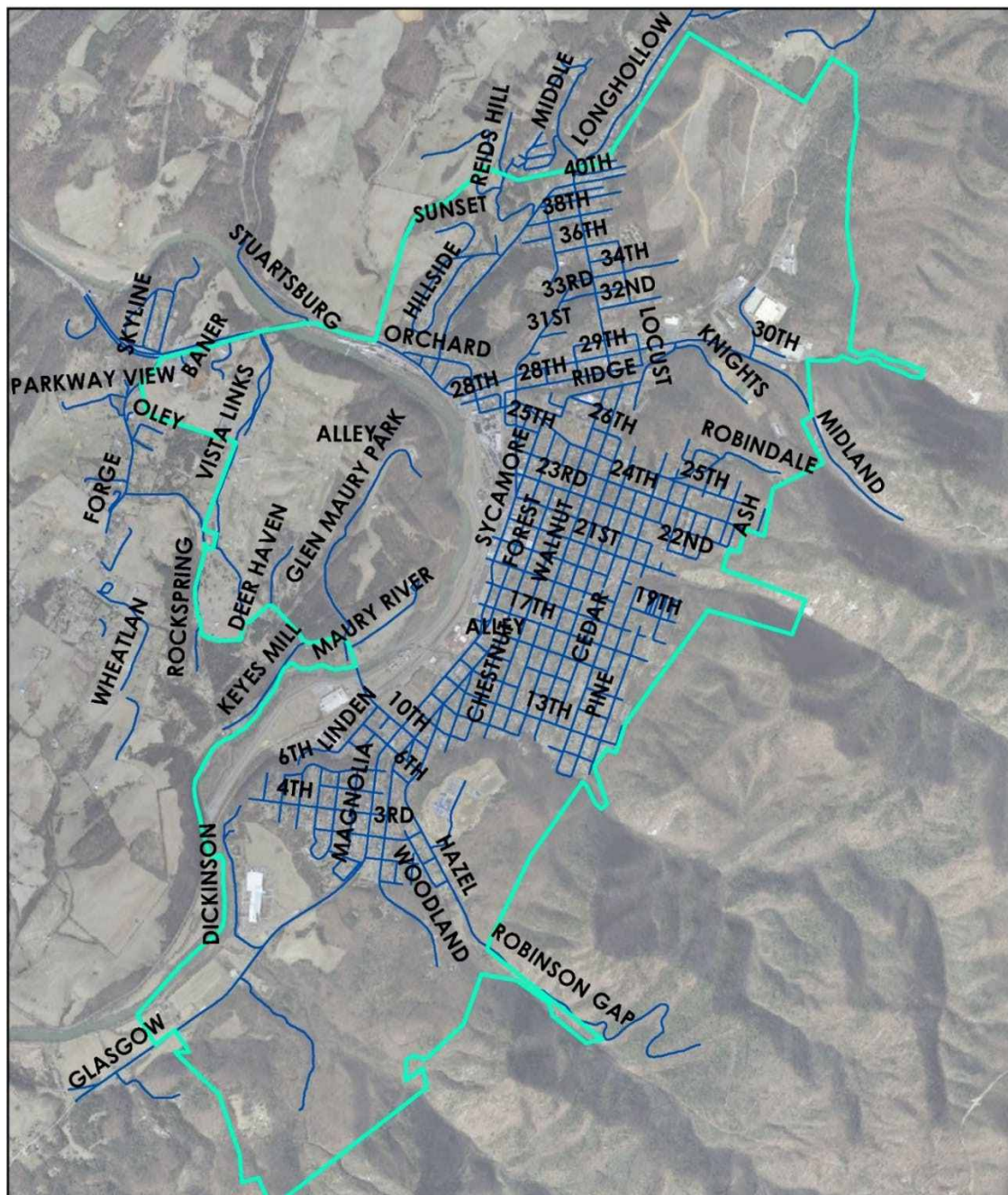


Figure 1-2
City of Buena Vista

2.0 POPULATION TRENDS

The city's population has remained steady since 2000 and some growth is anticipated. Below are details of the projected populations for the next 20 years, poverty data, and an ethnic breakdown.

Table 2-1 Population and Income

	Year 2000	Year 2010	Year 2023	Year 2030	Year 2040
Population	6,650	6,451	6,641	6,977	7,235
Median Household Income (in 2025 dollars)			\$54,458		
Per Capita Income in past 12 months (in 2025 dollars)			\$33,175		
Persons in Poverty (%)			22%		

Source:

[Buena Vista City, Buena Vista City, VA - Profile data - Census Reporter](#)

Table 2-2 Ethnic Components

Race and Hispanic Origin	Year 2019	
White alone (%)	86%	
Black or African American alone (%)	2%	
American Indian and Alaska Native alone (%)	0%	
Asian, alone (%)	1%	
Native Hawaiian and Other Pacific Islander, alone (%)	0%	
Two or More Races (%)	11%	
Hispanic or Latino (%)	1%	

Source:

[Buena Vista City, Buena Vista City, VA - Profile data - Census Reporter](#)

The 2040 population projection includes an estimated 247 new permanent residents within the city's service area. The population data above also includes approximately 1,250 students who attend Southern Virginia University within the city limits. The University expects this number to increase to 1,500 by 2030 and 1,750 by 2040, with 10 additional faculty members. The combination of new permanent residents, students, and faculty results in an estimated total population increase of 757 people by 2040.

Fiscal Stress

In 2018, Buena Vista ranked number 6 of 133 on Virginia's Index of Fiscal Stress for its cities and counties. When considered in the context of its 22% poverty rate, it is clear that a significant number of Buena Vista's citizens are suffering fiscally.

Source:

[2018 Report on Comparative Revenue Capacity, Revenue Effort, and Fiscal Stress of Virginia's Cities and Counties](#), published by Commission on Local Government, Commonwealth of Virginia

Projects recommended herein are oriented toward reducing flooding and benefit the City's population without regard to socio-economic status.

3.0 MAJOR FLOODING EVENTS

Buena Vista's flood history is as old as the City itself. Though record keeping was poor in the 19th century, it is known that severe floods occurred in 1870 and 1877. Subsequent notable events include the following

- March 1936: First well-documented flood; 320 acres flooded, \$3M in damages, 1 death.
- August 1969: Flood of record from Hurricane Camille; 420 acres flooded, \$40M in damages, 2 deaths.
- June 1972: Hurricane Agnes; early warnings reduced casualties, but damage was still widespread.
- November 1985: Hurricane Juan; heavy mountain rains; 380 acres flooded, \$44M in damages. 600 jobs lost.
- 1992: At least several hundred thousand dollars in damages
- June 1995: Two storms in one week; river crested at 20.3 feet, \$1.5M in damages, significant debris and sediment.
- January & September 1996: Snowmelt and Hurricane Fran; combined damages of \$1.2M.

4.0 PREVIOUS STUDIES

At least four modern studies have examined flooding history, causes, and possible solutions in Buena Vista:

1. 1999 NRCS Final Plan – Environmental Impact Statement for Buena Vista Watershed
2. 2002 Central Shenandoah Valley Regional Flood Mitigation Plan
3. 2020 Central Shenandoah Hazard Mitigation Plan
4. 2022 Buena Vista, Lexington, Rockbridge County Emergency Operations Plan

Of these documents, the 1999 NRCS Plan offers the most comprehensive set of recommendations and construction action items to reduce damage from major storm events. While information from all four documents is utilized throughout this 2025 report, the major focus is on the 1999 NRCS Plan. The 2022 study contains a useful section on debris management which is referenced in the Debris Management Plan.

Note that all cost estimates for both damage and construction from the 1999 NRCS study were increased by a multiple of 3.0 to arrive at their 2025 equivalents based upon published design cost data.

5.0 CLIMATE CHANGE

Climate change is expected to increase the frequency of heavy rainfall events, the exact numerical extent of which is not yet known. This will have the effect of increasing the severity of flooding and associated damage for a given return period. Hypothetically, for instance, a flood which formerly would have statistically occurred every 5 years may now occur every 4 years. This amplifies the need for Buena Vista to maintain its stream channels, culverts, and bridges so they are operating at their full hydraulic capacities. It also enhances the urgency to make improvements that will eliminate bottlenecks and increase overall capacity.

Throughout this report, flood damage cost estimates are provided for different flood frequencies. The reader is advised to interpolate the costs between return periods to gain a sense of how climate change could impact the cost of floods.

6.0 PAST FLOOD MITIGATION PROJECTS

6.1 James R. Olin Flood Protection Project, completed in October 1997, is the City's largest flood mitigation effort. Initiated after the 1985 flood, it was a \$40 million project funded by federal (75%), state (12.5%), and local (12.5%) sources. Key features include:

- 2 miles of earthen levee
- 1,000 feet of reinforced concrete floodwall
- Interior drainage canal
- Closure gates
- Enhanced flood warning system

The system is designed to protect against floods as severe as Hurricane Camille (1969), which exceeded the 100-year event. Note that the floodwall begins downstream of Chalkmine Run and ends upstream of Lowry Run. It does not reduce Maury River flooding in these areas.



Flooding at Forest Avenue 1992

6.2 Interior Streams: Channel Modification, Culvert Replacements, and other Drainage Projects

Over the decades, and often following floods, several drainage improvement projects have been designed and constructed by various entities (all dates are approximate):

- 1977: Several fords in streams were replaced with culverts. This probably had more to do with convenience than flood mitigation. Details are lost to time.
- 1985: Following Hurricane Juan, the Corps of Engineers initiated improvement projects on Pedlar Gap Run and Noel's Run which consisted of channelization using gabion baskets, embankment stabilization with large rip-rap/gabion baskets, and culvert enlargements. The culverts consist of corrugated metal arches and corrugated metal wingwalls. No records of the designs or construction drawings are available.
- 1992 and 1995: The City received funding from the Virginia Department of Housing and Community Development (DHCD) to reduce the flooding along the interior streams that traverse the City. Completed in two phases, the main feature of this project is a reinforced concrete lining on Indian Gap Run to increase its carrying capacity. This project was designed by Mattern & Craig, Inc., consulting engineers.
- 1999 NRCS Study (Final Plan – Environmental Impact Statement)
 - NRCS 1999 study originally planned the following measures
 - Chalk Mine Run

- 220 feet of earthen berm (enlargement of existing berm)
- 1 debris basin (1.5 acres)
- 1 bridge replaced with bigger bridge
- 1 culvert replaced with bridge
- 2,680 feet of channel improvement
- Indian Gap Run
 - 500 feet of concrete floodwall (about 3 feet high)
 - 1 debris basin (0.71 acres)
 - 2 railroad bridges replaced with box culverts
 - 1,150 feet of channel improvement
- Noel's Run (Reservoir Hollow)
 - 3 debris basins (0.9 acres, 0.8 acres, 0.2 acres)
- Pedlar Gap Run
 - 2 debris basins (1.10 acres, 0.2 acres)
 - 1 railroad culvert replaced
 - 1 bridge, immediately upstream of railroad culvert, removed
 - 3 culverts replaced with bridges
 - 1 bridge replaced with hy-span type bridge
 - 1,708 feet of channel improvement
- Lowry Run
 - Lowry Run and its major tributary, Poplar Cove Run, were not examined in the 1999 NRCS study.
 - Located at Buena Vista's southern border.
 - Approximately 2,300 acres.
 - No substantive development within this watershed.
 - FEMA approximated floodplain (Zone A) appears confined to channel.

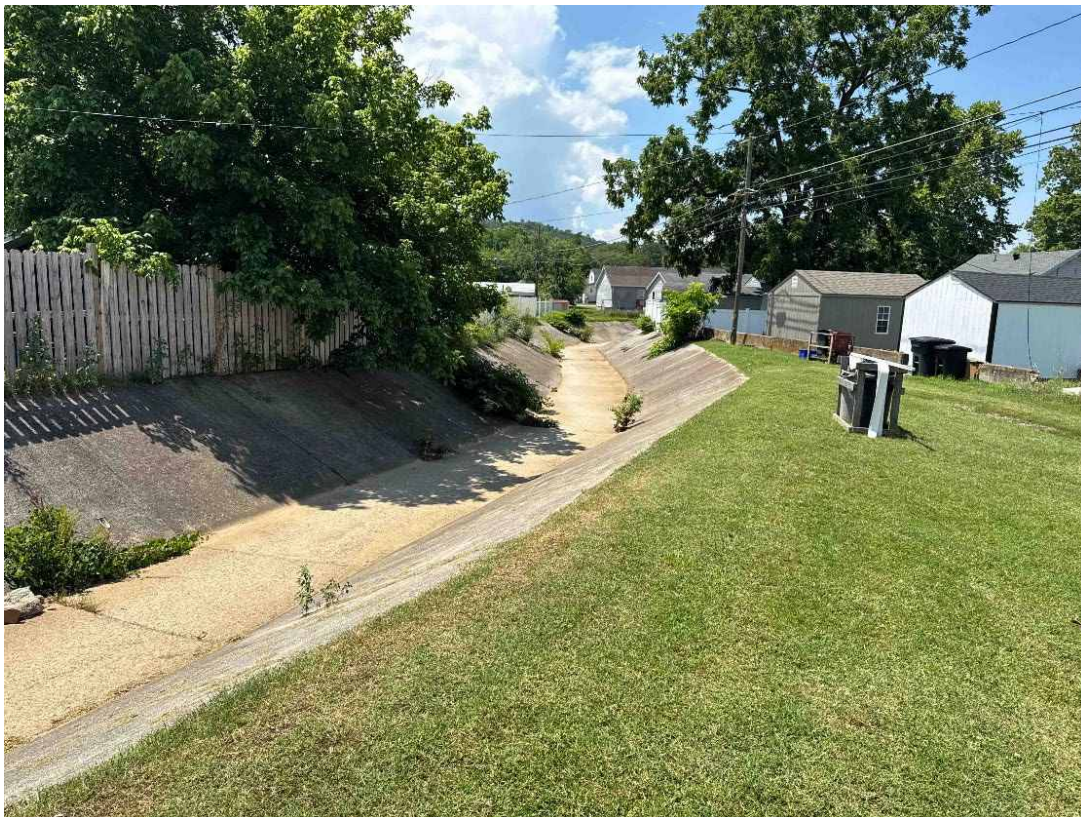
Summary of proposed NRCS improvements

- 7 debris basins
- 220 feet of earthen berm
- 500 feet of concrete floodwall
- 2 railroad bridges replaced
- 1 railroad culvert replaced
- 6 bridges and culverts replaced
- 1 bridge removed
- 5,538 feet of channel improvement

With the exception of the limited projects on Chalkmine Run described below, none of the NRCS projects were designed or constructed. The 1999 NRCS report did not include Lowry Run because its drainage shed is almost entirely undeveloped.

- 2010: Chalkmine Run
 - Constructed two debris basins that were designed by NRCS.
 - Replaced bridge to lumber yard at confluence of Chalkmine Run and Washer Hollow
 - Replaced Rockbridge Avenue Bridge
 - Replace Railroad Bridge (done by Norfolk Southern)
 - NRCS contracted with URS to design a channelization project from Rockbridge Avenue to Route 60 bridge. This was abandoned prior to permitting and was never constructed.

See the Maps in Appendix 1 and Photos in Appendix 5, along with other Chalkmine Run channelization and debris basin information in Appendices 6 through 10.



Concrete Channel Along Indian Gap Run (2025)

7.0 FLOODPLAIN MANAGEMENT AND REPETITIVE LOSS PROPERTIES

Buena Vista has adopted a floodplain management ordinance which requires new residential buildings be elevated to or above the base flood elevation (BFE). Additional requirements prevent the obstruction of the floodway portion of the floodplain. (Source: 2002 CSPDC Flood Mitigation Plan)

NFIP - The City of Buena Vista participates in the National Flood Insurance Program (NFIP) which is designed to provide insurance at affordable rates to policyholders. In return, the City has agreed to adopt and administer local floodplain management measures directed at protecting lives, existing property, and new construction from future flooding. As of 2018 there were 49 structures insured with an NFIP policy. Most of these appear to be owned by government or businesses. Also, as of 2018, there were thirty repetitive loss properties that have not been mitigated. Of these, only five were insured via NFIP. The City should promote and educate the public about the NFIP in an effort to increase the number of covered properties.

Residential Elevation and Acquisition Project:

To further reduce flood risk—especially for homes near interior streams—the City launched a project to elevate or acquire approximately 28 flood-prone residences. Funded by FEMA and the Virginia Department of Housing and Community Development, this initiative complemented previous flood protection efforts. (Source: 2002 CSPDC Flood Mitigation Plan)



Home Being Elevated

Industry Flood Action Measures - Several industries in Buena Vista have developed operational plans to be implemented in the event of flooding. Under these plans, procedures are specified at predetermined flood levels as reported by the City's emergency operations department. Such measures include early employee leave from the workplace, clearing parking areas, and relocation or elevation of inventory and materials.

Flood Warning System - The City participates in a flood warning system developed by the National Weather Service called the Integrated Flood Observing and Warning System (IFLOWS). This system combines existing sensor, communication and computer technology with advanced forecasting to provide guidance and advice to local authorities responsible for providing emergency services to their City's citizens.

Community Rating System (CRS) - The Community Rating System (CRS) is a FEMA program under the National Flood Insurance Program (NFIP) that rewards communities for going above minimum floodplain regulations by reducing flood insurance premiums for residents. It is voluntary and administered by FEMA and is applicable to any community already in the NFIP. The City should evaluate implementation of the Community Rating System (CRS) to potentially reduce NFIP policy premiums.

8.0 WORKS OF UNKNOWN ORIGIN

Elements of other projects are visible along the streams in Buena Vista, but their timing and impetus for creation are often unknown. For instance, in the mid-1970s, Pedlar Gap Run was reinforced on one side with a gabion basket wall at Woodland Avenue and a corrugated metal culvert was constructed at the crossing. Upstream of the gabion wall is an older wooden crib wall of unknown vintage. In 2023, the corrugated metal arch culvert at Woodland Avenue began collapsing at its inlet and separating from its headwall. In 2025, a temporary repair was made to reinstate the entrance. The culvert has extensive corrosion and recommended for near-term replacement later in this report.



Wooden Crib Wall at Left, High Flow Concrete Overbank, and Low Flow Natural Channel with Cobbles



Vegetated Gabion Wall at Woodland Ave Culvert (Constructed Circa 1977)

9.0 OVERVIEW OF 1999 NRCS ENVIRONMENTAL IMPACT STATEMENT

9.1 History

In 1999, the Natural Resources Conservation Service (NRCS) published its Final Plan – Environmental Impact Statement for the Buena Vista Watershed. This comprehensive document examined many facets of Buena Vista’s internal streams including their problem areas, flooding implications/costs, socio-economic considerations, cultural resources, threatened/endangered species, and several other factors. It then evaluated various alternatives meant to reduce flooding frequency and damage, and weighed their costs versus benefits. Finally, it recommended specific projects and elaborated on design and construction costs.

This well-researched and extremely thorough document is provided in Appendix 16 of this new report. Because the present (2025) report does not reiterate or expand upon every element of the 1999 report, it is suggested that both documents be studied to gain the best understanding of Buena Vista’s internal streams and their flooding impacts.

The specific areas examined in the 1999 study are the City’s four primary internal streams: Chalkmine Run/Washer Hollow, Indian Gap Run, Noel’s Run, and Pedlar Gap Run. It did not address a fifth stream, Lowry Run, due to it being almost completely undeveloped and at the southern end of the City, where its floodwaters do not merge with flood waters from the other streams. Together, the first four streams drain approximately 8,000 acres through Buena Vista to the Maury River, with Lowry Run adding another 2,307 acres. Chalkmine Run and its tributary, Washer Hollow, enter the Maury River just upstream of the James R. Olin Flood Protection Project (floodwall or levee) while the others generally flow directly into the Maury River through the floodwall unless a high flow event occurs, at which time they will follow the interior canal that discharges into the Maury River downstream of the levee’s terminus. The 1999 study concluded that the levee would have no effect on the interior stream flooding problems. Lowry Run enters the Maury River downstream of the floodwall and is unaffected by it.

