1945 - CID510130_RoanokeCity_CFPF-2

Application Details

Funding Opportunity:	1447-Virginia Community Flood Preparedness Fund - Project Grants - CY23 Round 4
Funding Opportunity Due Date:	Nov 12, 2023 11:59 PM
Program Area:	Virginia Community Flood Preparedness Fund
Status:	Under Review
Stage:	Final Application
Initial Submit Date:	Nov 9, 2023 8:44 AM
Initially Submitted By:	Marcus Aguilar
Last Submit Date:	
Last Submitted By:	

Contact Information

Primary Contact Information

Active User*:	Yes
Type:	External User
Name*:	Dr. (Salutation) Marcus (First Name) F (Middle Name) Aguilar (Last Name)
Title:	Civil Engineer II
Email*:	marcus.aguilar@roanokeva.gov
Address*:	1802 COURTLAND RD NE
	ROANOKE (City) Virginia (State/Province) 24012 (Postal Code/Zip)
Phone*:	540-580-7209 (Phone) Ext. ###-###-####
Fax:	###-###-####
Comments:	

Organization Information

Status*:	Approved
Name*:	ROANOKE CITY
Organization Type*:	Local Government
Tax ID*:	54-6001569
Unique Entity Identifier (UEI)*:	NBFNAEXRHD76

Organization Website:

Address*: City of Roanoke

215 Church Avenue, SW Room 364

Roanoke (City) Virginia (State/Province) 24011- (Postal Code/Zip)

Phone*: (540) 580-7209 Ext.
###-###-####

Fax: ###-###-####

Benefactor:

Vendor ID:

Comments:

VCFPF Applicant Information

Project Description

Name of Local Government*: City of Roanoke, Virginia

Your locality's CID number can be found at the following link: Community Status Book Report

NFIP/DCR Community Identification Number (CID)*: 510130

If a state or federally recognized Indian tribe,

Name of Tribe:

Authorized Individual*: Robert (First Name) Cowell (Last Name)

Mailing Address*: 215 Church Ave SW
Address Line 1

Address Line 2

ROANOKE (City) Virginia (State) 24011 (Zip Code)

Telephone Number*: 540-853-2333

Cell Phone Number*: 540-853-2333

Email*: bob.cowell@roanokeva.gov

Is the contact person different than the authorized individual?

Contact Person*: Yes

Contact: Marcus (First Name) Aguilar (Last Name)

1802 Courtland Rd. NE
Address Line 1

Address Line 2

Roanoke (City) Virginia (State) 24012 (Zip Code)

Telephone Number: 540-853-5918

Cell Phone Number: 540-580-7209

Email Address: marcus.aguilar@roanokeva.gov

Enter a description of the project for which you are applying to this funding opportunity

Project Description*:

1st and Salem Drainage Improvements - proposed project would reduce flood depths Downtown ~6" during the 25-yr. flood by replacing severely undersized storm drain pipes and re-aligning the pipes for improved hydraulic efficiency. Re-alignment would move the primary flow path of this drainage out from underneath an existing private building and into the public right-of-way, and would provide safe maintenance access for debris/sediment removal.

Low-income geographic area means any locality, or community within a locality, that has a median household income that is not greater than 80 percent of the local median household income, or any area in the Commonwealth designated as a qualified opportunity zone by the U.S. Secretary of the Treasury via his delegation of authority to the Internal Revenue Service. A project of any size within a low-income geographic area will be considered.

Is the proposal in this application intended to benefit a low-income geographic area as defined above?

Benefit a low-income geographic area*: Yes

Information regarding your census block(s) can be found at census.gov

Census Block(s) Where Project will Occur*: 517700011001, 517700011002

Is Project Located in an NFIP Participating Community?*: Yes

Is Project Located in a Special Flood Hazard Area?*: Yes

Flood Zone(s) (if applicable): Zone A - 1% Approximate

Flood Insurance Rate Map Number(s) (if applicable): 51161C0164G

Eligibility CFPF - Round 4 - Projects

Eligibility

Is the applicant a local government (including counties, cities, towns, municipal corporations, authorities, districts, commissions, or political subdivisions created by the General Assembly or pursuant to the Constitution or laws of the Commonwealth, or any combination of these)?