It is important to understand that most of these “Runs” are normally dry within the city limits except following heavy rains or extended wet spells. The NRCS study explains that the water is always present, but is flowing subterraneous through the deep layer of cobbles, colloquially known as “Riverjack”. There are localized exceptions to being dry such as Indian Gap Run and Noel’s Run, being continually wet (perennial) from their confluence to the Maury River. In this area many varieties of minnows and other aquatic life are evident. Pedlar Gap Run is more frequently wet in its upper reaches and Chalkmine Run exhibits only one area of frequent standing water - behind the Carriage House apartments, downstream of the debris basins.

The 1999 NRCS study applied several techniques in various locations to reduce flooding:

- Constructing large debris basins along stream channels to capture cobbles washing down from the surrounding mountains.
- Replacing/Enlarging/Removing culverts and bridges to convey greater flows, avoid capturing debris, and to make maintenance easier.
- Constructing flood walls and berms
- Improving/Realigning/Increasing gradients of stream channels to enhance their capacities and prevent debris from settling out.

Many of the recommendations from the 1999 NRCS study resulted from extensive HEC-1 and HEC-2 modeling performed by Dewberry & Davis in Fairfax. HEC-1 estimates stormwater runoff rates for various return periods while HEC-2 calculates the corresponding water surface elevations in the streams. These comprehensive models and study were not used to update FEMA's Flood Insurance Rate Map (FIRM) in 2002 and unfortunately the models are lost to time. In preparing this 2025 report, the author searched NRCS's archives in Richmond and initiated an effort by Dewberry & Davis to search their archives for the models. Neither turned-up the models. Later models for Chalkmine Run are in our possession from a circa 2010 study by URS related to a channelization project that was never permitted or constructed. It can be found in Appendix 6 and will be reviewed later in this report. Replicating the missing studies is beyond the scope of this 2025 report and is addressed later in the recommendations section.

Additionally, since the NRCS report did not evaluate Lowry Run, there is no comprehensive information to present. However, as part of this 2025 report, the drainage sheds were delineated and are discussed later.



Two scenarios were finalized in the 1999 models: existing conditions and potential conditions with the recommended improvements. Note that the existing conditions are referred to in NRCS terminology as “Future Without Project” or FWOP. Construction cost estimates were later prepared, then used to create cost-benefit analyses for a comprehensive project in each watershed to implement all the recommendations simultaneously. USDA’s Environmental Impact Statements utilize an unusual format for analyzing engineering problems and selecting alternatives. This can be difficult to follow, but the final recommendations are explained well.

Due to the levee which was completed in 1996 and designed to withstand Hurricane Camile, the Maury River should not flood Buena Vista during a 100-year plus storm event. The present FEMA Flood Insurance Rate Map (FIRM) shows the estimated extent of damage to the City that would be caused predominantly by the interior streams, which lack sufficient capacity under the best of circumstances due to their sizes, slopes, roughness, and obstructions such as culverts and bridges. Those “best circumstances” assume that the conveyances are free from debris and excessive buildup of cobbles. The field reviews conducted for this 2025 report indicate that most of the natural channels have buildups of rocks/sediment/vegetation. The culverts and bridges generally also have cobbles accumulated inside and significant woody debris often catches on interior walls/piers of multi-celled structures, thus reducing the effective opening areas.

Below is an excerpt from page 28 of the 1999 NRCS study summarizing the flood wall/levee

The need for treatment of the Buena Vista Watershed was first recognized and promoted by the Sponsors following the 1985 flood. The sponsors contacted both the U.S. Army Corps of Engineers and the NRCS after 1985. The Corps took the lead and developed a flood control plan for the control of the Maury River. The Corps has constructed a flood wall which will protect most of the City from Maury River flooding. The flood wall starts downstream of the confluence of the Maury River and Chalk Mine Run and extends to a point downstream of the original confluence of the Maury River and Pedlar Gap Run. Chalk Mine Run flows into the Maury River unobstructed by the flood wall. Noel's Run joins with Indian Gap Run before they get to the flood wall. Indian Gap Run then passes through the flood wall via culverts with flap gates. If the Maury River stage is too high, an alternate route is provided through an interior drainage canal. Pedlar Gap Run is diverted through a lower portion of the flood wall by an interior drainage canal via culverts with flap gates and then drains into the Maury River.

10.0 COSTS OF DAMAGE FROM VARIOUS STORMS

There have been no major floods in Buena Vista since the mid-1990s, therefore, there is no new flow or damage data to incorporate into this analysis. The 1999 study was thorough in assessing damage from recent floods and extrapolating that data through various return period up to the 100-year event. The Maury River Basin is subject to high flows throughout the year with the greatest flood frequency occurring in winter and spring, however, its two largest floods were caused by the remnants of hurricanes, with Camile in 1969 and Juan in 1985, as they moved up the Shenandoah Valley. The floodwall was constructed to reduce impacts from the Maury River, but it provides no respite from the interior streams. As noted in the 1999 study, the interior streams are most likely to flood when the soils are already wet due to long-duration rainfall followed by a short, high-intensity storm, as was the case with the flood of 1992.

Due to climate change, rainfall patterns appear to have changed since 1999, with localized, intense storms seeming to occur more frequently in the region, but not yet necessarily in Buena Vista. Therefore, it is conceivable that higher flows may statistically occur more often in the future. This would decrease the intervals at which damage occurs and increase overall recovery costs. Similarly, runoff volumes and intensities may increase due to deforestation from pestilence, fire, logging, urban development, or other factors.

Below is a long and important excerpt beginning on page 26 of the 1999 NRCS report which explains their methodical approach.

ANALYSIS OF THE RESOURCE DATA

The planning effort began with an assessment of damages from past storm events, along with careful analysis of the hydrology of the area and stream channel hydraulics. In order to assess the economic damages within Buena Vista, it was necessary to determine the level of current damages sustained by properties within the floodplain or that could possibly occur as a result of future storms. This is a two- part effort since both water levels and building elevations must be known.

The water level at any given location is determined by the volume of water for a given flood frequency, the slope and roughness of the channel, and the shape of the channel. A HEC-1 analysis done by the engineering firm of Dewberry & Davis was used to determine the flow discharges for nine subwatersheds within the drainage areas of Indian Gap Run and Noel's Run. An additional five subwatersheds were used to determine discharges within Pedlar Gap. Three subwatersheds were used on Chalk Mine Run. The flood frequencies used were 5, 25, and 100-years.

In order to expedite the planning effort, NRCS teamed up with the Federal Emergency Management Agency (FEMA) to hire a contractor to do the water surface profile analysis. Dewberry & Davis performed the work during the summer of 1996 under a contract with Woodward Clyde Federal Services. Dewberry & Davis used the HEC-2 computer program to determine the water surface elevations at 17 cross-sections on Chalk Mine Run, 37 cross-sections on Indian Gap Run, 20 cross-sections on Noel's Run, and 22 cross-sections on Pedlar Gap Run. Water surface profiles were determined for both the "without project" and the "with project" conditions.

In May of 1995, NRCS survey crews determined the first floor elevation and point of water entry elevation for every building in approximately 114 City blocks. An additional 12 blocks were surveyed in June of 1996. Approximately 900 buildings were surveyed.

For buildings without basements, the water elevations for the three storm frequencies were compared to the first floor elevation of the building. For structures with basements, the point of water entry was used as the point where damage began to occur. Water depth and damage relationships were based on functions provided by the Federal Insurance Administration of FEMA. Personal interviews with selected homeowners and private businesses were used to supplement elevation survey data. These interviews confirmed and quantified damages experienced during previous storm events, e.g., in 1995, 1992, 1985, and 1969.

Of the approximately 900 buildings surveyed, the analysis indicates that approximately 341 are subject to damages from interior stream flooding should a 100-year storm event occur. A 100-year storm event is a major storm and is considered to have a one percent chance of occurrence in any given year. About 277 buildings are projected to be damaged by 25-year storm events (4% chance of occurrence in any given year), and 39 buildings are estimated to be damaged by 5-year storm events (20% chance of occurrence in any given year). The two storms which occurred within a few days of one another in June of 1995 were of a 25-year storm event magnitude.

*The properties identified as possibly being subject to future damages represent an approximation based on the data collected and computer simulations of potential storms in the future. Such approximations are estimates based on the best data and analysis tools available. The number of properties and actual damages incurred as a result of future storm events may be more or less than the damages estimated and reported here. This is especially true given the complex and dynamic set of relationships which exist within the drainageways of these streams. **Multiple culverts of varied capacities are typical, as are variations in the channel capacities. In addition, the nature of the upper***

watershed includes an essentially inexhaustible supply of rock cobbles and other bedload materials such as trees and sediment. Thus, where stream blockages occur is a function of the volume and type of materials which are transported by the storms and where they are deposited. In-stream obstructions cause the water to spill out on to adjacent public and private properties, and damages result.

Of the 341 properties projected to receive damages from 100-year storm events, 34 are within the Chalk Mine Run subwatershed, 223 are within the influence of Indian Gap Run, 23 are associated with Noel's Run, and 60 are expected to be impacted by Pedlar Gap Run. These properties and associated grounds include 246 private residences, 71 businesses, 17 public facilities, 5 churches, 1 professional association, and 1 veterans' organization.

The evaluated damage categories for which monetary estimates were made are:

- a) damages to public and private buildings;*
- b) building content damages;*
- c) private clean-up/debris removal costs;*
- d) public infrastructure damage, clean-up/debris removal and repair;*
- e) administrative costs borne by Buena Vista and state and federal agencies to respond to emergency circumstances brought about by flooding (overtime, report and grant proposal preparation, processing of flood insurance policy claims, travel and per diem, etc.);*
- f) lost business income; and*
- g) flood damage cost avoidance expenditures.*

In addition, substantial disruption to emergency services is expected to occur with the larger storm events. However, emergency service disruption damages were not quantified and monetized. They weren't quantified because they were presumed to be relatively small in monetary terms, but could potentially cause loss of life. Disruptions of transportation in general, communication lines, and sewer and water services are also potential damages categories for which monetized estimates were not made.

A few explanations follow regarding the flood analysis. The number of properties flooded and the associated dollar value of damages which follow are based on "future without project" (FWOP) assumptions. The key assumption for the FWOP scenario is associated with the hydrologic and hydraulic effects anticipated from known efforts, or soon to be undertaken efforts to expand the intercity stream channel capacities. Buena Vista has already undertaken numerous works of improvement which will affect the intercity stream channel capacities via removal of some culverts, enlargement of others, etc. In addition, State and FEMA funded efforts will likely remove some properties from receiving damages via channel capacity expansion,

concrete lining of portions of the channel on Indian Gap Run, and relocation or elevation of some homes. All of these efforts were already known to be underway or planned for implementation and were used in this analysis in order to establish current conditions and trends.

Future without project damages were calculated based on interviews and analysis of the expected physical condition of the channels and their ability to contain drainage volumes during flood stages. The analysis indicates that substantial damages in the City will likely occur in the future primarily due to insufficient interior drainage channel capacity. Damages for the 100-year storm event are estimated to total around \$11,423,000 (\$34,269,000 in 2025 dollars). Damages from 25 and 5-year storm events are estimated around \$7,423,000 and \$484,000 (\$22,269,000 and 1,452,000 respectively in 2025 dollars). These are estimated damages due to intercity stream floods only. Damages would be much higher if the Army Corps of Engineer's flood wall were not in place and if the City's concrete lining of Indian Gap Run did not get implemented. Some storm events could conceivably cause simultaneous flooding on both the river and the intercity streams, and the combined waters could exacerbate the depth of flooding and ponding which would occur from intercity stream flooding only.

The FWOP damage estimates for 100-year storm events include approximately \$5.34 million dollars (\$16.02 million in 2025) in structure damages (47% of total damages), \$2.41 million dollars (\$7.232 million in 2025) in content damages (21%), \$1.87 million dollars (\$5.61 million in 2025) in public infrastructure damages (16%), and \$1.14 million dollars (\$3.42 million in 2025) in lost business income (10%). The FWOP damage estimates for 25-year storm events include \$3.72 million dollars (\$11.16 million in 2025) in structure damages (50% of total damages), \$1.69 million dollars (\$5.07 million in 2025) in content damages (23%), \$1.30 million dollars (\$3.9 million in 2025) in public infrastructure damages (18%), and \$454,000 (\$1.36 million in 2025) in lost business income (6%). FWOP damage estimates for 5-year storm events are estimated around \$484,000 (\$1.36 million in 2025) with damages to structures and their contents representing 54% and 22% of total damages respectively. Private clean-up costs and public administrative costs for the 5-year event were less than 2% of total damages in each case. The table below provides a complete breakdown of the estimated damages for all evaluated damage categories and storm events.

Table 10-1

Damages for Various Return Periods (Millions of 2025 Dollars)

Watershed	Percentate of Total Damage	Watershed Total 5-yr Damage (2025 M Dollars)	Watershed Total 25-yr Damage (2025 M Dollars)	Watershed Total 100-yr Damage (2025 M Dollars)
Indian Gap	62%	\$2.84	\$13.80	\$21.25
Noel's Run	14%	\$0.64	\$3.12	\$4.80
Chalk Mine Run	13%	\$0.59	\$2.89	\$4.46
Pedlar Gap	9%	<u>\$0.41</u>	<u>\$2.00</u>	<u>\$3.09</u>
	TOTALS:	\$4.48	\$21.82	\$33.59

Note that this table has been updated and provides costs in 2025 dollars which are based on a 3.0 multiplier from 1999 to 2025.

The above values are based upon not implementing the NRCS recommendations, but they do include all the reductions in flooding expected to result from the projects that were constructed before or nearly simultaneously with the study, such as channelizing and concreting Indian Gap Run. The report also notes the endless supply of cobbles washing down from the mountains and combining with other debris to clog waterways and culverts. Keeping channels, bridges, and culverts clear of these obstructions has the effect of reducing overtopping frequency from smaller storm events and reducing the damage they cause. Field reconnaissance performed for this report shows the concrete channel portions of Indian Gap Run to be fairly free of debris, however, the associated culverts and bridges are all in need of cleaning, as is the natural channel, both above and below the concrete section.

While 1969's Hurricane Camile is still discussed with awe due to its staggering 20" of overnight rainfall and associated devastation, Buena Vista must also remember those smaller storms from the 1980s and 1990s that caused so many problems and cost so much money. A major purpose of this 2025 report is to inform those who were not present and to remind those who were. **Do not get complacent because damage from past storms has faded from most memories.** The 2024-2025 television coverage of floods in Asheville, NC and Kerr County, TX drive home the point that in modern times, water is the earth's most powerful destructive medium.

The author's mother recalls visiting Buena Vista in the aftermath of Camille and seeing a horse's tail protruding from a field of mud that she estimated as several feet deep.

The following photos came from the Encyclopedia Virginia. The link also has a recording of a couple's account along the Rockfish River near Buckingham.

[Hurricane Camille \(August 1969\) - Encyclopedia Virginia](#)

These photos were taken after the flood waters had receded. Many of the downtown buildings have preserved their high-water marks which are several feet above the levels in these photos.



*Member of Buena Vista Rescue Squad Pulling Boat Along Sycamore Avenue with City Hall on the right.
Author Unknown, from The News & Advance (Lynchburg)*



*Downtown Buena Vista Cleanup following Hurricane Camille.
Credit: Gene Carrow from the Richmond Times-Dispatch*

11.0 DRAINAGE SHEDS, PROBLEM AREAS AND RECOMMENDED PROJECTS FROM 1999 STUDY

The four major interior drainage sheds will be examined individually, while Lowry Run will be described in less detail.

11.1 Indian Gap Run

See Appendix 1 for a map key and Appendix 2 associated photographs of present conditions.

From the 1999 NRCS study:

Indian Gap Run, Pedlar Gap Run, and Noel's Run were surveyed to determine their hydrogeomorphic characteristics. These streams are relatively confined, with narrow floodplains and low sinuosity. Stream bottoms are predominately cobble, but boulders and bedrock are common in some reaches. Channel gradients in the narrow gaps are relatively steep (3 to 5 percent). These watersheds are dominated by the Antietam formation composed of quartzose sandstone, which forms the series of peaks on the edge of the City. On the steep side slopes where the streams cut through this formation, boulder fields are common, providing a ready source of rock material to the streams. Smaller streambed material shows evidence of frequent movement. This rock debris has formed a broad outwash plain where the streams leave the mountains, lose their steep gradient, and drop the debris. Much of Buena Vista is built on this outwash plain. It is the natural tendency of the stream channels to move back and forth across the plain.

Of the 341 properties projected to receive damages from the 100-year storm event, 223 are within the influence of Indian Gap Run.

Table 11-1

Damages for Various Return Periods VS Cost of Implementing 1999 Recommendations (Millions of 2025 Dollars)

Watershed	Percentate of Total Damage	Watershed Total 5-yr Damage (2025 M Dollars)	Watershed Total 25-yr Damage (2025 M Dollars)	Watershed Total 100-yr Damage (2025 M Dollars)	Cost of Improvements Recommended in 1999 NRCS Study (2025 M Dollars)
Indian Gap	62%	\$2.84	\$13.80	\$21.25	\$6.94
Noel's Run	14%	\$0.64	\$3.12	\$4.80	\$1.95
Chalk Mine Run	13%	\$0.59	\$2.89	\$4.46	\$5.00
Pedlar Gap	9%	\$0.41	\$2.00	\$3.09	\$6.87
TOTALS:		\$4.48	\$21.82	\$33.59	\$20.77

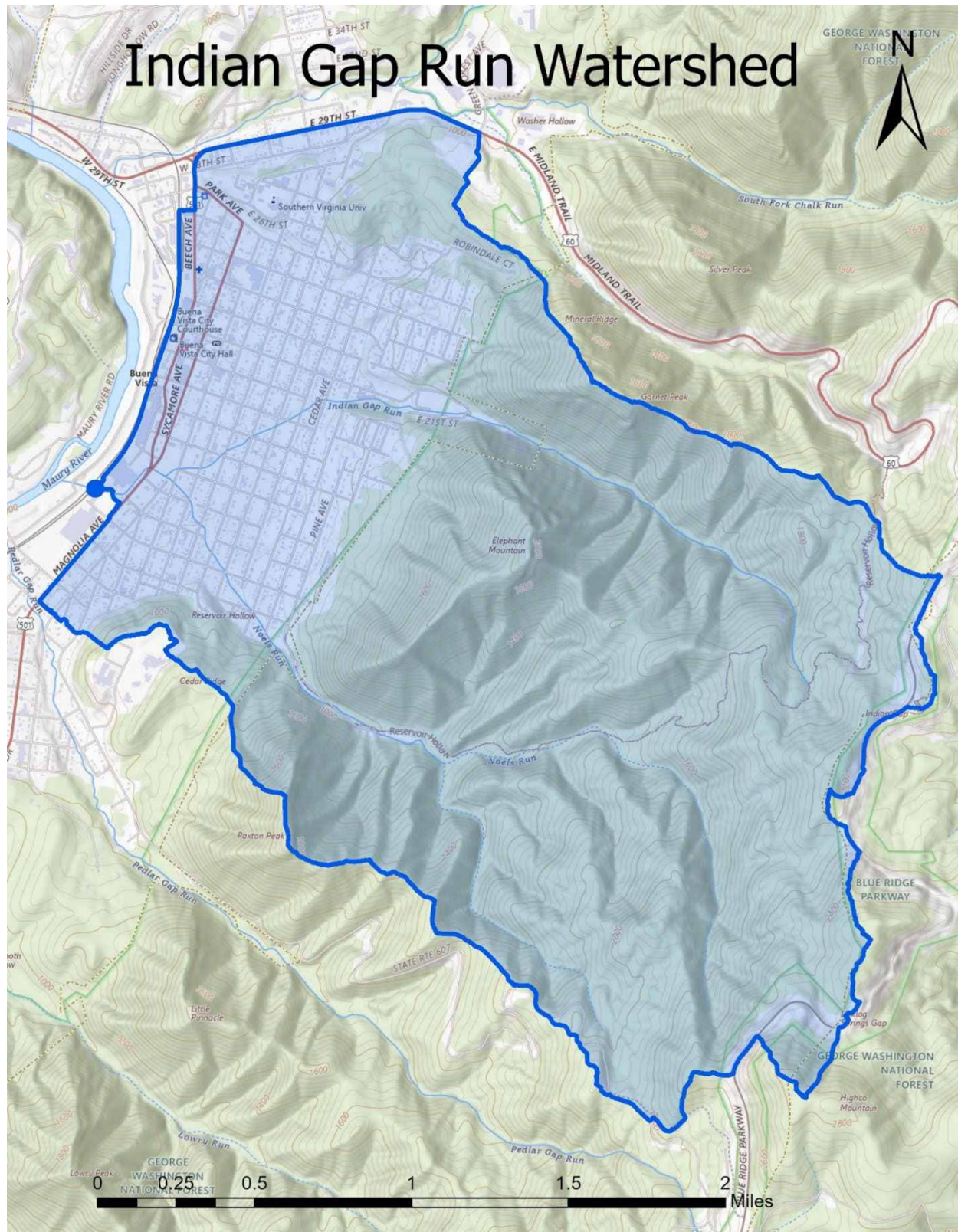


Figure 11-1-1

(Noel's Run is Included in the Drainage Shed)

1999 Watershed Description of Indian Gap Run (page 39)

Drainage Area Above Confluence with Noel's Run: 1051.5 acres (1.64 sq. mi.)

- Woods: 873.3 acres (83%)
- Open: 9 acres (1%)
- Residential: 169.2 acres (16%)

Indian Gap was modeled as a single channel from its headwaters to the confluence with the Maury River. Noel's Run was modeled as a tributary.

Drainage Area of Watershed to Confluence with Maury River: 2839.9 acres (4.44 sq. Mi.) which includes Noel's Run.

Channel Length Modeled: 7700 linear feet Discharge at confluence with Maury River:

5-year frequency event: 1652 cfs

25-year frequency event: 4019 cfs

100-year frequency event: 5942 cfs

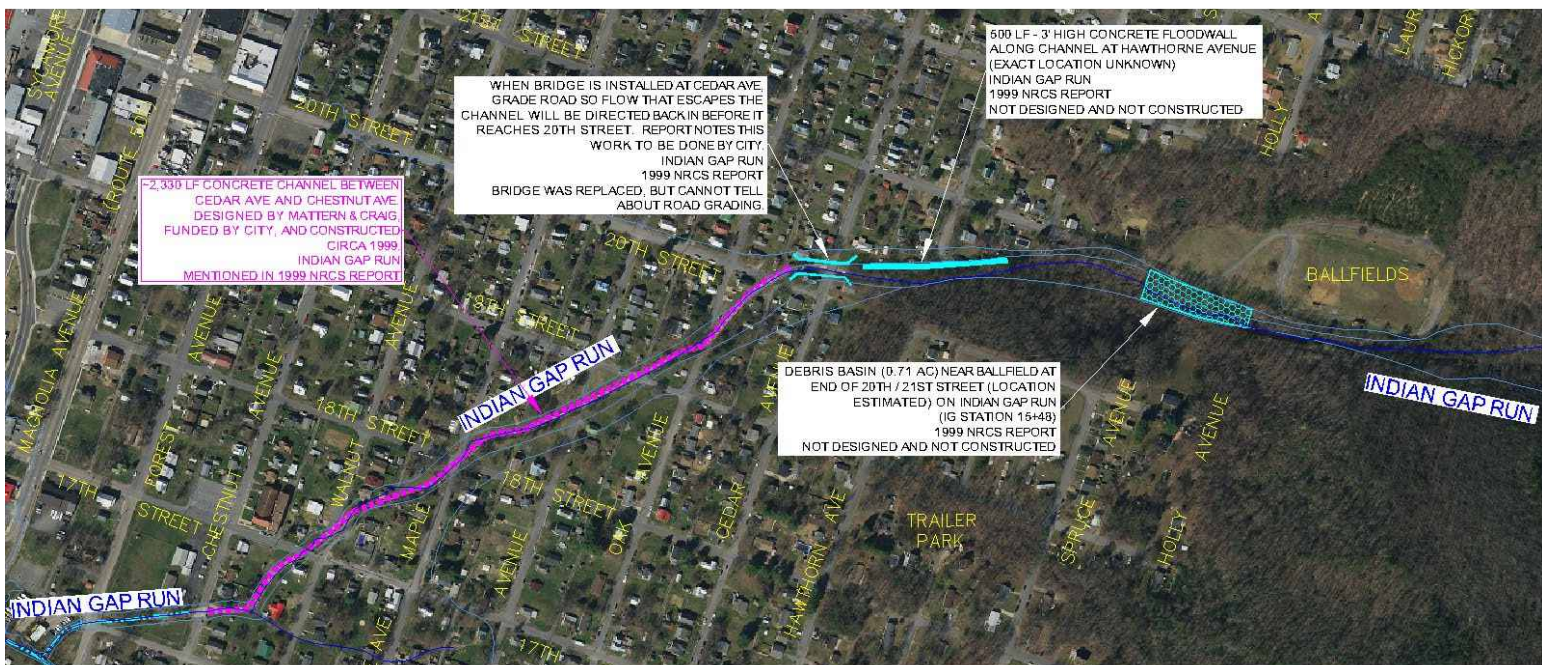


Figure 11-1-2 Indian Gap Run NRCS Recommended Projects

2025 Flood Data Related to Railroad Bridge Repairs

There are two railroad bridges on Indian Gap Run between Modine and the flood canal. The upstream-most bridge has experienced significant scour under one

of its piers and in April 2025, the consulting firm HDR prepared a flood analysis to accompany a repair plan. Those are provided in Appendices 12 and 13.

The HDR analysis utilized the Streamstats website for data related to predicting the Indian Gap Run flowrates for the various return periods. Below is a table comparing them with the 1999 NRCS study which used TR-55 hydrology to predict the flows. As shown, they differ significantly, despite their similar drainage shed areas with NRCS at 4.4 sq-mi and HDR at 4.1 sq-mi. This is similar to the difference on Chalkmine Run between FEMA's 1977 FIS and the 1999 NRCS study (see that section for additional information).

Table 11-2
Comparison of Predicted Flows in Indian Gap Run from 1999 NRCS and 2025 Streamstats

Recurrence Interval	1999 NRCS (cfs)	2025	
		Streamstats (cfs)	NRCS / Streamstats
2	-	318	-
5	1652	637	2.6
10	-	922	-
25	4019	1360	3.0
50	-	1760	-
100	5942	2190	2.7
500	-	2710	-

The differences range from 2.6x to 3.0x which NRCS would likely attribute to Streamstats' lack of historical flows for reference. TR-55 uses the topography, land covers, underlying soils, time of concentration, and rainfall data to predict flows. With such disparities in predicted flows, it is likely that other bridge and culvert owners do not perceive their structures as bottlenecks, and thus do not feel compelled to make capacity improvements.





Scour Under Pier of Upstream Railroad Bridge (set for repair)

Problem Description of Indian Gap Run

According to the 1999 study, there are three areas where flooding from Indian Gap Run occurs.

Above Cedar Avenue, water escapes from the channel and causes damages along Twentieth Street.

- The channel capacity is inadequate.
- The water moves directly down the hill and is unable to rejoin the channel.

Flooding also occurs in the lower section of the concrete channel.

- In the 1999 NRCS study, Buena Vista's design for the planned (and later constructed) concrete channel from Cedar Street to Chestnut Street was used as the existing condition in both the "Future without Project" and the "Future with Treatment" model.
- Flooding along most of the channel will be negligible after the concrete channel is in place.
- The HEC-2 model, in supercritical flow, shows that there will be two hydraulic jumps in the concrete channel below Walnut Avenue.

However, the vast majority of the damages occur from ponded water in the lower part of the watershed.

- There are two railroad bridges just above the floodwall gates. The downstream bridge is less than 18 feet wide and is a significant constriction to the flow.
- The upstream railroad bridge and its embankment also are a constriction.

- The gates through the floodwall are flap gates. As such, they will allow the free outlet of water from Indian Gap Run unless the Maury River is at a flood elevation greater than that of the interior stream. At that point, the water will be diverted into the interior drainage channel.

The culverts and bridges along the channel were modeled in the 1999 study as follows for the "Future without Project" (aka the existing) condition:

- Norfolk & Western Railroad: unchanged
- Norfolk & Southern Railroad: unchanged
- Route 501 (Magnolia Avenue): unchanged
 - 2025 Note: Sometime after 1999, the Magnolia Avenue bridge was replaced by VDOT with a double box culvert of 10'w x 6'h. This is considerably smaller than the recommended quadruple 8'w x 6'h culverts recommended in the NRCS study. It is not known if any modeling was done when this decision was made.

Debris blockages were not modeled in 1999 due to the impossibility of predicting which combination of culverts would clog in a given storm. The channel was assumed to be free of debris, which emphasizes the need to keep the channel clear.

1999 Recommended Projects for Indian Gap Run, Project Status, and 2025 Recommendations

Note that all Recommendations from the 1999 study (italicized below) are still considered valid and should be implemented as practicable. Recommendations and strategies will be discussed in more detail later in this report.

- *Install a debris basin near the ballfield at the end of 21st Street.*
 - This has not been done.
 - The suggested location has a large, wide floodplain opposite the ballfield which is conducive to constructing a debris basin. Ownership of the property is not known.
 - The natural channel above and below the concrete channel contains considerable cobble and debris, whereas the concrete channel is almost completely clear. This implies that significant cobbles are coming from the mountain, but are carried through the concrete channel as intended, then deposited in the natural channel.
- *Install a 3' high concrete floodwall along the channel at Hawthorne Avenue (500 feet).*
 - This has not been done.
- *When the new bridge is installed at Cedar Avenue, grade the road so the flow that escapes the channel will be directed back in before it*

- reaches Twentieth Street. (This was to be done by the City), but the road does not appear to have been graded in this way.*
- *Add approximately 300 feet of channel improvements below Magnolia Avenue and 700 feet of channel improvements above Magnolia Avenue. (To be done by VDOT).*
 - **Several hundred feet of improvements to the channel have been completed since 1999, probably when VDOT replaced the Magnolia Avenue bridge. The design for this is not on hand and the effects the floodplain elevations are not known.**
 - *Replace the Magnolia Avenue bridge with four 8'x6' box culverts. Approximately 150 FEET of Noel's Run will be improved to match the new grade on Indian Gap Run.*
 - The bridge has been replaced by the aforementioned double 10'w x 6'h box culvert, which is smaller than the NRCS recommendation, and Noel's Run was not modified.
 - *Replace the two railroad bridges with five 10'x10' box culverts, 130 feet long.*
 - This has not been done.
 - We recommend that the City contact Norfolk Southern and inquire about any plans to replace these bridges in the foreseeable future versus just rehabilitating the upstream bridge's pier.
 - The City needs to get the capacity issue on Norfolk Southern's radar and hopefully get a note into their database so if the bridges are replaced, they can be enlarged to increase hydraulic capacity. Otherwise, it will probably never get done.

Table 11-3
NRCS Project Cost Estimates for Indian Gap Run in 2025 Dollars

Cost Category	Recommended Alternative from 1999 Study in 2025 Dollars
Indian Gap Run	
Construction Cost	\$6,045,000
Property Rights	\$201,000
Road Relocations	\$21,000
Utility Relocations	\$45,000
Local Administration	\$45,000
Local Technical Assistance	\$69,000
NRCS Administration	\$150,000
NRCS Technical Assistance	<u>\$366,000</u>
Total Estimated Cost	\$6,942,000

Unfortunately, the available NRCS data does not thoroughly break down costs for individual elements, therefore it is difficult to remove the work at the Magnolia Avenue culvert and downstream channel. Even with a 3.0 cost multiplier from 1999 to 2025, the total watershed cost of \$6.942M appears to be low. Given the overall lack of detail in the original published report, it is not possible to determine what cost was ascribed to any particular project.

Even without having the individual costs associated with each project, it is safe to surmise that the largest costs would have been replacing the Magnolia Avenue culvert (done by VDOT) and the two railroad bridges.



Indian Gap Run after April 1992 Flood with Reeves Bros. Plant in Background. Modine is on opposite bank



*Debris and Sediment Blocking Street Culvert Opening (bottom left)
Near Confluence of Noel's and Indian Gap Runs after April 1992 Flood*

Maintenance Recommendations for Indian Gap Run

With the construction of the concrete channel and replacement Magnolia Avenue culvert (still likely too small), the downstream railroad bridges are the primary bottleneck in the system. However, keeping the culverts and natural channel open is important to minimizing flooding frequency and associated property and financial damage.

Appendix 2 contains photos and descriptions of the channel and appurtenances.

Appendix 11 contains a summary of all recommended maintenance costs.

Table 11-4-1 below contains a summary of maintenance recommendations and a preliminary budget. Tasks are ranked in importance from 1 to 5, with 5 being the most important within a particular watershed (**not for all watersheds combined**). The 1999 NRCS study points out that most of the City's interior damage occurs within the Indian Gap Run watershed. Of this, the majority is in the lower reaches and is caused by inadequate bridge capacities. The concrete channel in most of the upper portion significantly reduces the potential financial losses in that portion. Without replacing the offending bridges in the lower reaches, the two most important and achievable things Buena Vista can do are

1. Properly maintain the existing concrete channel to preserve its long life expectancy. This consists mostly of removing sediment and plant growth from between cracks/construction joints and then sealing the gaps thoroughly. In some places, shallow groundwater is exfiltrating the cracks. Crack sealing should be scheduled for dry periods.
 - Consult with a structural engineer to prepare a set of requirements for this work.
 - The work may be performed in-house by Public Works or bid-out to a contractor and overseen by Public Works.
 - Look for grants that may help pay for the structural engineer and/or the maintenance costs.
2. Maintain the culverts and natural channels free from cobbles, sediment, debris, and vegetation. Blockages can readily escalate costs of damage from a 5-year storm to those of a 10-year storm or greater.
 - The work may be performed in-house by Public Works or may be bid-out to a contractor and overseen by Public Works.

Permits are generally required for working within stream embankments with equipment. They are addressed in a separate section of this report.

Specific Recommendations for Indian Gap Run

With the construction of the concrete channel, the downstream railroad bridges are the primary bottleneck in the system and cause the greatest financial harm. The City has no ability to replace

these bridges, However, it can keep the culverts and natural channel open, which are critical to minimizing flooding risk.

Table 11-4-1
Indian Gap Run: Recommended Maintenance - Preliminary Cost Estimates

Photo	Location	Description	Quantity	Unit	Unit Cost	Total Cost	Priority 1-highest 3-lowest	Notes
IGR # 2, 3	Park Entrance and Beginning of Concrete Channel at Cedar	Remove cobbles and Woody Debris	950	lf	\$50	\$47,500	2	
IGR # 5 to 9	Entire length of concrete channel	Remove sporadic vegetation	2400	lf	\$5	\$12,000	2	
IGR # 5 to 9	Entire length of concrete channel	Seal cracks in concrete	2400	lf	\$15	\$36,000	2	
IGR # 9	Chestnut Avenue and 100' Downstream	Remove cobbles, debris, and woody vegetation from channel and culvert	150	lf	\$50	\$7,500	1	
None	Channel between Chestnut Avenue and Forest Avenue	Remove and dispose of cobbles, sediment, debris, woody material	100	lf	\$50	\$5,000	1	
IGR # 10, 11	Forest Avenue Culvert and 100' Upstream to 175' Downstream at Confluence with Noel's Run	Remove cobbles, debris, and woody vegetation from channel and culvert	325	lf	\$50	\$16,250	1	
IGR # 11 to 12	Channel from Noel's Run Confluence to Magnolia Avenue	Remove cobbles, debris, and woody vegetation from channel	275	lf	\$100	\$27,500	3	
IGR # 12	Culvert at Magnolia and Sycamore	Remove cobbles, debris, and woody vegetation from channel and culvert	1	ls	\$10,000	\$10,000	1	
IGR # 13 to 14	Channel from Magnolia/Sycamore to Railroad Bridge	Remove cobbles, debris, and woody vegetation from channel	1100	lf	\$75	\$82,500	3	Much of this is on Modine property. Need to perform a more detailed evaluation
IGR # 14	Flood Gates	NA	0	lf	\$0	\$0	NA	Corps of Engineers determines maintenance of canal, floodwall, and gates

Total of Priority 1 Maintenance Projects \$38,750
Total of Priority 2 Maintenance Projects \$95,500
Total of Priority 3 Maintenance Projects \$110,000
Total of All Maintenance Projects \$244,250

Overall Recommendations for Indian Gap Run

1. Perform regular maintenance as previously described.
2. Speak with VDOT about the early 2000s Magnolia Avenue culvert and channel work.
 - Was a hydraulic model created for that project? If so, get a digital copy and archive it, placing a copy with this report.
3. Speak with Norfolk Southern about their two bridges.
 - Have they done any hydraulic modeling other than what is in the HDR report? If so, get a digital copy.
 - How did they justify using Streamstats instead of TR-55 or HEC-HMS? Can they design future bridges using the latter methods?
 - When are the bridges slated for replacement?
 - What must the City do to ensure that they are replaced with larger structures?
4. Be aware of all the 1999 NRCS recommendations and put them into your GIS system at appropriate locations so they are not forgotten. This can be considered part of an “asset management” plan.
5. Set a calendar reminder annually to revisit the recommendations and keep new staff up to speed on things they may otherwise never learn.
6. Look for opportunities to improve the hydraulic capacities of culverts/bridges whenever they are replaced or undergo heavy rehabilitation. Do the same for channels whenever they are worked-on.
7. Despite efforts to locate copies of the 1999 NRCS HEC-1 and HEC-2 models, they are lost to time. Buena Vista should apply for a grant to systematically recreate the studies for each of the three remaining watersheds (a Chalkmine Run model is available from 2010) over the course of 6 fiscal years. Modern technology and available Lidar data make this much less expensive than in the 1990s, but it would still represent a significant cost, which is why it should be spread out.
 - Use the models to determine which potential improvements would have the greatest return on investment for preventing damage.
 - Apply for grants to help pay for the design or construction of the recommended improvements.

11.2 Noel's Run

Noel's Run's 1,630 acre drainage shed joins Indian Gap Run's 1,420 shed immediately downstream of Woodland Avenue. None of the Noel's Run improvements recommended in the 1999 NRCS study are known to have been designed or constructed, though many concrete culverts were constructed prior to that study.

Noel's Run's channel is approximately 9,600 feet long and in its perennial upper reaches it supports native brook trout (*Salvelinus fontinalis*). Within its lower sections and city limits, it becomes intermittent as the channel bottom is porous due primarily to deposited cobbles resulting from its shallow gradient. This forms a broad outwash plain through which the stream has a natural tendency to move back and forth. The minimally sloped stream also drops all manner of woody material, detritus, and human refuse. The combined deposits reduce capacities of channels, culverts, and bridges.

The Virginia Department of Wildlife Resources (DWR) describes Noel's Run as a class II wild trout stream. According to the 1999 study, where sampled by DWR, it ranges from 7'-12' wide with a high gradient, averaging from 320-380 feet of fall per mile. Shading averages from 80-100% throughout the trout and mountainous stream sections of the watershed. The section of Noel's Run where the trout are located is on U.S. Forest Service land, which is upstream of the proposed projects for Buena Vista. Lack of shading and other urban impacts limit habitat for fish and other aquatic species in the downstream sections of all the tributaries.