Local Government*: Yes

Yes - Eligible for consideration
No - Not eligible for consideration

Does the local government have an approved resilience plan and has provided a copy or link to the plan with this application?

Resilience Plan*: Yes

Yes - Eligible for consideration under all categories
No - Eligible for consideration for studies, capacity building, and planning only

If the applicant is not a town, city, or county, are letters of support from all affected local governments included in this application?

Letters of Support*: N/A

Yes - Eligible for consideration
No - Not eligible for consideration
N/A - Not applicable

Has this or any portion of this project been included in any application or program previously funded by the Department?

Previously Funded*: No

Yes - Not eligible for consideration
No - Eligible for consideration

Has the applicant provided evidence of an ability to provide the required matching funds?

Evidence of Match Funds*: Yes

Yes - Eligible for consideration
No - Not eligible for consideration
N/A - Match not required

Scoring Criteria for Flood Prevention and Protection Projects - Round 4

Scoring

Category Scoring:
Hold CTRL to select multiple options

Project Category*: All hybrid approaches whose end result is a nature-based solution,All other projects

Is the project area socially vulnerable? (based on ADAPT Virginia?s Social Vulnerability Index Score)
Social Vulnerability Scoring:
Very High Social Vulnerability (More than 1.5)
High Social Vulnerability (1.0 to 1.5)
Moderate Social Vulnerability (0.0 to 1.0)
Low Social Vulnerability (-1.0 to 0.0)
Very Low Social Vulnerability (Less than -1.0)

Socially Vulnerable*: Moderate Social Vulnerability (0.0 to 1.0)

Is the proposed project part of an effort to join or remedy the community?s probation or suspension from the NFIP?

NFIP*: No

Is the proposed project in a low-income geographic area as defined below?
"Low-income geographic area" means any locality, or community within a locality, that has a median household income that is not greater than 80 percent of the local median household income, or any area in the Commonwealth designated as a qualified opportunity zone by the U.S. Secretary of the Treasury via his delegation of authority to the Internal Revenue Service. A project of any size within a low-income geographic area will be considered.

Low-Income Geographic Area*: Yes

Projects eligible for funding may also reduce nutrient and sediment pollution to local waters and the Chesapeake Bay and assist the Commonwealth in achieving local and/or Chesapeake Bay TMDLs. Does the proposed project include implementation of one or more best management practices with a nitrogen, phosphorus, or sediment reduction efficiency established by the Virginia Department of Environmental Quality or the Chesapeake Bay Program Partnership in support of the Chesapeake Bay TMDL Phase III Watershed Implementation Plan?

Reduction of Nutrient and Sediment Pollution*: Yes

Does this project provide ?community scale? benefits?

Community Scale Benefits*: More than one census block

Expected Lifespan of Project

Expected Lifespan of Project*: Over 20 Years

Comments:

As this project is the first project in a series of proposed green and gray infrastructure solutions to Downtown flooding, the project is submitted as a hybrid solution. See also Scope of Work Narrative Appendix F

Scope of Work - Projects - Round 4

Scope of Work

Upload your Scope of Work
Please refer to Part IV, Section B. of the grant manual for guidance on how to create your scope of work

Scope of Work*: CID510130_RoanokeCity_CFPF-2 - 1st and Salem.pdf

Comments:

Attached Scope of Work Narrative contains responses to all queries in this portal. In order to relate sections in the Scope of Work Narrative with WebGrants form, please see "Portal-Narrative Crosswalk.pdf"

Budget Narrative

Budget Narrative Attachment*: Portal-Narrative Crosswalk.pdf

Comments:

See Section 5 and Appendix B, scope of work narrative

Scope of Work Supporting Information - Projects

Supporting Information - Projects

Provide population data for the local government in which the project is taking place

Population*: 97847.00

Provide information on the flood risk of the project area, including whether the project is in a mapped floodplain, what flood zone it is in, and when it was last mapped. If the property or area around it has been flooded before, share information on the dates of past flood events and the amount of damage sustained

Historic Flooding data and Hydrologic Studies*: Portal-Narrative Crosswalk.pdf

Include studies, data, reports that demonstrate the proposed project minimizes flood vulnerabilities and does not create flooding or increased flooding (adverse impact) to other properties

No Adverse Impact*: Portal-Narrative Crosswalk.pdf

Include supporting documents demonstrating the local government's ability to provide its share of the project costs. This must include an estimate of the total project cost, a description of the source of the funds being used, evidence of the local government's ability to pay for the project in full or quarterly prior to reimbursement, and a signed pledge agreement from each contributing organization

Ability to Provide Share of Cost*: Portal-Narrative Crosswalk.pdf

A benefit-cost analysis must be submitted with the project application

Benefit-Cost Analysis*: Portal-Narrative Crosswalk.pdf

Provide a list of repetitive loss and/or severe repetitive loss properties. Do not provide the addresses for the properties, but include an exact number of repetitive loss and/or severe repetitive loss structures within the project area

Repetitive Loss and/or Severe Repetitive Loss Properties*: Portal-Narrative Crosswalk.pdf

Describe the residential and commercial structures impacted by this project, including how they contribute to the community such as historic, economic, or social value. Provide an exact number of residential structures and commercial structures in the project area

Residential and/or Commercial Structures*:

See scope of work narrative Sections 3.1, 4.1.e, 4.1.g.ii.

If there are critical facilities/infrastructure within the project area, describe each facility

Critical Facilities/Infrastructure*:

See scope of work narrative Sections 4.1.g.iii.
No critical facilities/infrastructure within project area

Explain the local government's financial and staff resources. How many relevant staff members does the local government have? To what relevant software does the local government have access? What are the local government's capabilities?

Financial and Staff Resources*:

See scope of work narrative Sections 4.1.d, 4.2.a

Identify and describe the goals and objectives of the project. Include a description of the expected results of the completed project and explain the expected benefits of the project. This may include financial benefits, increased awareness, decreased risk, etc.

Goals and Objectives*:

See scope of work narrative Section 3.2

Outline a plan of action laying out the scope and detail of how the proposed work will be accomplished with a timeline identifying expected completion dates. Determine milestones for the project that will be used to track progress. Explain what deliverables can be expected at each milestone, and what the final project deliverables will be. Identify other project partners

Approach, Milestones, and Deliverables*: Portal-Narrative Crosswalk.pdf

Where applicable, briefly describe the relationship between this project and other past, current, or future resilience projects. If the applicant has received or applied for any other grants or loans, please identify those projects, and, if applicable, describe any problems that arose with meeting the obligations of the grant and how the obligations of this project will be met

Relationship to Other Projects*:

See scope of work narrative Section 4.6
As previously described, this project represents the first of several Downtown flood resilience projects to be constructed over the next fifty years as per the Downtown Flooding PER. In addition to this grant proposal, the City also has an application under review in FEMA?s 2020 Building Resilient Infrastructure and Communities (BRIC) program to support the development of construction documents for green infrastructure upstream of Downtown. It is anticipated that the construction phase of these projects would be submitted to a future round of BRIC or to DCR?s CFPF program, depending on the final scope of these projects. In order to understand the importance of the 1st and Salem Drainage Improvements project, it is imperative that the project be evaluated in the context of the larger scale improvements that the City plans to make with respect to Downtown

Flooding.

For ongoing projects or projects that will require future maintenance, such as infrastructure, flood warning and response systems, signs, websites, or flood risk applications, a maintenance, management, and monitoring plan for the projects must be provided

Maintenance Plan*: Portal-Narrative Crosswalk.pdf

Describe how the project meets each of the applicable scoring criteria contained in Appendix B. Documentation can be incorporated into the Scope of Work Narrative

Criteria*:

"Section 4.8 - Criteria" in the attached scope of work narrative provides a table that enumerates the scoring for this project with supporting information

Budget

Budget Summary

Grant Matching Requirement*: LOW INCOME - Projects that will result in hybrid solutions - Fund 90%/Match 10%

I certify that my project is in a low-income geographic area: Yes

Total Project Amount*: $2,460,000.00

REQUIRED Match Percentage Amount: $246,000.00

BUDGET TOTALS

Before submitting your application be sure that you meet the match requirements for your project type.

Match Percentage: 10.00%
Verify that your match percentage matches your required match percentage amount above.

Total Requested Fund Amount: $2,214,000.00

Total Match Amount: $246,000.00

TOTAL: $2,460,000.00

Personnel

Description	Requested Fund Amount	Match Amount	Match Source
No Data for Table			

Fringe Benefits

Description	Requested Fund Amount	Match Amount	Match Source
No Data for Table			

Travel

Description	Requested Fund Amount	Match Amount	Match Source
No Data for Table			

Equipment

Description	Requested Fund Amount	Match Amount	Match Source
No Data for Table			

Supplies

Description	Requested Fund Amount	Match Amount	Match Source
No Data for Table			

Construction

Description	Requested Fund Amount	Match Amount	Match Source
Construction Cost per Engineer's Estimate	$2,214,000.00	$246,000.00	City of Roanoke Capital Improvement Program
	$2,214,000.00	**$246,000.00**	

Contracts

Description	Requested Fund Amount	Match Amount	Match Source
No Data for Table			

Maintenance Costs

Description	Requested Fund Amount	Match Amount	Match Source
No Data for Table			

Pre-Award and Startup Costs

Description	Requested Fund Amount	Match Amount	Match Source
Engineering Design and Permitting	$86,592.60	$9,621.40	City of Roanoke Capital Improvement Program
		$9,621.40	

Other Direct Costs

Description	Requested Fund Amount	Match Amount	Match Source
No Data for Table			

Long and Short Term Loan Budget - Projects - VCFPF

Budget Summary

Are you applying for a short term, long term, or no loan as part of your application?

If you are not applying for a loan, select "not applying for loan" and leave all other fields on this screen blank