Of the 341 properties projected to receive damage from 100-year storm events, 23 are associated with Noel's Run and expected to result in structural damage of \$669,000 (\$2,007,000 in 2025 dollars).

The 1999 NRCS study in Appendix 16 indicates that the Noel's Run HEC-2 model had 20 cross-sections that were analyzed for both the "with" and "without" project scenarios. The locations and inundation limits are mostly discernable on the NRCS maps B-5 (without project) and B-9 (with project) although the hand-colored shading is very light and must be carefully examined to see that the project actually reduces the inundation limits.

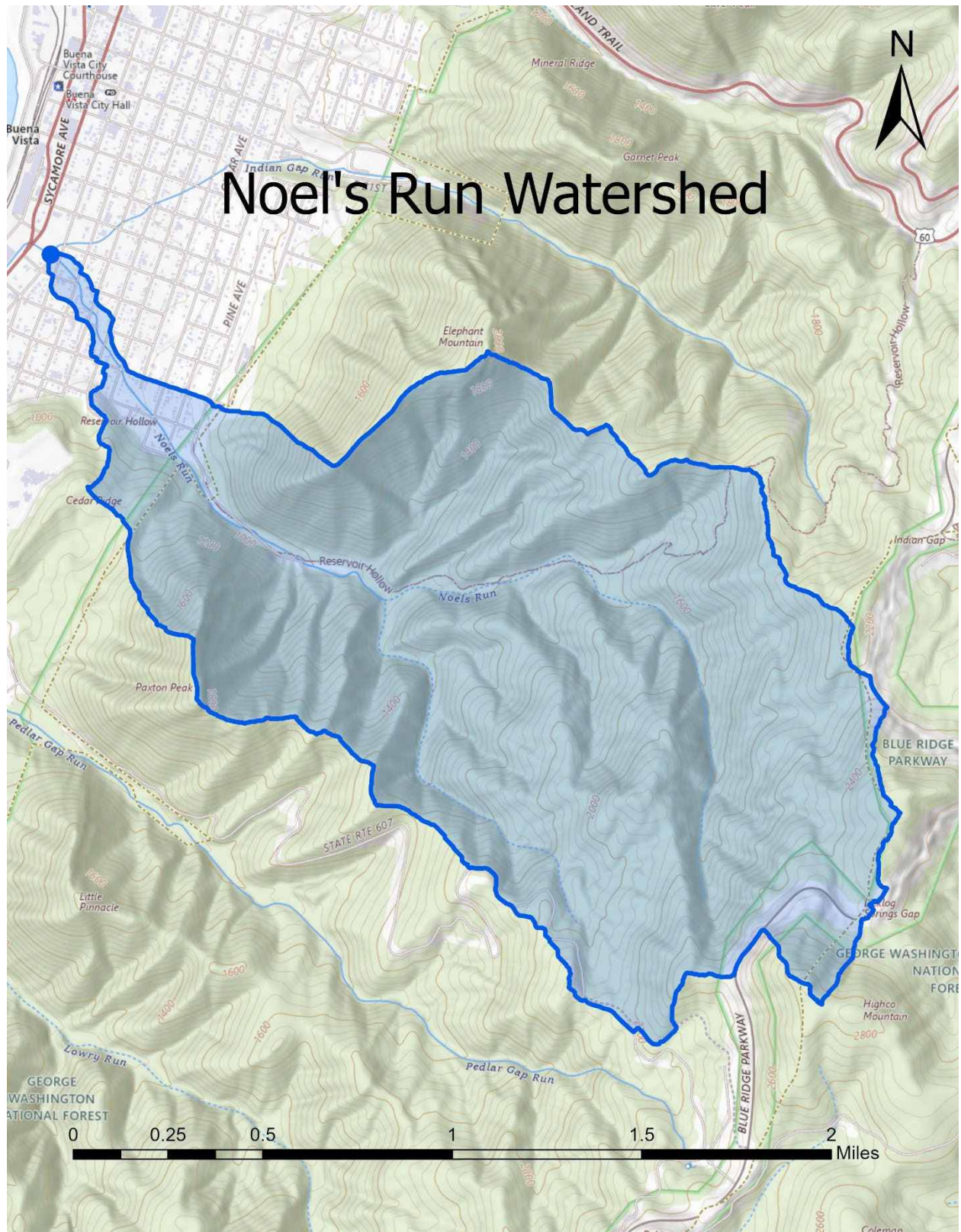


Figure 11-2-1



Destruction of 12th Street from Noel's Run in 1992

Problem Description of Noel's Run from 1999 NRCS Study

For Noel's Run, overland flow occurs along the entire length of the channel. Additional damage is caused by the ponding at the lower end of the stream below Chestnut Avenue.

From Pine Street to Chestnut Avenue, water escapes from the channel and flows overland in a path that is parallel to the channel.

- *The capacity of the stream is not adequate to carry the water during storm events.*
- *Water that escapes from the channel does not tend to return to the channel.*
- *There is an abundance of debris in the channel that further reduces the channel capacity.*

From Chestnut Avenue to the confluence with Indian Gap Run, the flooding is caused by ponded water.

- *In the "Future without Project" condition, the ponding at the lower end of the channel is primarily caused by backwater from Indian Gap Run.*
- *The ponding from Indian Gap Run is masking the actual flooding that is occurring below Chestnut Avenue from Noel's Run. When the ponding from Indian Gap Run is reduced by modeling Alternative 2 (from 1999 study), then other causes of flooding are revealed. From Chestnut Avenue to Forest*

Avenue, overland flooding occurs parallel to the channel. However, the extent of the overland flow is greater below Chestnut Avenue than it is above Chestnut Avenue. The flatter grade that begins at Chestnut Avenue causes the water to flow slower and deeper than it does on steeper grades. From Forest Avenue to the confluence with Indian Gap Run, ponding from Indian Gap Run is still dominant.

- *There may be a channel constriction at Forest Avenue that will continue to be masked by the ponded water.*

Table 11-2-1

Damages for Various Return Periods VS Cost of Implementing 1999 Recommendations (Millions of 2025 Dollars)

Watershed	Percentate of Total Damage	Watershed Total 5-yr Damage (2025 M Dollars)	Watershed Total 25-yr Damage (2025 M Dollars)	Watershed Total 100-yr Damage (2025 M Dollars)	Cost of Improvements Recommended in 1999 NRCS Study (2025 M Dollars)
Indian Gap	62%	\$2.84	\$13.80	\$21.25	\$6.94
Noel's Run	14%	\$0.64	\$3.12	\$4.80	\$1.95
Chalk Mine Run	13%	\$0.59	\$2.89	\$4.46	\$5.00
Pedlar Gap	9%	\$0.41	\$2.00	\$3.09	\$6.87
	TOTALS:	\$4.48	\$21.82	\$33.59	\$20.77

1999 NRCS Recommended Projects for Noel's Run

Install 3 Debris Basins:

- headwaters - 0.71 acres at the end of Pine Street (Sta 25+28)
- intermediate - 0.80 acres at the end of Oak Avenue (Sta 38+00)
- intermediate - 0.20 acres upstream of Maple Avenue (Sta 45+05)

The 1999 study noted that although the modeled channel improvements were adequate to carry the storm flows, the overland flow from upstream areas did not return to the channel where it could be contained. Therefore, no channel improvements were recommended. The debris basins should help to keep the water contained within the channel and avoid turning a small flood event into a major flood event.

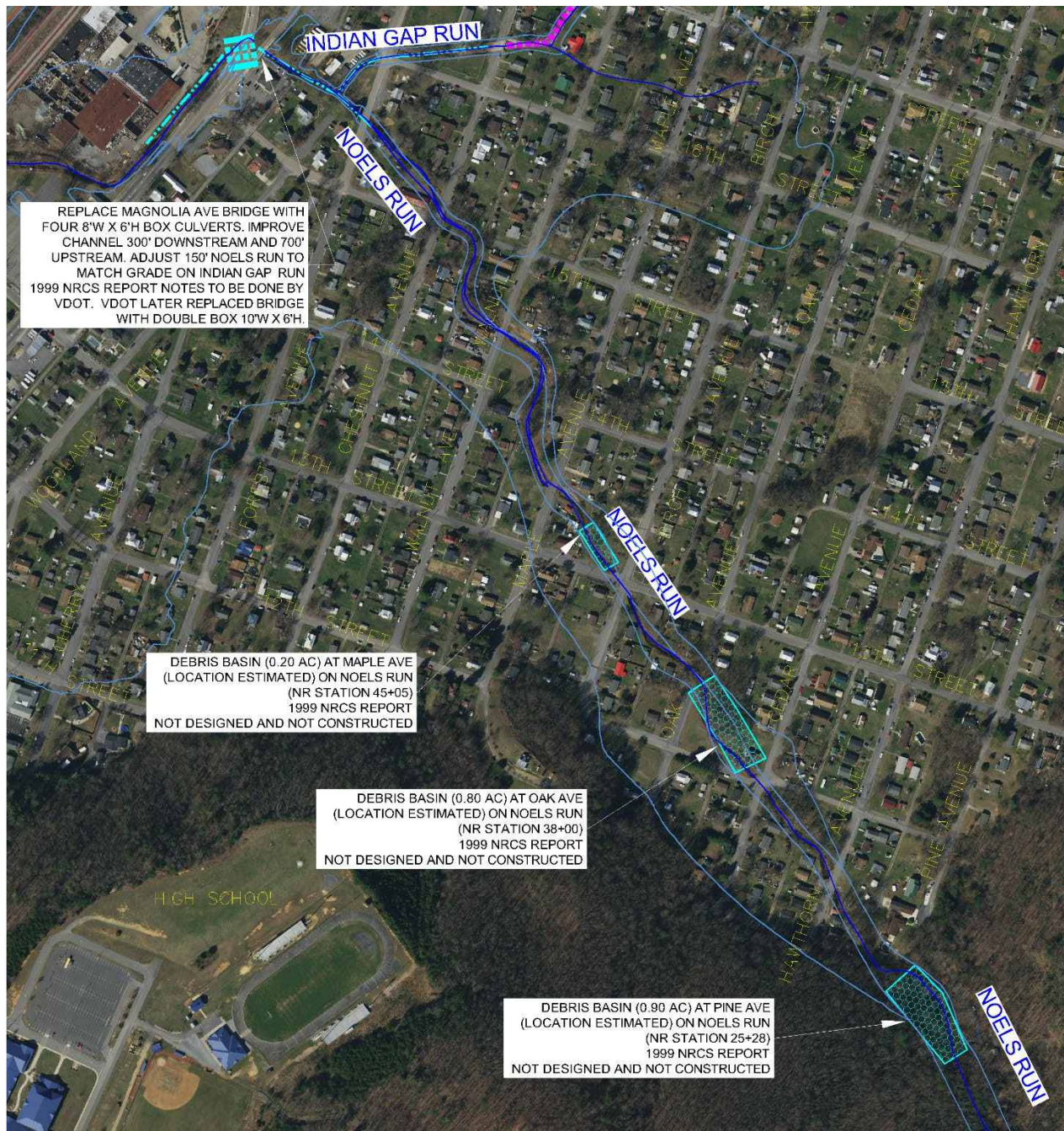


Figure 11-2-2 Noel's Run NRCS Recommended Projects

Table 11-2-2

Cost Category	Recommended Alternative from 1999 Study in 2025 Dollars
Noel's Run	
Construction Cost	\$1,578,000
Property Rights	\$156,000
Utility Relocations	\$30,000
Local Administration	\$15,000
Local Technical Assistance	\$24,000
NRCS Administration	\$60,000
NRCS Technical Assistance	\$93,000
Total Estimated Cost	\$1,953,000

As illustrated by the photos in Appendix 3, there are approximately eight concrete culverts and one corrugated metal culvert along Noel's Run from Pine Avenue to its confluence with Indian Gap Run. It is critically important that these culverts and the associated channels be maintained to their maximum capacities because, as noted by NRCS, once flood waters exit the channel, they do not tend to re-enter. Thus, the damage will continue downstream.

Specific Recommendations for Noel's Run

The City should evaluate property ownership and land acquisition costs for the debris basins and then do a preliminary engineering report (PER) to examine total costs and other factors associated with constructing as many of the basins as practicable. The 2025 cost of \$1.953M may be a bit high, but the NRCS backup data used to determine their 1999 cost is not available. Buena Vista should seek to construct all three of the basins, but it should absolutely construct at least one. These are considered capital projects. Buena Vista should investigate grants such as CFPF that may be used to construct debris basins and/or pay for recommended maintenance.

Table 11-2-3

Noel's Run: Recommended Capital Projects - Preliminary Cost Estimates

Photo	Location	Description	Quantity	Unit	Unit Cost	Total Cost	Priority 1-highest 3-lowest	Notes
NR # 2	End of Pine Street	Construct New Debris Basins	1	each	\$651,000	\$651,000	1	Study land ownership and Basin Configs, PER
None	End of Oak Avenue	Construct New Debris Basins	1	each	\$651,000	\$651,000	2	Study land ownership and Basin Configs, PER
None	Upstream of Maple Avenue	Construct New Debris Basins	1	each	\$651,000	\$651,000	2	Study land ownership and Basin Configs, PER

Total of Priority 1 Capital Projects \$651,000

Total of Priority 2 Capital Projects \$1,302,000

Total of Capital Projects \$1,953,000

Noel's Run: Recommended Maintenance - Preliminary Cost Estimates

Photo	Location	Description	Quantity	Unit	Unit Cost	Total Cost	Priority 1-highest 3-lowest	Notes
NR # 3	Hawthorn Avenue Culvert and channel 100' upstream and 100' downstream	Remove cobbles and Woody Debris from Culvert and Channel 100' in each direction	250	lf	\$50	\$12,500	2	
NR # 3	Hawthorne Avenue	Re-grout rip-rap after removing debris and woody plant material	1	ls	\$1,000	\$1,000	2	
NR # 4	Cedar Avenue Culvert and Channel 100' Upstream and Downstream	Remove cobbles and Woody Debris from Culvert and Channel 100' in each direction	50	lf	\$50	\$2,500	1	Lots of larger size cobbles at this location and heavily overgrown banks
NR # 4	Cedar Avenue	Repair concrete apron at culvert outlet to prevent undermining	1	ls	\$7,500	\$7,500	1	
NR # 5	Birch and 13th and Channel 100' Upstream and Downstream	Remove cobbles and Woody Debris from Channel 100' in each direction	250	lf	\$50	\$12,500	1	The deck of the culvert appears to be removable to facilitate cleaning out flood debris with heavy equipment. Non-woody vegetation may remain on edges of gabion baskets.
NR # 5	Birch and 13th	Repair concrete apron at culvert outlet to prevent undermining	1	ls	\$7,500	\$7,500	1	
NR # 6	Maple Avenue and Channel 100' Upstream and Downstream	Remove cobbles and Woody Debris from Channel 100' in each direction	250	lf	\$100	\$25,000	1	
NR # 7	Walnut Avenue and Channel 100' Upstream and Downstream	Remove cobbles and Woody Debris from Channel 100' in each direction	250	lf	\$100	\$25,000	1	There is a long concrete wall downstream that was constructed by the property owner.
NR # 8	Chestnut Avenue and Channel 100' Upstream and Downstream	Remove cobbles and Woody Debris from Channel 100' in each direction	250	lf	\$100	\$25,000	1	
NR # 9	Forest Avenue	Remove cobbles and Woody Debris from Channel 100' in each direction	250	lf	\$100	\$25,000	1	

Total of Priority 1 Maintenance Projects \$130,000

Total of Priority 2 Maintenance Projects \$13,500

Total of Priority 3 Maintenance Projects \$0

Total of All Maintenance Projects \$143,500

General Recommendations for Noel's Run

1. Create a basic strategy for addressing cleanup following flood events. Include and outline and responsibility for overseeing the effort.
2. Perform regular maintenance as previously described.
3. Try to determine when the culverts were constructed.
 - Was a hydraulic model created for that project? If so, get a digital copy.
4. Be aware of all the 1999 NRCS recommendations and put them into your GIS system at appropriate locations so they are not forgotten.
5. Set a calendar reminder annually to revisit the recommendations and keep new staff up to speed on things they may otherwise never learn.
6. Look for opportunities to improve the hydraulic capacities of culverts/bridges whenever they are replaced or undergo heavy rehabilitation. Do the same for channels whenever they are worked-on.
7. Despite efforts to locate copies of the 1999 NRCS HEC-1 and HEC-2 models, they are lost to time. Buena Vista should systematically recreate the studies for each of the three remaining watersheds (a Chalkmine Run model is available from 2010) over the course of 6 fiscal years. Modern technology and available Lidar data make this much less expensive than in the 1990s, but it would still represent a significant cost, which is why it should be spread out.

11.3 Pedlar Gap Run

Pedlar Gap Run normally discharges into the Maury River at 10th Street, but if the Maury is flooding, it is redirected into the canal which enters the Maury at the southern end of town. None of the Pedlar Gap improvements recommended in the 1999 NRCS study are believed to have been designed or constructed.

According to the 1999 NRCS study, Pedlar Gap Run's channel is approximately 18,000 feet long and flows perennially in its upper reaches. Within its lower sections and city limits, it becomes intermittent as the channel bottom is porous due primarily to deposited cobbles resulting from its shallow gradient. This forms a broad outwash plain through which the stream has a natural tendency to move back and forth. The minimally sloped stream also drops all manner of woody material, detritus, and human refuse. The combined deposits reduce capacities of channels, culverts, and bridges.

The Virginia Department of Wildlife Resources (DWR) classifies Pedlar Gap Run as a class III wild trout stream. According to the 1999 study, where sampled by DWR, it ranges from 4'-12' wide with a high gradient, averaging from 320-380 feet of fall per mile. Shading averages from 80-100% throughout the mountainous stream sections of the watershed. The section of Pedlar Gap Run where the trout are located is on U.S. Forest Service land, which is upstream of Buena Vista. Lack of shading and other urban impacts limits habitat for fish and other aquatic species in the downstream sections.

The HEC-1 and HEC-2 models utilized 5 sub-sheds and 22 cross-sections, both with and without project. According to the 1999 study, sixty (60) properties are expected to be affected by flooding within PGR watershed without the project. Those models are lost to posterity.

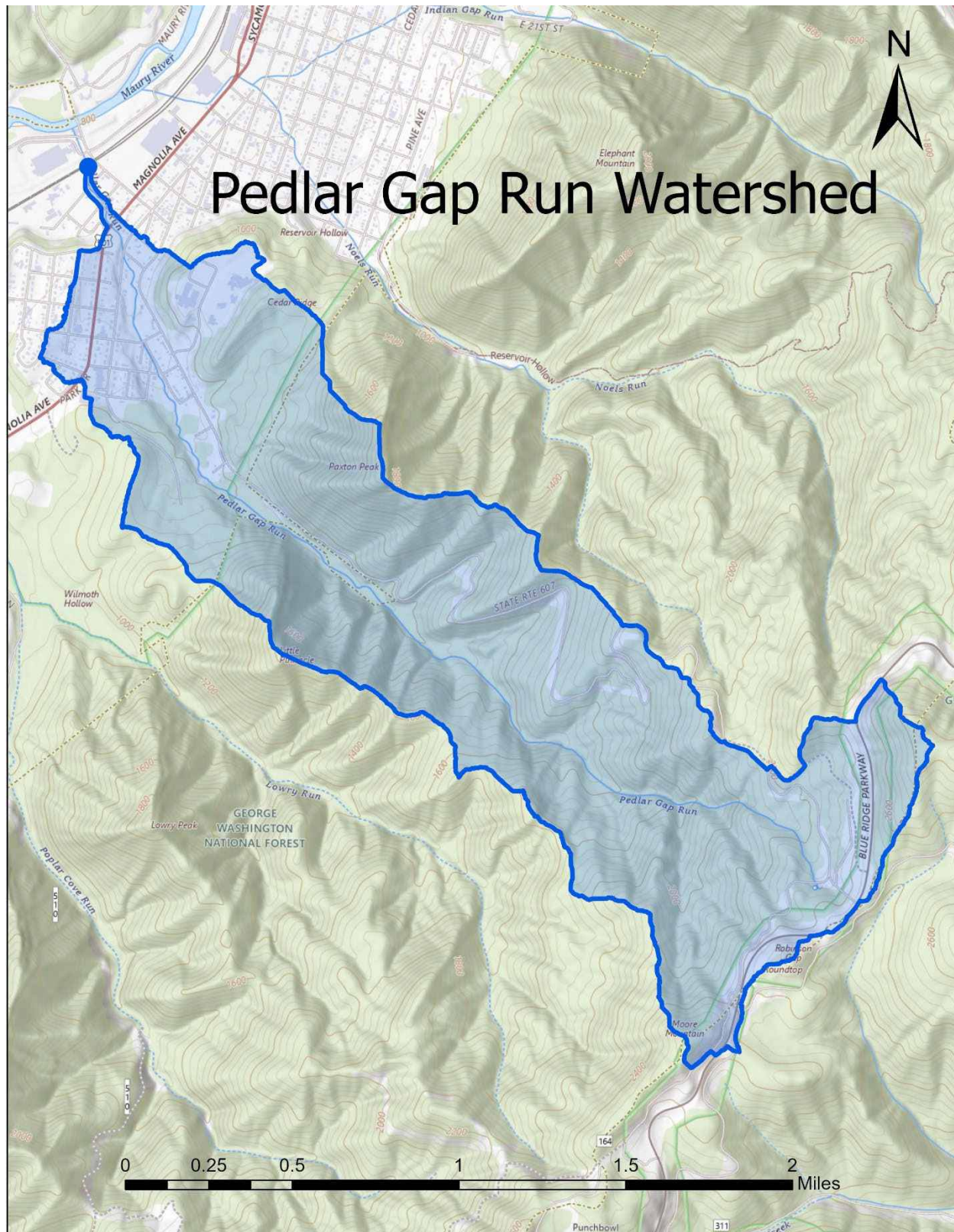


Figure 11-3-1

11.3.1 Pedlar Gap Run specifics from 1999 NRCS study

According to the 1999 NRCS study, the flooding in the Pedlar Gap Run watershed is similar to that of the other streams in Buena Vista. There is ponding in the lower end of the channel, overland flow along the length of the channel, and debris blockages throughout. Additional ponding occurs in the upper part of the watershed at some of the culverts. Much of the damage can be attributed to the stream crossings that are too small to pass the increased discharges caused by changes in land use.

Upstream of Woodland Avenue, several projects to increase stream capacity are in place and functioning properly as of 1999. These are from a Corps of Engineers project that occurred just after the flood of 1985. They consist of gabion channel improvements, some rip-rap areas within the channel, and new culverts at 3rd Street and Linden Avenue. There were no additional improvements recommended above Woodland Avenue by the 1999 study except for two debris basins.

Drainage Area: 1299 acres (2.03 sq. mi.)

- Woods: 1172 acres (90%)
- Residential: 120 acres (9%)
- Open: 5 acres (0.4%)
- Industrial: 2 acres (0.2%)
- Channel Length Modeled: 8395 feet

Discharge at confluence with Maury River:

- 5-year frequency event: 621 cfs
- 25-year frequency event: 1698 cfs
- 100-year frequency event: 2607 cfs

Table 11-3-1

Damages for Various Return Periods VS Cost of Implementing 1999 Recommendations (Millions of 2025 Dollars)

Watershed	Percentate of Total Damage	Watershed Total 5-yr Damage (2025 M Dollars)	Watershed Total 25-yr Damage (2025 M Dollars)	Watershed Total 100-yr Damage (2025 M Dollars)	Cost of Improvements Recommended in 1999 NRCS Study (2025 M Dollars)
Indian Gap	62%	\$2.84	\$13.80	\$21.25	\$6.94
Noel's Run	14%	\$0.64	\$3.12	\$4.80	\$1.95
Chalk Mine Run	13%	\$0.59	\$2.89	\$4.46	\$5.00
Pedlar Gap	9%	<u>\$0.41</u>	<u>\$2.00</u>	<u>\$3.09</u>	<u>\$6.87</u>
TOTALS:		\$4.48	\$21.82	\$33.59	\$20.77



Figure 11-3-2 Pedlar Gap Run NRCS Recommended Projects



Scouring of Stream Channel on Pedlar Gap Run after April 1992 flooding



Destruction of Street and Blockage of Culvert with Debris and Sediment on Pedlar Gap Run from April 1992 Flood

Problem Description of Pedlar Gap Run

According to the 1999 study, the majority of the damages caused by flooding from Pedlar Gap Run are from ponding in the lower end of the channel. However, flooding does occur along the length of the channel due to changes in stream capacity. Debris blockages exacerbate that condition.

Overland flow occurs from Third Street to just below Ninth Street. The channel capacity is not adequate to carry the flows during storm events. Most of the stream crossings on this channel do not have adequate capacity to transport flows from storm events.

Upstream of the 3rd Street crossing, the water is ponded.

The abandoned bridge in the (now former) woodyard below Linden Avenue and the Norfolk Southern Railroad crossing both cause the water to be ponded during larger storms. The configuration of the outlet at the railroad crossing is such that it is possible to lower the outlet by approximately 5 feet without causing a backwater effect within the stream. This will increase the average slope of the channel and increase the velocity. The proposed channel improvements from 1999 would also increase the cross-sectional area of the channel. These two changes would have the effect of minimizing out-of-bank flow along the improved length of the stream. It is important to note that environmental regulations and standard design practices for modifying stream channels have changed since 1999. In 2025, nature-oriented methods such as the Rosgen Geomorphic Channel Design are more standard. These are more complex than simply constructing a trapezoid, as they often seek to mimic natural sinuosity, which reduces the slope of the channel. At a minimum, some form of low-flow channel would be included to maintain adequate velocity along with a wider channel for higher flows.

General Technical Considerations

- Although a trapezoidal shape was modeled in the channel improvements, it is not the optimum shape for a good channel design. A low flow channel should be provided within the main channel to maximize the sediment carrying capacity of base level flows. This is also more ecologically sound.

In keeping with State regulations, Stormwater management (detention) for new development to maintain existing discharge levels is critical.

- Any debris basins installed should be well maintained to get the maximum benefit.

- It would be appropriate to restrict additional construction in the 100-year floodplain.

Pedlar Gap Run Recommended Plan from 1999

- Install one debris basin above 2nd Street and another one above 5th Street.
- Remove the Woodland Avenue culvert and replace it with a hy-span type bridge.
- Replace the Magnolia Avenue bridge with three 10'x 8' box culverts.
- Remove the 9th Street culvert and replace the culvert with a hy-span type bridge.
- Replace the railroad culvert with two 10'x10' box culverts and lower the invert elevation by 5 feet. Approximately 120 feet of channel would be realigned.
- Remove the Linden Avenue culvert and replace it with a hy-span type bridge deck.
- Remove the abandoned lumber yard bridge.
- Improve the channel from the railroad to a point approximately 250 feet above Woodland Avenue (1708 feet, includes 120 feet of channel re-alignment).

Future flood damages and threats to loss of life would be substantially reduced with the recommended alternative. However, they cannot be eliminated entirely. Damaged properties remaining from the 100-year storm event as a result of the recommended 1999 alternative include 10 within Pedlar Gap Run.

Economic Considerations

The following table displays all cost categories for the Pedlar Gap Run selected alternative from 1999, expressed in 2025 dollars. The 1999 NRCS report did not include costs for constructing individual elements.

Table 11-3-2

Cost Category	Recommended Alternative from 1999 Study in 2025 Dollars
Pedlar Gap Run	
Construction Cost	\$5,913,000
Property Rights	\$309,000
Utility Relocations	\$150,000
Local Administration	\$30,000
Local Technical Assistance	\$45,000
NRCS Administration	\$150,000
NRCS Technical Assistance	<u>\$276,000</u>
Total Estimated Cost	\$6,873,000

Specific Recommendations for Pedlar Gap Run

As with the other channels, maximizing containment of floodwater within the Pedlar Gap Run channel is critical to reducing flood damage. A reasonably-implemented part of this strategy includes replacing the Woodland Avenue Culvert and constructing the debris basins recommended in the NRCS study, along with keeping the channel clean. It is much easier to remove cobbles, etc. from the debris basins than it is to remove them from the culverts and the entire length of the stream channel. Channel improvements and culvert replacements in the lower reaches are more costly and pose more regulatory hurdles, thus reducing the City's appetite for implementing them. The following two tables prioritize realistic capital projects and maintenance items.

Table 11-3-3

Pedlar Gap Run: Recommended Capital Projects - Preliminary Cost Estimates

Photo	Location	Description	Quantity	Unit	Unit Cost	Total Cost	Priority 1-highest 3-lowest	Notes
PGR # 4	Woodland Avenue Culvert	Culvert has failed. Replace with Arch-type structure or box.	150	lf	\$2,000	\$300,000	1	This is a capital project for replacement and is not listed as a maintenance cost
PGR # 4	Woodland Avenue Culvert	Analysis, Design, and Construction Admin. for Culvert Replacement	1	ls	\$121,000	\$121,000	1	This is a capital project for replacement and is not listed as a maintenance cost
None	Above 2nd Street Above 5th Street	Construct New Debris Basins	2	each	\$651,000	\$1,302,000	2	This is a capital project for replacement and is not listed as a maintenance cost

Total of Priority 1 Capital Projects **\$421,000**

Total of Priority 2 Capital Projects **\$1,302,000**

Total of Capital Projects **\$1,723,000**

Pedlar Gap Run: Recommended Maintenance - Preliminary Cost Estimates

Photo	Location	Description	Quantity	Unit	Unit Cost	Total Cost	Priority 1-highest 3-lowest	Notes
PGR # 2	Gabion channel along Evergreen down to 3rd St	Remove and dispose of cobbles, sediment, debris, woody material	600	lf	\$50	\$30,000	1	
PGR # 3	Culvert at 3rd St	Repair gash/corrosion, remove cobbles and woody material	1	ls	\$5,000	\$5,000	1	
PGR # 3	Channel 100' downstream of 3rd St	Remove and dispose of cobbles, sediment, debris, woody material	100	lf	\$50	\$5,000	2	
None	Channel from 100' downstream of 3rd St to 100' above Woodland Ave Culvert	Remove and dispose of cobbles, sediment, debris, woody material	1350	lf	\$50	\$67,500	3	
None	Channel from Woodland Avenue to 100' above Magnolia Avenue	Remove and dispose of cobbles, sediment, debris, woody material	300	lf	\$50	\$15,000	3	
PGR # 5	Magnolia Ave Bridge and 100' upstream and downstream	Remove sediment, vegetation, and Cobbles from channel and under bridge to 100' upstream/downstream	200	lf	\$50	\$10,000	1	
PGR # 5, 6	Channel from 100' below Magnolia Avenue to 100' above 9th Street	Remove and dispose of cobbles, sediment, debris, woody material	100	lf	\$50	\$5,000	3	
PGR # 6	9th Street Culvert and 100' Upstream and Downstream	Remove debris from channel between Magnolia and 9th and repair damaged concrete bottom where applicable.	200	lf	\$50	\$10,000	2	
None	Channel from 100' below 9th Street to 100' above Linden Avenue	Remove and dispose of cobbles, sediment, debris, woody material	220	lf	\$50	\$11,000	3	
PGR # 7	Linden Avenue Culvert and 100' Upstream and Downstream	Remove and dispose of cobbles, sediment, debris, woody material	1	ls	\$15,000	\$15,000	1	

Total of Priority 1 Maintenance Projects **\$60,000**

Total of Priority 2 Maintenance Projects **\$15,000**

Total of Priority 3 Maintenance Project **\$98,500**

Total of All Maintenance Projects **\$173,500**

Of particular importance is the 1970s era corrugated metal culvert at Woodland Avenue. It is completely inadequate for the 100-year flood event and has physically collapsed at its entrance. Its interior bottom has corroded and is completely absent for its entire length. In late 2025 the City implemented a temporary entrance repair to at least get water into the culvert once again. The 1999 NRCS report recommended replacing it with a Hy-Span arch, but it did not provide the size. This culvert is approximately 150' long and skewed under the road. It also has a sanitary sewer line passing under it with a manhole near the culvert entrance. This replacement project has been given top priority with a budgetary estimate of \$300,000 for construction and \$121,000 for hydrologic/hydraulic analyses, design, and construction administration. Because this culvert lies within a FEMA Zone A (no calculated flood elevations) a LOMR or CLOMR are not required.

Choosing an appropriate replacement structure will require a fairly complex 2-Dimensional model within HEC-RAS because the water tends to escape the channel upstream of Woodland Avenue and flow away at a depth shallower than what remains in the channel. Multiple iterations of the model will be needed to determine the logical replacement size. This is due to effects noted in the 1999 NRCS study such as inadequate adjacent channels and downstream structural impediments such as the Magnolia Avenue bridge and the 9th Street Culvert. The NRCS study attempted to mostly eliminate flooding from the 100-year storm event by comprehensively assuming that all projects were constructed and all bottlenecks removed.

We recommend that the City prepare a Preliminary Engineering Report (PER) to model the floodplain through this area to determine the logical size for the replacement structure. It would examine numerous iterations of channel size and upstream/downstream improvements, then recommend a replacement size based upon all factors. For instance, it may prove unworkable to construct a Hyspan or culvert that is wide enough to pass the 100-year storm event without substantially widening the channel and affecting adjacent houses. In other words, it could become a prohibitively expensive slippery slope. It may prove more appropriate to pass a smaller event such as the 25-year storm. The City should apply for a CFPF grant to fund the design and construction of the replacement structure.



Outlet Showing Complete Absence of Pipe Bottom for Entire Length



Top: Failed Entrance Prior to Temporary Repair
Bottom: Temporary Repair (10' of replacement pipe at entrance)

General Recommendations for Pedlar Gap Run

1. Create a basic strategy for addressing cleanup following flood events. Include an outline and responsibility for overseeing the effort.
2. Budget an annual amount to keep-up the maintenance efforts following the initial work.
3. Determine if grants are available to pay for cleaning up the channels and culverts.
4. Utilize Nature-Based methods for projects when practicable.
5. Try to determine when the culverts were constructed.
 - Was a hydraulic model created for that project? If so, get a digital copy.
6. Be aware of all the 1999 NRCS recommendations and flag them in your GIS system at appropriate locations so they are not forgotten.
7. Set a calendar reminder annually to revisit the recommendations and keep new staff up-to-speed on things they may otherwise never learn.
8. Look for opportunities to improve the hydraulic capacities of culverts/bridges whenever they are replaced or undergo heavy rehabilitation. Do the same for channels whenever they are worked-on.
9. Despite efforts to locate copies of the 1999 NRCS HEC-1 and HEC-2 models, they are lost to time. Buena Vista should systematically recreate the studies for each of the three remaining watersheds (a Chalkmine Run model is available from 2010) over the course of 6 fiscal years. Modern technology and available Lidar data make this much less expensive than in the 1990s, but it would still represent a significant cost, which is why it should be spread out.

11.4 Chalkmine Run and Washer Hollow

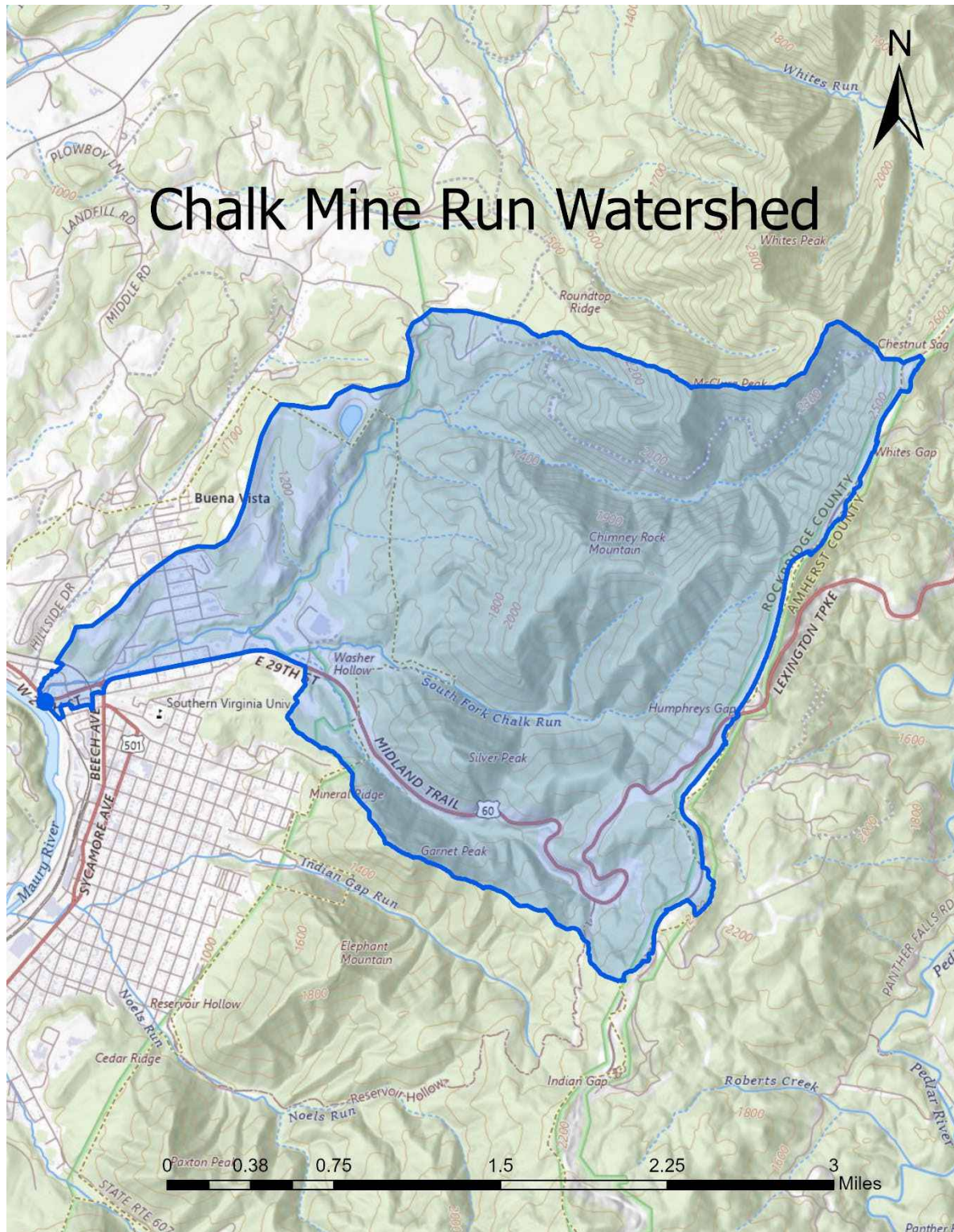


Figure 11-4-1

Chalk Mine Run and its tributary, Washer Hollow, both experience flooding along the length of the channel. According to the 1999 NRCS study, this is due primarily to lack of channel capacity and to stream crossing constrictions. The lower end of Chalk Mine Run, below Route 60, also experiences flooding from the Maury River. (The U.S. Army Corps of Engineers floodwall begins downstream of the outlet of Chalk Mine Run.) **Most of the crossings along this stream are relatively large as of 2025 because several bottlenecks were replaced between 2000 and 2010. They included the culvert at Rockbridge Avenue and the bridge to Fitzgerald's Lumber Plant, along with the Norfolk Southern bridge, all of which were replaced by bridges. Additionally, Buena Vista removed the culvert at Alleghany Avenue, and VDOT modified the Route 60 bridge to enhance its hydraulic capacity.** See Appendix 1 for a map key and Appendix 5 associated photographs of present conditions.