Long or Short Term*: Not Applying for Loan

Total Project Amount: $0.00

Total Requested Fund Amount: $0.00

TOTAL: $0.00

Salaries

Description	Requested Fund Amount
No Data for Table	

Fringe Benefits

Description	Requested Fund Amount
No Data for Table	

Travel

Description	Requested Fund Amount
No Data for Table	

Equipment

Description	Requested Fund Amount
No Data for Table	

Supplies

Description	Requested Fund Amount
No Data for Table	

Construction

Description	Requested Fund Amount
No Data for Table	

Contracts

Description	Requested Fund Amount
No Data for Table	

Other Direct Costs

Description	Requested Fund Amount
No Data for Table	

Supporting Documentation

Supporting Documentation

Named Attachment	Required	Description	File Name	Type	Size	Upload Date
Detailed map of the project area(s) (Projects/Studies)		See also Appendix C.1, scope of work narrative	01 - Detailed Project Area Map.pdf	pdf	7 MB	11/02/2023 12:05 PM
FIRMette of the project area(s) (Projects/Studies)		Appendix C.2, scope of work narrative	02 - FIRMette.pdf	pdf	1 MB	11/02/2023 12:06 PM
Historic flood damage data and/or images (Projects/Studies)		See Appendix D and Section 4.1.b. in scope of work narrative	Portal-Narrative Crosswalk.pdf	pdf	140 KB	11/02/2023 12:07 PM
A link to or a copy of the current floodplain ordinance		https://library.municode.com/va/roanoke/codes/code_of_ordinances?nodeId=CORO1979_CH36.2ZO_ART3RESPZODI_DIV5OVDI_S36.2-333FLOVDIF	Portal-Narrative Crosswalk.pdf	pdf	140 KB	11/02/2023 12:07 PM
Maintenance and management plan for project		See Section 4.7 in scope of work narrative	Portal-Narrative Crosswalk.pdf	pdf	140 KB	11/02/2023 12:07 PM
A link to or a copy of the current hazard mitigation plan		https://rvarc.org/wp-content/uploads/2019/08/RVAR_Hazard_Mitigation_Plan_2019.pdf	Portal-Narrative Crosswalk.pdf	pdf	140 KB	11/02/2023 12:08 PM
A link to or a copy of the current comprehensive plan		https://planroanoke.org/city-plan-2040/	Portal-Narrative Crosswalk.pdf	pdf	140 KB	11/02/2023 12:08 PM
Social vulnerability index score(s) for the project area		see Section 4.1a scope of work narrative	Portal-Narrative Crosswalk.pdf	pdf	140 KB	11/02/2023 12:08 PM
Authorization to request funding from the Fund from governing body or chief executive of the local government		See also Appendix C.13, scope of work narrative	13 - Council Resolution No. 42806-101623.pdf	pdf	20 KB	11/02/2023 12:09 PM
Signed pledge agreement from each contributing organization		Executed Appendix A attached and in Scope of Work Narrative	Appendix A - Project Application Form.pdf	pdf	329 KB	11/07/2023 10:40 AM
Maintenance Plan		See Section 4.7 scope of work narrative	Portal-Narrative Crosswalk.pdf	pdf	140 KB	11/02/2023 12:09 PM

Benefit-cost analysis must be submitted with project applications over $2,000,000. in lieu of using the FEMA benefit-cost analysis tool, applicants may submit a narrative to describe in detail the cost benefits and value. The narrative must explicitly indicate the risk reduction benefits of a flood mitigation project and compares those benefits to its cost-effectiveness.

Benefit Cost Analysis		See Section 4.1.e. scope of work narrative	Portal-Narrative Crosswalk.pdf	pdf	140 KB	11/02/2023 12:10 PM
Other Relevant Attachments		See Appendices D-G scope of work narrative	Portal-Narrative Crosswalk.pdf	pdf	140 KB	11/02/2023 12:10 PM

Letters of Support

Description	File Name	Type	Size	Upload Date
No files attached.				

Resilience Plan

Resilience Plan

Description	File Name	Type	Size	Upload Date
Roanoke Flood Resilience Plan approved by Council and DCR	2023 City of Roanoke Flood Resilience Plan_DCR.pdf	pdf	7 MB	11/02/2023 12:11 PM

CITY OF ROANOKE

Flood Resilience Plan

September 25, 2023

City of Roanoke

Department of Public Works
Stormwater Utility
1802 Courtland Rd, NE
Roanoke, VA 24012

A. Morton Thomas and Associates, Inc.
1166 Jamestown Road, Suite D
Williamsburg, VA 23185
amtengineering.com

Wetland Studies and Solutions, Inc.
5300 Wellington Branch Dr.
Gainesville, VA 20155
wetlands.com

CITY OF ROANOKE FLOOD RESILIENCE PLAN

EXECUTIVE SUMMARY

The City of Roanoke's geography and history are intertwined with the abundant water resources that flow through the Roanoke Valley – the Roanoke River, its tributaries and the salt marsh now hidden below Roanoke's Downtown. These water resources were critical during the City's early development, and the Roanoke River and tributaries continue to be an important natural asset for those that live, work, learn and play in its watershed. The challenge of living in proximity to these waterways is the periodic flooding that disrupts community life and the local economy. Flooding has become an increasingly important issue with the continued need for community growth, the related housing and commercial development, and the increase in rainstorm severity due to climate change. While these are important issues for Roanoke, they are not unique as urban flooding has one of the greatest social and economic impact of any natural hazard in the United States. To mitigate the growing risk of urban flooding, adoption of the principle of "flood resilience" has become a prominent strategy in communities nationwide.