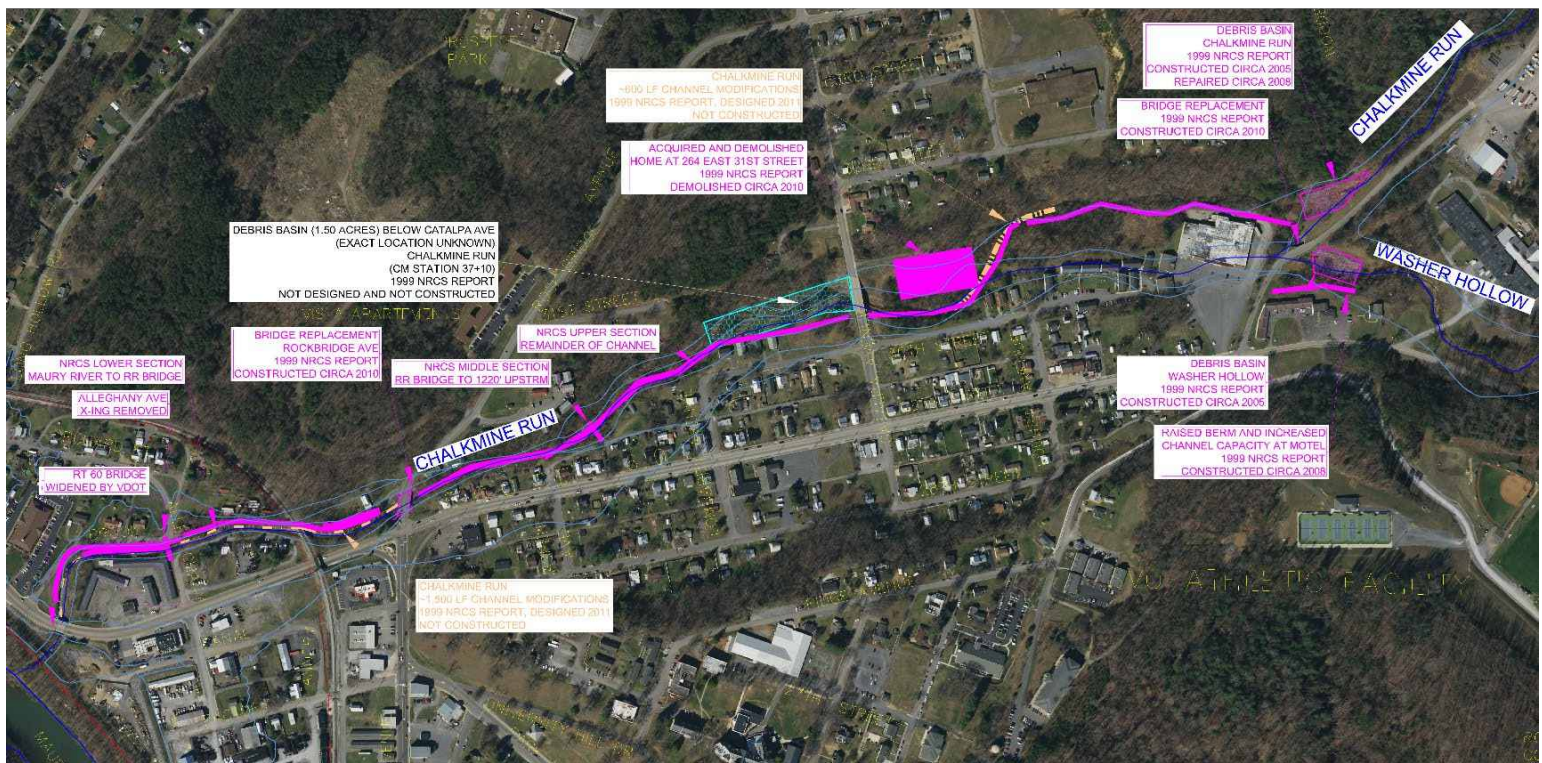


Figure 11-4-2 Chalkmine Run NRCS Recommended Projects

Of Buena Vista's interior streams, Chalkmine Run is the only one which had any of the 1999 NRCS recommendations implemented. In keeping with the present report's format, the problems and recommendations from the 1999 study have been repeated and their statuses noted.



Rockbridge Avenue Bridge Circa 2010



Rockbridge Avenue Bridge Circa 2025

Table 11-4-1

Damages for Various Return Periods VS Cost of Implementing 1999 Recommendations (Millions of 2025 Dollars)

Watershed	Percentate of Total Damage	Watershed Total 5-yr Damage (2025 M Dollars)	Watershed Total 25-yr Damage (2025 M Dollars)	Watershed Total 100-yr Damage (2025 M Dollars)	Cost of Improvements Recommended in 1999 NRCS Study (2025 M Dollars)
Indian Gap	62%	\$2.84	\$13.80	\$21.25	\$6.94
Noel's Run	14%	\$0.64	\$3.12	\$4.80	\$1.95
Chalk Mine Run	13%	\$0.59	\$2.89	\$4.46	\$5.00
Pedlar Gap	9%	\$0.41	\$2.00	\$3.09	\$6.87
TOTALS:		\$4.48	\$21.82	\$33.59	\$20.77

The above damage costs would be less in 2025 due to the projects that were actually constructed. They are explained later in this section.

It is important to note that the above discharge data from the 1999 NRCS study was vastly different from the discharge data used by FEMA in their 1970s vintage model. This is discussed later in this report.

According to the 1999 NRCS Study:

The water surface elevation in the lower end of Chalk Mine Run will vary with the elevation of the water in the Maury River. To judge the effect of these elevation changes, several different starting elevations were modeled. In each case, the water surface profiles were identical above the Route 60 bridge. This leads to the conclusion that the flood elevations on Chalk Mine Run will not be impacted by the water surface elevation in the Maury River for the size of storm that will produce a 100-year storm event.

This sounds somewhat confusing and is not reconcilable without the 1999 models. The 2025 interpretation is that for the flows modeled in Chalkmine Run, the water surface elevations in the Maury River are not high enough to affect Chalkmine Run above the Route 60 bridge. Above the bridge, the water surface elevations are dictated by the channel characteristics above the bridge. Below the bridge, the water surface of the Maury River affects the water surface elevations in the channel. The abandoned Railroad Bridge 20 yards upstream of the Maury River was not discussed, but it is narrow and would definitely be an impediment to Chalkmine Run flows if backwater from the Maury is disregarded.

Watershed Description of Chalk Mine Run

Drainage Area: 3847.3 acres (6.01 sq. mi.)

Woods: 3469.2 acres (90%)

Residential: 221.5 acres (6%)

Industrial: 116.3 acres (3%)
Commercial/Business: 40.3 acres (1%)

Channel Length Modeled:
Main: 7735 linear feet
Washer Hollow Tributary: 980 linear feet

Discharge at confluence with the Maury River:
5-year frequency event: 2165 cfs
25-year frequency event: 5670 cfs
100-year frequency event: 8480 cfs (FEMA used 1,920 cfs in their 1970s model)

*It is important to note that the above discharge data from the 1999 NRCS study was vastly different from the discharge data used by FEMA in their 1970s vintage model. This is discussed later in this report.

For comparison, FEMA had the 100-year flow at 1,920 cfs, compared to NRCS at 8,480, a 4.4-fold increase. The reason given in a 2010 URS, Inc. study (more on that later) is that FEMA used a regression analysis of stream gauges, whereas NRCS used USDA's TR-55 hydrologic methodology that accounts for land covers, underlying soils, land slopes, and 24-hr rainfall depths. Several variations of the TR-55 approach were examined by NRCS and their final predicted flows were checked by the NRCS National Design, Construction, and Soil Mechanics Center in Fort Worth, Texas, then accepted on November 27, 2006. URS's analysis independently replicated the method and arrived at similar values to NRCS. The URS HEC-RAS models utilized the URS values. The flow rates from FEMA, the 2006 NRCS study, and the 2010 URS models are shown in the table below which was excerpted from URS's study.

Table 11-4-2

Recurrence Interval	Peak Discharge (cfs)					
	FEMA Circa 1977	1999 NRCS	2004 NRCS TR-55 with TP-40	2006 NRCS TR-55 using NOAA 14, Buena Vista Rainfall Depth	Regression Peak Discharge Estimate for the Ungaged Site for Recurrence Interval (1)	Value Used In HEC-RAS Model
2		-	1932	1118	366	1118
5		2165	3413	2146	796	2146
10		-	5032	3085	1233	3085
25		5670	5885	4549	1967	4549
100	1920	8480	9624	7348	3454	7336

Table of the various Chalkmine Run flows calculated at different times using different methods.

The above information was sourced from NRCS's 1999 report, NRCS's 2006 Hydrology & Hydraulics (H&H) report and the URS 2010 Design Package. The 2006 NRCS is part of the URS 2010 report and is found in Section C, Appendix B of that study. It is contained in Appendix 6 of this 2025 report.

Problem Description of Chalk Mine Run

In the 1999 study, Chalk Mine Run was divided into three reaches based upon the three primary damage areas. Overland flow, ponding, and debris are the primary damage sources.

Lower Reach

From the Norfolk Southern Railroad bridge downstream to the confluence with the Maury River (1475 linear feet), there is ponding due to the lack of channel grade and capacity.

Middle Reach

From the Norfolk Southern Railroad bridge upstream 1220 feet, the channel capacity is inadequate to carry flood flows.

- Excess water from the channel floods Route 60 at the railroad bridge.
- The culvert under Rockbridge Avenue is too small.
- **This culvert was replaced with a bridge in the early 2000s.**

Upper Reach

From the upstream end of the second section to the confluence of Chalk Mine Run (5040 linear feet) and the tributary Washer Hollow (980 linear feet), the channel capacity is inadequate to carry flood flows.

- The bridge to former lumber plant is too small. **This culvert was replaced with a bridge in the early 2000s.**

Potential Solutions for Chalk Mine Run

The possible solutions considered include:

- debris basins
- channel enlargement
- replacement of bridges
- installation of berms
- enhancement of existing berms
- flood retention structures
- stormwater overflow areas

Recommended Alternative for Chalk Mine Run from 1999 Report

- Construct debris basins on Chalkmine Run and Washer Hollow just above their confluence.
 - **These debris basins were constructed circa 2005 and repaired in 2010.**
- Increase channel capacity for 1190 linear feet immediately above Norfolk Southern bridge (305 linear feet of riprap, 885 linear feet of earth channel)
 - This does not appear to have been done
- Replace Rockbridge Avenue culvert with a bridge
 - **This was done in the early 2000s**
- Increase channel capacity for 350 linear feet going downstream on main channel behind shopping center from the confluence of Washer Hollow and Chalk Mine (earth channel)
 - **This was designed circa 2011, but never permitted or constructed.**
- Increase channel capacity on Washer Hollow upstream of confluence with Chalk Mine Run for 315 linear feet (140 linear feet of earth channel, 175 linear feet of riprap)
 - This does not appear to have been done
- Increase storage capacity of channel for larger storm events by excavating material from existing basin area above lumber plant bridge
 - This does not appear to have been done



Chalkmine Run Debris Basin Circa 2010



The Same Basin in 2025

- Replace lumber plant bridge with a larger structure
 - **The bridge was replaced in the early 2000s**
- Raise existing berm to provide additional protection for shopping center (water will remain in channel area rather than break over into parking lot)
 - **This was done in the early 2000s**
- Construct a debris basin below the Catalpa Street bridge for the purpose of trapping sediment and debris during smaller storm events.
 - This debris basin was not constructed
- Increase channel capacity below Norfolk Southern bridge for a distance of 825 linear feet (545 linear feet of riprap channel and 280 linear feet of earth channel)
 - **This was designed circa 2011 by URS, but never permitted or constructed.**

Table 11-4-3

Cost Category	Recommended Alternative from 1999 Study in 2025 Dollars
Chalk Mine Run	
Construction Cost	\$4,029,000
Property Rights	\$588,000
Utility Relocations	\$45,000
Local Administration	\$30,000
Local Technical Assistance	\$45,000
NRCS Administration	\$75,000
NRCS Technical Assistance	\$183,000
Total Estimated Cost	\$4,998,000

There is no available breakdown of these costs for individual projects.

Compared to the other streams, Chalkmine Run received a great deal of attention and had several projects designed and constructed in the early 2000s. The debris basins help to intercept cobbles and other material from the upper reaches of the drainage shed while the three new bridges (Rockbridge Ave, Railroad, and Lumberyard) reduce backwater. The raised berm behind the motel near the lumber yard aids in keeping water within the channel. Other improvements not specifically listed in the 1999 study were also made, including Buena Vista removing the culvert from Alleghany Avenue and VDOT making hydraulic capacity improvements to the Route 60 bridge.

As of 2025, the bridges appear to be in good condition, though the adjacent channel and banks are in need of maintenance, as later discussed. It is clear that several property owners have informally worked on the channels, as shown below in a photo taken behind the Carriage House Apartments.



Rip-Rap Covered by a Tarp Reinforcing the Embankment Behind Carriage House Apartments

As previously mentioned, in 2009, NRCS engaged URS Group, Inc. of Gaithersburg, Maryland to prepare a design for the “Chalk Mine Run Channel Modifications (Route 60 Upstream to Rockbridge Avenue)” The design was complete in January 2011 and incorporated the three new bridges, along with the hydraulic improvements to the Route 60 bridge, as well as the newly opened channel at Alleghany Avenue. The entire URS study is contained within a directory in Appendix 6. The Engineer’s estimate of probable construction cost from 2011 was \$5.07 million which would likely exceed \$10 million in 2025.

The proposed modifications were meant to contain the **5-year storm event within the channel, and if possible, to contain the 10-year storm**. The project would realign channel reaches and change their cross-sections. The channels would have the characteristics listed in the following table.

Table 11-4-4 Description of Proposed Channel Walls (from URS report)

Table 6-1: Description of Proposed Channel Walls		
Reach Description	Length	Proposed Modification
From upstream side of Route 60 to a point located approximately 80' upstream of the centerline extension of Allegany Avenue.	670 feet	Vertical concrete wall channel bank protection with a natural channel bottom
From approximately 80' upstream to 220' upstream of the centerline extension of Allegany Avenue.	140 feet	Transition with concrete wall on the north bank and gabion wall on the south bank
From the upstream end of the concrete channel bank modification to tie into the existing downstream wing wall of the N&W railroad bridge. Upstream wing wall of the N&W railroad bridge to the downstream side of Rockbridge Avenue bridge abutment riprap.	685 feet	Gabion basket channel bank protection with a natural channel bottom

The project appears to have been abandoned by Buena Vista before all the regulatory hurdles needed for permitting and construction had been addressed. A major factor was likely the ramifications of NRCS/URS predicted flow rates versus the much smaller rates used in the original FEMA floodplain model. The legal regulatory floodplain and floodway limits are those marked on FEMA's Flood Insurance Rate Maps. Even though the proposed project was only meant to address the 5/10-year storms, the work would take place within the floodway and therefore the models had to demonstrate that the 100-year water surface would not rise as a result of the project. The difficulty is that the NRCS/URS model had flows that were 4+ times larger than FEMA's, so clearly the water surface would rise. FEMA has procedures available for addressing such problems. One is the Conditional Letter of Map Revision, or CLOMR, through which the 100-year regulatory floodplain/floodway can be altered with better data and modeling. Unfortunately, this solution created a derivative problem in that increasing the flows would expand the limits of the floodplain and necessitate that FDIC insured lenders require flood insurance on mortgaged properties. That would have significantly increased the number of affected property owners who would suddenly have to purchase flood insurance, a cost which most find distasteful, regardless of the security it provides.

NRCS and URS had several correspondences with FEMA regarding the appropriate flows to use for that area and there does not seem to have been a resolution prior to the project being halted by Buena Vista, definitive reasons for which are not known. Based upon conversations with people involved, it is possible the project was halted because of other financial concerns or because there was no political will to expand the floodplain and raise some residents' insurance premiums. There may also have been changes to Congressional funding programs and appropriations.

The CLOMR workmaps prepared by URS (See Sheet 1 of Appendix 7) show that the FEMA (referred to as FIS for Flood Insurance Study) 100-year flow would be fully contained within the proposed channel improvements between Route 60 and Rockbridge Avenue. It is worth noting that the FEMA/FIS 100-yr flow is almost identical to the NRCS/URS 5-yr flow:

FEMA/FIS 100-yr 1,920 cfs
NRCS/URS 5-yr 2,146 cfs

One potential solution to resolving the disparity between the computed floodplains might have been for URS to use FEMA's flow rate in their published channel design calculations. This would not have changed their channel design (which was only for their 5-year flow anyway) and it would not have altered the floodplain limits in a way that would expand Flood Insurance requirements. This is shown below in an excerpt from the URS Workmap illustrating the Existing 100-yr flood limits and the Proposed 100-yr flood limits after the channel improvements. We suspect that the project was terminated before all this had been resolved. The map is included in Appendix 7.

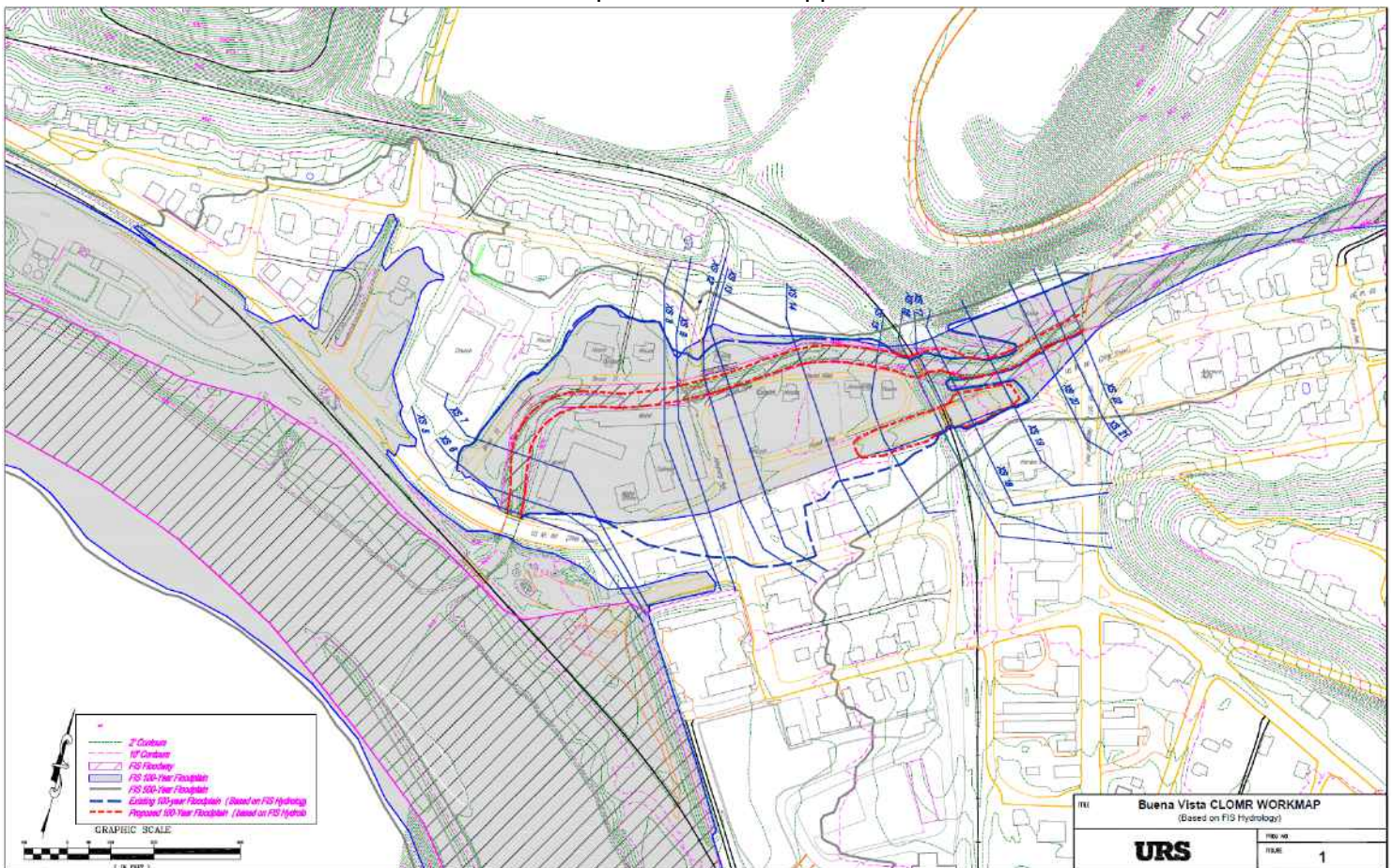


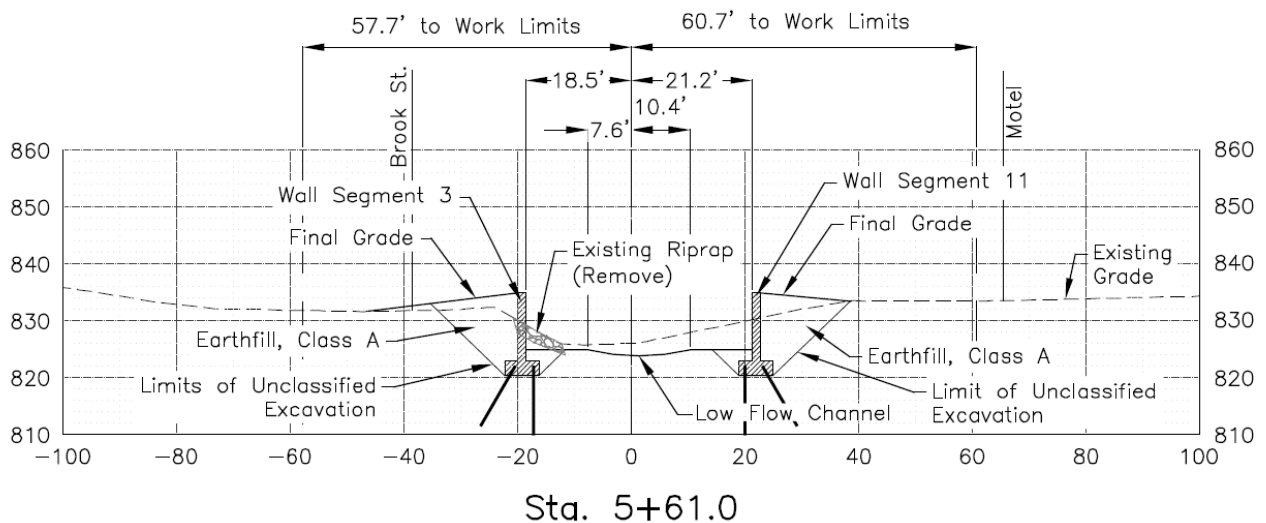
Figure 11-4-3 URS CLOMR Workmap Showing Calculated Floodplain Based on FEMA FIS Flows

The photo below was taken in 2010 looking downstream at the motel which is just upstream of the Route 60 bridge. Since then, the channel has further deteriorated, placing the structure in even greater jeopardy. Buena Vista leadership has recently expressed a desire to evaluate options for stabilizing the channel in this area to reduce damage potential damage to the motel and nearby properties.



The upstream end of the motel is approximately 650' upstream of Route 60, which is less than half the estimated 1,495' of proposed channel improvements in the URS study. A sensible first step toward examining the situation in 2025 would be to modify the URS model to use the FEMA/FIS 100-yr flow, and remove the recommended improvements upstream of the motel, then evaluate the impacts on the surrounding floodplain. The best-case-outcome would be that the water escaping the narrower upstream channel would not flood the motel and that the shorter length of channel improvements along the motel would be sufficient to protect it. Any section of channel should be designed to withstand higher flows than FEMA's 100-yr event. There is a tremendous increase in momentum and energy between 1,920 cfs and 7,743 cfs and the sharp turn behind the motel would be subject to extreme horizontal force as the water changes direction.

As previously noted, the URS's estimate of probable construction cost from 2011 was \$5.07 million which would likely exceed \$10 million in 2025. The most expensive part of that is behind the motel because it uses concrete retaining walls on each side of the stream with a natural low-flow channel in the middle. The cost is exacerbated by the need for micro-piles in this area to stabilize the wall against extreme forces and soil conditions. Below is an excerpted section from the URS plans. It is directly behind the 90-degree bend in the motel and channel closest to Route 60. The micro-piles are the heavy vertical and diagonal lines below the wall footings.



Below is URS's 2011 construction cost estimate for the entire project. The vast majority of the concrete and steel, along with the micro-piles, would be required for the section behind the motel. Taken together, they are approximately half of the total \$5.057M cost from 2011. It is reasonable to estimate that the area behind the motel would have been 2/3 of the 2011 cost which would have been \$3.4M, which is \$6.8M in 2025 dollars.

Buena Vista should evaluate the cost of implementing a plan such as this versus the value of the properties that are flooded during various return periods. It is likely that for much less money, the motel could be purchased and demolished, then reconstructed at a higher elevation with floodproofing against the 100-year storm, instead of the 5 or 10-year storm.

The 1999 NRCS damage estimates are shown above in 2025 dollars. It may be difficult to justify spending \$6.8M to protect against the 5-yr to 10-yr storm event.

Table 11-4-5 Construction Cost Estimate for Channelizing Chalkmine Run Between Route 60 Bridge and Rockbridge Avenue (From URS report)

Buena Vista, VA Engineering Estimate							
BID ITEMS							
Item No.	Work or Materials	Spec. No.	Total Quantity	Units	Unit Price	Total Amount	Pay Method
1	Clearing and Grubbing	2	1	Lump Sum	\$23,550	\$ 23,550.00	
2	Structure Removal	3	1	Lump Sum	\$12,000	\$ 12,000.00	
3	Pollution Control	5	1	Lump Sum	\$44,352.00	\$ 44,352.00	
4	Seeding and Mulching	6	2.9	Acre	\$3,000.00	\$ 8,700.00	
5	Construction Surveys	7	1	Lump Sum	\$15,000	\$ 15,000.00	
6	Mobilization and Demobilization	8	1	Lump Sum	\$500,000	\$ 500,000.00	
7	Traffic Control	9	1	Lump Sum	\$50,000.00	\$ 50,000.00	
8	Removal of Water	11	1	Lump Sum	\$211,200.00	\$ 211,200.00	
9	Unclassified Excavation	21	29,503	Cu. Yd.	\$8.00	\$ 236,024.00	
10	Earthfill Class A	23	15,766	Cu. Yd.	\$9.35	\$ 147,412.10	
11	Drainfill	24	1,100	Cu. Yd.	\$27.00	\$ 29,700.00	
12	Class 4000 Concrete	31	2,633.7	Cu. Yd.	\$500.00	\$ 1,316,850.00	
13	Reinforcing Steel, Structural	34	436,260	Lbs.	\$1.00	\$ 436,260.47	
14	Riprap	61	179	Ton	\$50.00	\$ 8,957.25	
15	Wire Mesh Gabions	64	4925	Cu. Yd.	\$125.00	\$ 615,625.00	
16	Contractor Quality Control	94	1	Lump Sum	\$45,000.00	\$ 45,000.00	
17	Geotextile	95	7,313	Sq. Yd.	\$1.82	\$ 13,310.02	
18	Micropiles	413	7,775	Linear Foot	\$100.00	\$ 777,510.00	
19	Split Rail Fence	414	1,800	Linear Foot	\$20.00	\$ 36,000.00	
20	Plantings	6	403	Each	\$17.00	\$ 6,851.00	
21	Topsoiling	23	14035	Sq. Yd.	\$3.50	\$ 49,122.50	
22	Excavation Shoring and Bracing	21	1	Lump Sum	\$147,388.50	\$ 147,388.50	
23	Permanent Gravel Road	415	65	Linear Foot	\$10.00	\$ 650.00	
24	Permanent Paved Road	415	665	Linear Foot	\$40.00	\$ 26,600.00	
25	Permanent Seal-Coated Roads	415	357	Linear Foot	\$16.00	\$ 5,712.00	
26	Guardrail	415	286	Linear Foot	\$27.50	\$ 7,865.00	
27	Removal of Excess Earth Materials	21	22,211	Ton	\$13.33	\$ 296,140.00	
TOTAL ENGINEER'S ESTIMATE:						\$5,067,779.84	

**Table 11-4-6
Damages for Various Return Periods (Millions of 2025 Dollars)**

Watershed	Percentate of Total Damage	Watershed Total 5-yr Damage (2025 M Dollars)	Watershed Total 25-yr Damage (2025 M Dollars)	Watershed Total 100-yr Damage (2025 M Dollars)
Indian Gap	62%	\$2.84	\$13.80	\$21.25
Noel's Run	14%	\$0.64	\$3.12	\$4.80
Chalk Mine Run	13%	\$0.59	\$2.89	\$4.46
Pedlar Gap	9%	\$0.41	\$2.00	\$3.09
TOTALS:		\$4.48	\$21.82	\$33.59

Buena Vista should evaluate the cost of implementing a plan such as this versus the value of the properties that are flooded during various return periods. The 1999 NRCS damage estimates are shown above in 2025 dollars. It may be difficult to justify spending \$6.8M to protect against the 5-yr to 10-yr storm event unless it would protect multiple properties.

Specific Recommendations for Chalkmine Run

1. Rehabilitate the Two Debris Basins. As with the other streams, keeping floodwater contained in the channel is critical to reducing flood damage. Estimated cost of \$40,000. This is considered a capital project.

Until approximately 2018, the two debris basins were maintained by prisoners on work crews from the local jail. Since that program ceased, Buena Vista's Public Works Department has been without the resources to do the job. It is worth noting that Buena Vista signed an agreement with NRCS stating that the City would maintain the debris basins. That is provided in Appendix 9 and the Operations and Maintenance Manual is provided in Appendix 10. As of 2025, the debris basins are in desperate need of maintenance. A great deal of sediment, woody debris, and cobbles have filled much of the main area and are allowing trees and smaller woody vegetation to proliferate. The debris basins are the first line of defense against the cobbles and other material that clog bridge openings and reduces channels' cross-sectional areas. They should be restored immediately.

2. The worst erosion and most impending damage appear to be behind the motel for approximately 300' downstream of Alleghany Avenue. Here, the channel top is sometimes within 2' to 3' horizontally of the building. If the motel structure is expected to remain indefinitely, the property owner or the City should consider at least removing the obstructive vegetation and armoring the motel embankment with large rip-rap such as Class III. This would be a capital project.



Some of the vegetation, such as large tree roots, is helping to stabilize the bank, especially on the side opposite of the motel. This should probably not be removed unless there is a plan in place to stabilize the immediate area.



The 2010 URS plan would have increased the channel capacity in this area to contain the 5-yr to 10-yr event and would have made the channel resistant to damage from much larger storms.

3. During reconnaissance for this study, a commercial firewood production and storage area was noted within the floodplain. When standing on the Catalpa Avenue bridge and looking upstream, it is clearly visible on the left. It appears to be located on the parcel which is prone to flooding and which was bought-out in the 1990s by the CDBG grant, with the structure being demolished. This location is visible on the map in Appendix 1. The logs and firewood represent a source of debris that could wash downstream and potentially exacerbate flooding. The City should address this with the property owner.

Table 11-4-7

Chalkmine Run: Recommended Capital Projects - Preliminary Cost Estimates

Photo	Location	Description	Quantity	Unit	Unit Cost	Total Cost	Priority 1-highest 3-lowest	Notes
CMR # 1	North Branch of Chalkmine Run on north side of road to lumber yard.	Remove sediment, cobbles, debris, and woody growth from entire debris basin.	1	ls	\$20,000	\$20,000	1	This is considered a capital project for replacement and is not listed as a maintenance cost
CMR # 2	South Branch of Chalkmine Run, aka Washer Hollow, on south side of road to lumber yard.	Remove sediment, cobbles, debris, and woody growth from entire debris basin.	1	ls	\$20,000	\$20,000	1	This is considered a capital project for replacement and is not listed as a maintenance cost
CMR # 8	South side of channel from Alleghany Avenue at motel to 30' below bend in channel (300 lf)	Place Class III rip-rap with geotextile matting on embankment along motel. 300 lf x 6' high= 1500 sf. 1800 sf/2.2 sf per stone= 819 stones. 819 stones x 1000 lb/stone= 819,000 lb= 410 tons	410	ton	\$200	\$82,000	1	This is a very rough recommendation. Evaluate channel in fall/winter when it can be seen more clearly. Prepare a basic sketch-type plan and better cost estimate.

Total of Priority 1 Capital Projects \$122,000

Chalkmine Run: Recommended Maintenance - Preliminary Cost Estimates

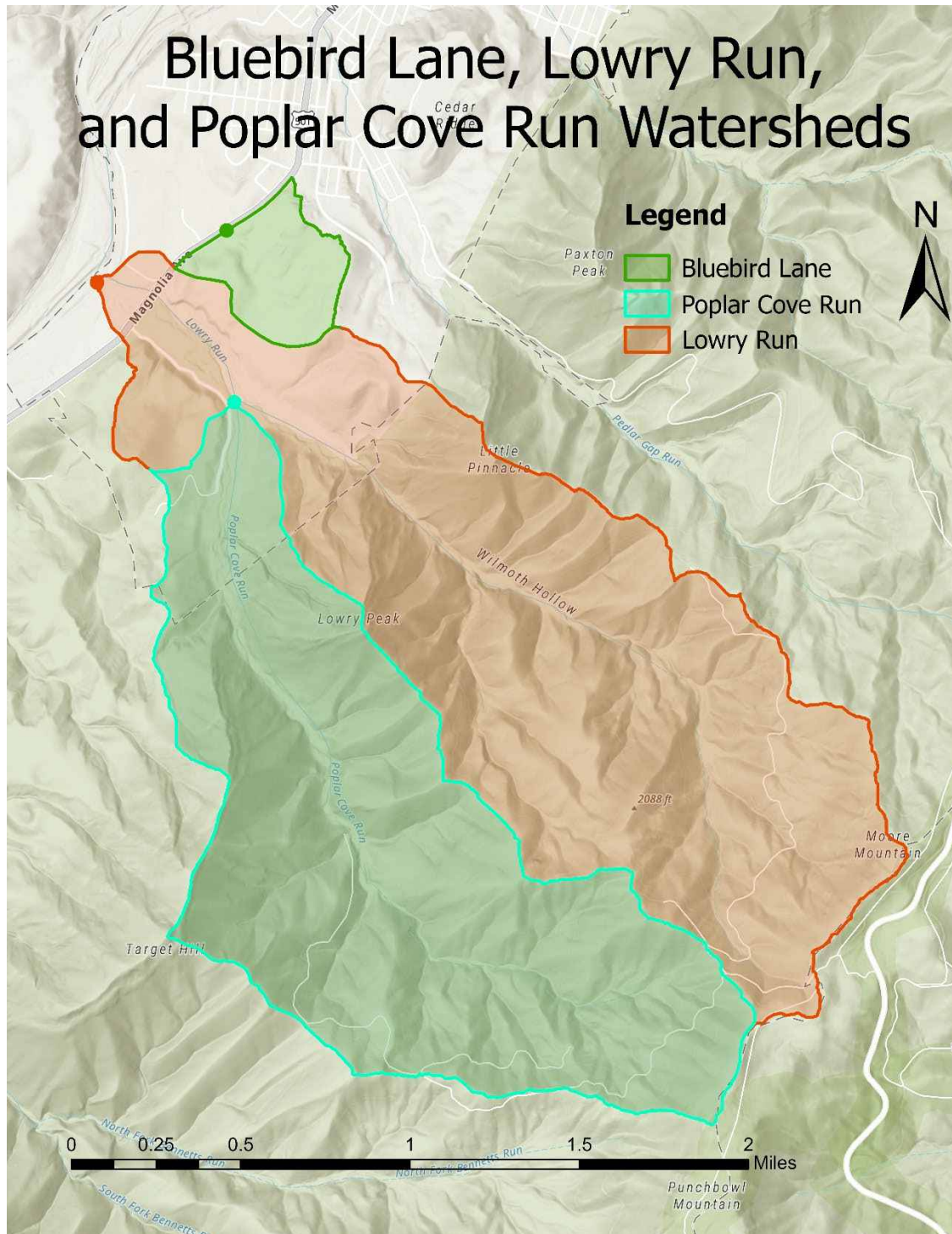
CMR # 3,4	Channel from confluence of steams at lumber yard bridge to downstream end of Carriage House Apartments	Remove cobbles, vegetation and other obstructions from channel.	1100	lf	\$100	\$110,000	3	Standing Water seems common in this area. Check for wetland prior to budgeting or scheduling work
CMR # 3,4	Carriage House Apartment to Catalpa Avenue bridge	Remove cobbles, vegetation and other obstructions from channel.	800	lf	\$50	\$40,000	3	
CMR # 4	Catalpa Avenue bridge to Rockbrige Avenue bridge	Remove cobbles, vegetation and other obstructions from channel.	1900	lf	\$50	\$95,000	3	
CMR # 5	Rockbrige Avenue bridge	Remove cobbles and Woody Debris from Channel 100' in each direction	250	lf	\$100	\$25,000	2	
CMR # 5,6	Channel from 100' below Rockbrige Avenue bridge to 100' above Railroad bridge	Remove cobbles, vegetation and other obstructions from channel.	250	lf	\$50	\$12,500	3	
CMR # 7	Railroad bridge	Remove cobbles and Woody Debris from Channel 100' in each direction	250	lf	\$100	\$25,000	2	Check with Railroad regarding any special permit requirements
CMR # 8	Channel from 100' below Railroad bridge to Alleghany Avenue at motel	Remove cobbles, vegetation and other obstructions from channel.	450	lf	\$75	\$33,750	2	Evaluate rip-rap channel sides after maintenance and reinstall rip-rap that has slid into the channel.
CMR # 9	Channel from Alleghany Avenue to downstream side of Route 60 bridge	Remove vegetation and other obstructions from channel.	725	lf	\$50	\$36,250	3	Evaluatle rip-rap channel sides after maintenance and reinstall rip-rap that has slid into the channel

Chalkmine Run Non-Capital Projects

Total of Priority 1 Maintenance Projects \$0
Total of Priority 2 Maintenance Projects \$83,750
Total of Priority 3 Maintenance Projects \$293,750
Total of All Non-Capital Projects \$377,500

11.5 Lowry Run, Poplar Cove Run, and “Bluebird Lane”

Poplar Cove Run joins Lowry Run at the southern end of Buena Vista. Their respective 1,062 acres and 1,245 acres combine just upstream of Route 501, retaining the Lowry Run name before entering the Maury River southwest of Dickinson Lane. Unless noted otherwise, references to Lowry Run include Poplar Cove Run.



The overall Lowry Run watershed was not examined in the 1999 NRCS study because it has almost no development. However, there has been recent interest in potential mixed-use projects. The following image taken from FEMA's website shows the Zone A (approximated) floodplains of both Poplar Cove Run and Lowry Run. Note that the floodplain Zone AE in the northeast is Pedlar Gap Run. Based upon this map, it seems that almost none of the floodplain on the eastern side of Route 501 is attributable to the Maury River. Instead, it appears to result from Lowry Run and Poplar Cove Run. Of course, those are estimated floodplains, so they could prove smaller or larger if a proper study were performed.