The plan is organized as follows: Section 1 defines scope and purpose, Section 2 summarizes Roanoke's flood history, Section 3 characterizes Roanoke's demographics and vulnerabilities in the context of social equity and Section 4 adds to this knowledge based on the results of the public engagement process performed for this Plan. Section 5 is the culmination of the Plan into five key principles of flood resilience:

1. Climate Change – Does the effort internalize climate change impacts (increased rainfall intensity and temperature) into design and implementation of efforts?
2. Social Equity – Does the effort acknowledge community vulnerabilities and work towards equitable outcomes in its conception? Will the effort improve or strengthen the social fabric in vulnerable parts of the community?
3. Community Scale Benefits – Will the effort render benefits at a U.S. Census Block scale or larger? Will at least 10% of the City's population benefit from the project? Is the effort consistent with regional efforts?
4. Economy and Land Use – Does the effort acknowledge fiscal realities and focus on cost-effectiveness? Does the effort encourage the usage and development of land that internalizes present and future flood risk? Is it consistent with best practice for floodplain management?
5. Nature-Based Approach – Will the effort leverage environmental processes and natural systems to minimize mitigate flood impacts and reduce pollutants of concern including fine sediment, pathogens and organic chemicals?

These five principles are then used to evaluate existing City efforts in Section 6 and propose future flood resilience projects in Section 7. The flood resilience efforts proposed in Section 7 are consistent with existing City efforts, and provide specific, actionable work items that will assure that long-range resilience concepts are embedded in the City's decision-making processes with respect to floodplain management and flood-related infrastructure planning. Overall, it is anticipated that adoption and implementation of the five key flood resilience principles and the specific project proposals will further support the City Plan 2040 vision of a strong, livable, economically resilient community that exists in harmony with nature while ensuring that programs and actions are equitable for all members of the community.

TABLE OF CONTENTS

1. INTRODUCTION

1.1 STATEMENT OF PURPOSE

Flood Resilience

The capability to anticipate, prepare for, respond to and recover from a significant flood-related disruption or shock with minimum damage to social well-being, health, the economy and the environment

The term "resilience" is defined as the capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, health the economy and the environment[1]. Resilience is a concept of major significance for communities in a rapidly changing world. In the context of flooding, resilience focuses both on minimizing the impacts of flooding and equipping a community to respond to and rebound from the impacts of flood events. This includes both the direct, short-term shocks related to a specific flood event, as well as the longer-term issues that flood risk can create in a community. The Commonwealth of Virginia recognized this challenge when it created the Community Flood Preparedness Fund in 2020.

The City is growing and its vision, as expressed through our Comprehensive Plan, is to be a strong, livable, economically resilient community that exists in harmony with nature while ensuring that programs and actions are equitable for all members of the community. This is a particular challenge in an urban environment where there is a need to provide additional housing and related infrastructure. This development to support growth can occur, while understanding the needs of a diverse community, and incorporating flood resilience principles in a manner that supports community growth. This vision is consistent with the State's vision for creating strong, resilient communities.

With an acknowledgement of the present and future flood risk in the community, and a desire to apply resilience principles to the long-range mitigation of and response to this risk, the City of Roanoke has developed this Flood Resilience Plan to identify a path to a more flood resilient Roanoke. As such, **the purpose of this document is to define the City's principles of flood resilience, to identify gaps in existing City efforts with respect to these principles, and to provide specific action items that can be performed to make progress towards these principles**.

The plan follows the principles of the Community Flood Preparedness Fund as defined by the Department of Conservation and Recreation (DCR) and the elements and direction of City Plan 2040. Appendix A includes a cross references between DCR's criteria for resilience plans with the contents of this document.