Bluebird Lane provides access to the City's industrial park. It lies between the former Munters building and the new gas company maintenance building. Two culverts cross under Route 501 in this area to drain approximately 82 acres as shown on the topographic map between Pedlar Gap Run and Lowry Run. The capacities of the culverts would need to be confirmed prior to any new development draining to it.

The area adjacent to Lowry Run is fairly flat near Route 501 and gains considerable elevation toward the southeast, just like the City's other internal streams. The person who owns much of the Lowry Run property informed this author that the trout stream channel was decimated by the floods of the early 1990s. Given the topography and historical evidence, it is reasonable to surmise that Lowry Run is subject to the same kinds of severe flooding, erosion, and cobble/debris transport as the other streams within Buena Vista.

Recommendations for Lowry Run and Poplar Cove Run

New development is subject to Virginia's very stringent stormwater management laws and any substantive construction projects will be required to detain their runoff in order to prevent erosion and flooding. Additionally, there are other things Buena Vista can do to minimize impacts from Lowry Run:

1. Buena Vista's floodplain ordinance allows FEMA Zone A estimated floodplains to be analyzed by a competent professional, with the results having the same local development requirements as would FEMA Zone AE, with respect to floodplains and the floodway. Using Buena Vista's floodplain ordinance as a guide, the City could require that an actual floodplain study be performed for Lowry Run and Poplar Cove Run using HEC-HMS for hydrology and HEC-RAS for hydraulics. The results would be overlaid on FEMA's regulatory floodplain for comparison. It may be possible to use VGIN 1' contours for much of the terrain model, supplemented by ground survey in flatter areas or where dense development may occur. The floodplain elevations need not extend too far upstream of where development is expected to stop or clearly diverge from the floodplain.

The HEC-RAS model will predict the water surface elevations for Buena Vista's zoning purposes, but the FEMA map will determine whether flood insurance will be required by lenders. If desired, FEMA has processes for changing the regulatory floodplain locations on their Flood Insurance Rate Maps (FIRMs). These are known as Letters of Map Revision (LOMR) and Conditional Letters of Map Revision (CLOMR). They are very involved and can take considerable time and money to prepare and get approved. Developers prefer to avoid them unless there is a compelling need to modify FEMA's FIRMs.

The lower extent of the HEC-RAS model should be a known water surface elevation on the Maury River, ensuring that the effects of VDOT's bridge over Lowry Run are understood since it will have a very significant impact on the upstream water surface elevations.

The cost to a developer for a floodplain study to satisfy the City requirements without a LOMR or CLOMR could vary considerably depending on whether flow stays in the channel or escapes and flows away as it does in the other streams. If it ponds without flowing away, then a 1-Dimensional model would likely be sufficient. If it flows away,

then a 2-Dimensional model may be required. Estimates for the two range from \$30,000 to \$90,000.

If a developer stays clear of the approximated FEMA floodplain and is obviously not in jeopardy of flooding, then it may be possible to avoid all floodplain analyses and the associated costs. The most significant factor would be the VDOT bridge.

Once there are actual concepts for development, the City can determine whether these extensive studies are necessary and could make zoning actions contingent upon their findings.

While no actual flowrate modeling has been done for the Lowry Run shed, a reasonable 100-year working estimate from the City's four other internal streams is 2 cubic feet per second (cfs) per 1 acre of contributing drainage area. Using this approximation, Lowry Run's 2,307 acres would produce a 100-year peak of 4,614 cfs.

2. The 1999 NRCS study stresses the benefits of debris basins along the stream channels. Buena Vista should consider requiring these in logical location(s) for new development within Lowry and Poplar Cove Runs. Of course, these may use valuable land and could represent a significant cost to a developer, and according to the 1999 NRCS report, they could each cost \$651,000 in 2025 dollars.
3. Buena Vista should require that any new, significantly sized developments be responsible for maintaining their own stream channels via an owners' association or something similar. The City should also require easements that would allow for inspections and enforcement in a manner similar to stormwater detention facilities.

Recommendations for Bluebird Lane Watershed

There is considerable interest in developing much of Bluebird Lane's 82 acre watershed on the east side of Route 501. No FEMA floodplain is present in this area, but the VDOT capacity requirements for the culverts will have to be satisfied, as will the State's stormwater management regulations necessitating detention to reduce the peak runoff rates. Due to this shed's small size, there are no recommendations beyond diligent enforcement of the existing regulations.

2. 12.0 Debris Management Plan

A separate Debris Management Plan was prepared with input from Planning staff and local Emergency Management personnel. It is provided in Appendix 22.

13.0 Conclusions

Buena Vista has not endured a significant flood in over 25-years and is statistically overdue. In the past 10-years, the nearby City of Lexington has experienced several heavy rainfall events that would likely have caused significant damage in Buena Vista. The 1999 NRCS study modeled and evaluated four of the five interior streams and recommended millions of dollars in improvements. Unfortunately, those HEC-1 and HEC-2 models are lost to time. Of the suggested improvements, only a few on Chalkmine Run consisting of two debris basins and three bridges were actually constructed, with lower-reach channelization improvements being designed in 2010, but never permitted or constructed. Definitive reasons for that project being abandoned are not known.

According to the NRCS estimates from 1999, and put into 2025 dollars, Buena Vista could be subject to \$4.5M in damages from a 5-year flood event, \$21.8M in damages from a 25-year flood event, and \$33.6M from a 100-year flood event.

Table 13-1-1

Damages for Various Return Periods VS Cost of Implementing 1999 Recommendations (Millions of 2025 Dollars)

Watershed	Percentage of Total Damage	Watershed Total 5-yr Damage (2025 M Dollars)	Watershed Total 25-yr Damage (2025 M Dollars)	Watershed Total 100-yr Damage (2025 M Dollars)	Cost of Improvements Recommended in 1999 NRCS Study (2025 M Dollars)	5-yr Damage/Improvement Cost (\$Msaved/\$Mspent)	25-yr Damage/Improvement Cost (\$Msaved/\$Mspent)	100-yr Damage/Improvement Cost (\$Msaved/\$Mspent)
Indian Gap	62%	\$2.84	\$13.80	\$21.25	\$6.94	0.4	2.0	3.1
Noel's Run	14%	\$0.64	\$3.12	\$4.80	\$1.95	0.3	1.6	2.5
Chalk Mine Run	13%	\$0.59	\$2.89	\$4.46	\$5.00	0.1	0.6	0.9
Pedlar Gap	9%	<u>\$0.41</u>	<u>\$2.00</u>	<u>\$3.09</u>	<u>\$6.87</u>	0.1	0.3	0.4
TOTALS:		\$4.48	\$21.82	\$33.59	\$20.77	0.2	1.1	1.6
						Average	Average	Average

The left section of the table above shows the estimated damage to each watershed for the 5, 25, and 100-year storm events. The middle section contains the 2025 project implementation costs for each watershed from the 1999 study, and the right section divides the former by the latter to show the dollars saved in damages from the 5, 25, and 100-yr events per dollar spent on implementing the recommendations. The city-wide averages (bottom right of the table) are \$0.20 (5-yr), \$1.10 (25-yr), and \$1.60 (100-yr) in damages avoided for each \$1.00 spent. When considering these costs, it is important to note that there will be multiple 5-yr and 25-yr events over the course of 100 years, therefore the expected savings in damage are actually much larger when taken over 100 years.

For the 100-year storm event, Indian Gap Run and Noel's Run have \$3.1 and \$2.5 saved per dollar spent, while Chalkmine Run and Pedlar Gap Run each have less than \$1 saved for every \$1 spent. Most of the damage occurs in the lowest part of the Indian Gap Run watershed, resulting largely from backed-up water due to inadequate channels, culverts, and bridges.

The published 1999 study looked at each drainage shed in its entirety from a damage and project cost perspective. Nowhere did it list costs or water level impacts of individual elements such as replacing a railroad bridge or enlarging a channel. Unfortunately, without recreating the lost HEC-1 and HEC-2 models from the 1999 study, it is impossible to adequately evaluate the individual project elements versus their reductions to the flood depths.

The channels and appurtenances within the City are generally in need of substantial maintenance and some reconstruction. Keeping the channels and culverts/bridges clear and at full capacity helps avoid turning flood damage from a 5-year storm into that from a 10-year storm, or from a 25-yr storm into that from a 100-yr storm.

14.0 Recommendations:

Review all recommendations in individual sections to gain a complete understanding.

Bear in mind that based upon the 1999 NRCS study, the most significant reductions to flooding frequency and severity are likely to come from replacing railroad bridges and making adjacent channel improvements. Due to the costs and external ownership, these are not realistically achievable in the near-term. This 2025 report reiterates those recommendations while offering workable capital and maintenance projects that Buena Vista can begin immediately.

Construction Recommendations (Capital Projects)

A. Replace Woodland Avenue Culvert: **TOP PRIORITY** – The temporary repairs have just been completed and the enlarged replacement structure must be designed and constructed.

- a. Hydrologic and Hydraulic Analyses
 - i. Create HEC-HMS and HEC-RAS models of the immediate area and nearby downstream impediments.
 - ii. Evaluate reasonable return period and best structure to replace failed and inadequately sized culvert from the 1970s.
 - iii. Prepare budgetary construction cost estimate
- b. Design a replacement structure based upon reasonable return periods versus cost.
 - i. Engineering Analysis, Design, Bidding, and Construction Administration estimated to cost \$121,000
 - ii. Conceptual construction cost estimated at $150 \text{ If} \times \$2,000/\text{If} = \$300,000$

- iii. Apply for a CFPF grant to pay for the design and construction of the replacement structure and other associated costs.
- iv. Utilize nature-based solutions as practicable
 1. Set invert of culvert below normal stream channel to allow animal passage despite channel being normally dry.
 2. Utilize low-flow channels when practicable.
 3. Review other possibilities

B. Restore Debris Basins on Chalkmine Run: TOP PRIORITY

1. Utilize original design documents and maintenance requirements established by NRCS and agreed-to by City when basins were constructed. See Appendices 9 and 10.
2. The restoration costs are estimated at \$20,000 each for a total of \$40,000
3. This could possibly be done by workers paid via a CFPF grant as mentioned in b. immediately above.

C. Construct Remaining NRCS Recommended Debris Basins: SECONDARY PRIORITY

NRCS recommended constructing seven additional debris basins on three interior streams. The City should examine ownership of the recommended locations and explore costs associated with acquiring properties and constructing the debris basins in more detail. Based upon limited cost data from the NRCS report, the total cost of an average basin in 2025 is estimated at \$651,000 for a total cost of \$3.91 million. Buena Vista should rank potential locations based upon functionality and cost, then pursue funding to acquire land, design, and then construct as many basins as possible. These are very important, but are given secondary priority due to the complications and expense as compared to the Top Priorities.

Recommended Maintenance

1. Inspections and Maintenance
 - a. Initial Tasks and Funding – **TOP PRIORITY** apply for a CFPF grant to hire two workers for two years to perform deferred maintenance on the stream channels and their appurtenances. If allowable, include enough in the grant application to pay for costs associated with using the City's existing heavy equipment.
 1. Most of the work can be accomplished with a backhoe, a skidsteer, and a dump truck.
 2. Exception is the concrete repairs at Indian Gap Run channel which may require hiring a construction contractor.
 1. Hire an Engineer to review the concrete cracks and recommend a repair regimen

3. If workers finish early, have them work on the closed pipe collection system in the downtown area.
 4. Apply for a Joint Permit Application (JPA) to enable working with heavy equipment in the stream channels. Renew or reapply as needed to maintain legality. Permit preparation for four non-navigable streams is estimated at \$12,000.
2. Establish Maintenance Responsibilities: Buena Vista must determine who is responsible for maintaining the creek channels: the City, the property owner, or no one?
 - a. Was an easement placed on the concrete portion of Indian Gap Run when it was constructed?
 - b. Are there any maintenance easements on the other channels?
 - c. It is assumed that the City would be responsible for maintaining the elements within the right-of-way which would capture all the culverts, bridges, and short sections of the channels.
 1. Section 612.16 of Buena Vista's floodplain ordinance is written to absolve the City of liability associated with flooding, including debris-induced flooding. The City should review the ordinance to confirm the extent of the City's potential liability, if any, related to any maintenance efforts for which it is singularly responsible. The floodplain ordinance is provided in Appendix 23.
 2. Would the City's insurance cover any part of potential liability?
 - d. The City should determine whether it can pass an ordinance requiring property owners to maintain their channels and how to handle a channel centerline that is also a property line.

The City should collaborate with the Department of Environmental Quality to review its flood management ordinances and permitting and enforcement procedures for compliance with current regulations and adherence to best practices.

3. The maintenance cost estimates in the following table assume that a contractor is hired to complete the tasks. As previously described, the City should pursue a CFPF grant to hire two workers for two years. This would likely reduce the total cost.

Table 14-1

Deferred Maintenance Summary Based Upon Priority

Priority	Watershed	Total Cost
1-highest		
3-lowest		
1	Indian Gap Run	\$38,750
1	Noel's Run	\$130,000
1	Pedlar Gap Run	\$60,000
1	Chalkmine Run	\$89,200
	Priority 1 Total	\$317,950
2		
2		
2		
2		
2	Indian Gap Run	\$95,500
2	Noel's Run	\$13,500
2	Pedlar Gap Run	\$15,000
2	Chalkmine Run	\$83,750
	Priority 2 Total	\$207,750
3		
3		
3		
3		
3	Indian Gap Run	\$110,000
3	Noel's Run	\$0
3	Pedlar Gap Run	\$98,500
3	Chalkmine Run	\$293,750
	Priority 3 Total	\$502,250
Total of All Maintenance		
	Priorities	\$1,027,950

Ongoing Maintenance Recommendations

1. After completing deferred maintenance/cleanup, establish a schedule to maintain two streams per year. This will ensure that each stream receives attention every other year.
2. After each significant rainfall, inspect all culverts and bridges from the roadways for debris and potential blockages. Encourage citizens to call if they see blockages. Perform emergency maintenance as needed to keep them clear.
3. Once yearly, inspect all channels and structures from within the channels.
4. Incorporate asset management into the GIS database to track details, photos, and maintenance histories of all stormdrain elements. This should ultimately include the four streams and their appurtenances as well as the City's entire stormwater collection/conveyance pipe system. Doing this will ensure that institutional knowledge is not lost when personnel depart or retire.

5. It is likely that cobbles will build-up over time and effectively reduce channel depths. This may be observable by comparing high resolution contour data such as that available through VGIN. Buena Vista should consult with VGIN to confirm this approach and if valid, Buena Vista should purchase the necessary data from VGIN every time it is updated. Keeping the channels and banks free of excess vegetation will allow the most accurate Lidar mapping.

Funding Mechanisms

1. Apply for the previously recommended CFPF grants.
2. Research other grants that may be available, such as from DHCD, DEQ, and FEMA. Grants come and go, so it's important to stay abreast. The Central Shenandoah Planning District Commission (CSPDC) is a good source of information.
3. Consider a city-wide stormwater fee that would be used to maintain and improve the streams and pipes within the stormwater system. These are generally assessed based upon a parcel's impervious area. Lexington enacted such a fee in 2025.
4. Pass an ordinance requiring property owners to maintain their own stream channels and embankments, thus relieving the City of the cost. Bear in mind that the City must have the political will to enforce such a requirement.

Additional Recommendations

There are several other things that Buena Vista should do to support its stormwater system and reduce the severity of flooding.

1. Make 'betterment' improvements to channels, culverts, and bridges when other work is done. The bottlenecks causing the most damage are the bridges and culverts in the lower reaches of the system. Whenever these types of structures are rehabilitated or replaced, they should be upsized to increase hydraulic capacity. Some will argue that there is no point in spending extra money when so many other impediments to flow will remain unchanged. Unfortunately, there will never be an opportunity to simultaneously replace all the bottlenecks as recommended in the 1999 NRCS study. Therefore, the only way to lessen the problems will be one element at a time.

To facilitate this, the City must maintain constant contact with the railroad, VDOT and other in-stream structure owners to ensure that they do not implement a project affecting a creek without the City having an opportunity to increase capacity.

2. In order for the City to quantify the benefits of the "betterment" described above, and to justify certain capital improvements, hydraulic models are necessary. As stated innumerable throughout this 2025 report, it is tragic that no one retained copies of the

HEC-1 and HEC-2 models from the 1990s. Creating modern models on short notice because a bridge or culvert must be replaced would probably not be possible, so an opportunity may be lost. The solution is to recreate the models in the near term so they are on-hand.

The availability of high-resolution, 1' contour data and other modern resources make it much easier and cost-effective to create in-house floodplain models that could be used to quantify the effects of improvements to channels, culverts, and bridges. Buena Vista should have the models recreated for the three internal watersheds (a Chalkmine Run model is available from the 2010 channel improvements plan that was never implemented). The City could apply for a CFPF grant to do all three models. If unsuccessful, the City should either continue trying, pare the application back to one model, or budget its own money to do one model every year, or every other year, until they are complete. Each model should have the existing conditions, plus whatever recommendations can be gleaned from the NRCS study. Recall that the NRCS report does not always give dimensions or adequately explain the physical properties of all their recommended enhancements. Once created, the models are easily tweaked to estimate the effects of changes. This will enable the City to rank potential projects based upon expected costs and flood reduction benefits.

The models also make it much easier to analyze the effects of nature-based solutions for channel improvements, and finally, they make it simple to quantify increases in flood frequency, depth, and inundation area resulting from changes in rainfall patterns due to climate change.

The intention of these models would not be to modify the regulatory FEMA floodplains, instead they would make it possible to quantify the effects of making improvements to channels, bridges, and culverts. The 1999 NRCS study looked at each watershed as a whole and did not publish the benefits of individual projects.

The cost of each model will depend upon several factors such as the channel length, number of crossings, quality of lidar data, and the amount of field work required since each culvert and bridge must be hand-measured. Additionally, because much of the water escapes the channels and flows overland into downtown, 2-Dimensional HEC-RAS models may be necessary. A budgetary estimate is \$100,000 per model which would be \$300,000 total. There would be economies of scale for doing all three simultaneously. The costs would include hydrologic runoff modeling in HEC-HMS and flood modeling in HEC-RAS.

3. Buena Vista has not experienced a significant flood in 30 years. Its elected officials and leadership staff must recognize the potential for catastrophic damage and understand that it is only a matter of time before it happens again. The City is under significant financial stress, largely as a result of past flooding, and is unable to pay for the \$20.77 million dollars in projects recommended by NRCS in their 1999 report. It is also not

realistic to believe that any single source of funding is available to make the improvements. The City should seek Community Flood Preparedness Fund (CFPF) grants and loans to implement other projects recommended by NRCS and evaluated/ranked by the proposed HEC-RAS models.

4. Buena Vista should reconcile which source of flow data should be used for flood analyses when working with structure owners such as VDOT and Norfolk Southern. We recommend TR-55/HEC-HMS which we believe to be more accurate, and definitely more conservative, than the statistical Stream Stats data which requires no engineering calculations.
5. The City should promote and educate the public about the National Flood Insurance Program (NFIP) in an effort to increase the number of properties covered.
6. The City should evaluate implementation of the Community Rating System (CRS) to potentially reduce NFIP policy premiums.
7. The City should conduct detailed study and mapping of its existing gray (traditional hard infrastructure such as pipes, inlets, channels) and green stormwater management (grass swales, rain gardens, etc.) collection and conveyance systems to identify and address localized flooding, erosion and sediment control, and water quality concerns.
8. The City should engage the Virginia Department of Emergency Management for technical assistance in procurement of contractors for debris management. Also, they should consider strategic reuse of collected debris, such as rocks, limbs, etc. for other flood hazard, stabilization, or other environmental projects, such as fill material, armoring riverine banks, etc.

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