1.2 OVERARCHING THEMES AND PRINCIPLES

There are three overarching themes that apply to the City's flood resilience:

- Roanoke is a growing city with an urban development pattern. Policy, programs and actions need to creatively account for the balance of a growing community that is becoming more resilient.
- Achieving a high level of resilience cannot be achieved by the City alone. It is a collective, community effort with the City playing a critical role in developing programs and policy as well as implementing projects.

[1] From U.S. Global Change Research Program - https://www.globalchange.gov/climate-change/glossary

- With limited resources, being good stewards of our land and capital resources is critical and is based on an understanding of community needs.

These themes are applied to flood resilience planning principles. These principles recognize:

- The changing climate and how it will affect rainfall and flood risk for our community.
- Nature based solutions are preferred as the most sustainable options for flood resilience and can offer other community benefits beyond reducing flood risk.

> *Nature-based solutions are sustainable practices that weave natural features and processes into the built environment to promote adaptation and resilience.*

This plan's three flood resilience themes and resilience planning principles are tied to the five key principles of flood resilience:

1. Climate Change
2. Social Equity
3. Community Scale Benefits
4. Economy and Land Use
5. Nature-Based Approach

These themes and principles support the plan's objective of providing a blueprint for the City's flood future efforts to build upon and expand on considerable stormwater and floodplain management plans, policies and projects to guide the City towards greater resilience to flood risk.

1.3 Methods and Scope

In order to form a Plan that applies resilience-thinking appropriately to the City's specific context, the following document structure is used: first an introduction is provided that clarifies the purpose, methodology and scope of this Resilience Plan in Section 1. Next, Section 2 provides a summary of how Roanoke's history and hydrology shapes the present-day context for flood resilience, with a summary of other related vulnerabilities. Section 3 is focused on characterizing Roanoke's demographics and vulnerabilities in the context of social equity and Section 4 adds to this knowledge base using the public engagement process for this Plan. Section 5 assimilates the previous sections into five key flood resilience principles, which are used to evaluate existing City efforts in Section 6 and propose future flood resilience projects and programs in Section 7.

The planning team consisted of City staff from the Departments of Public Works, Planning, Building and Development, and Parks and Recreation and a consultant team from A. Morton Thomas, Inc. (AMT) and Wetland Studies and Solutions Inc. (WSSI). Public outreach for the plan was conducted from January 2023 to March 2023. The plan was reviewed by pertinent City leadership prior to presentation to and adoption by City Council. While this document memorializes the resilience-thinking and public outreach completed to date, it is acknowledged that community engagement is an ongoing, project specific process that will continue as the proposed ideas in this plan make their way to implementation. This plan is therefore subject to future revisions, as concepts of flood resilience and community perspectives evolve.

Finally, it is important to understand that the focus of this plan is flood resilience and not resilience more broadly (e.g. economic, health, energy) as a broader evaluation of other known threats and hazards and the complex interdependencies between the different types of critical infrastructure during emergency events is outside of the scope of this work. Notwithstanding, the methods, analysis, findings and recommendations in this plan are carefully crafted to support a broader application of resilience thinking across these domains.

2. BACKGROUND

2.1 HISTORY AND HYDROLOGY

The City of Roanoke is a mid-sized locality (population ~100K, 43 mi^2) in southwest Virginia located near the bottom (i.e. downstream terminus) of a 513 mi^2 watershed known as the "Upper Roanoke River Watershed" (Figure 1). The watershed is comprised of steep Appalachian and Blue Ridge Mountain slopes, with relatively thin soils that drain into flatter river floodplains as the Roanoke River flows into Roanoke County, City of Salem, City of Roanoke and subsequently into Smith Mountain Lake and the Virginia Piedmont. In addition to the approximately 10 miles of Roanoke River within the City, drainage within the City's service area is comprised of 13 smaller tributary waterways amounting to 63 stream miles and an additional 450 miles of storm drainpipe and nearly twenty-two thousand related drainage structures (manholes, inlets, outfalls, etc.).

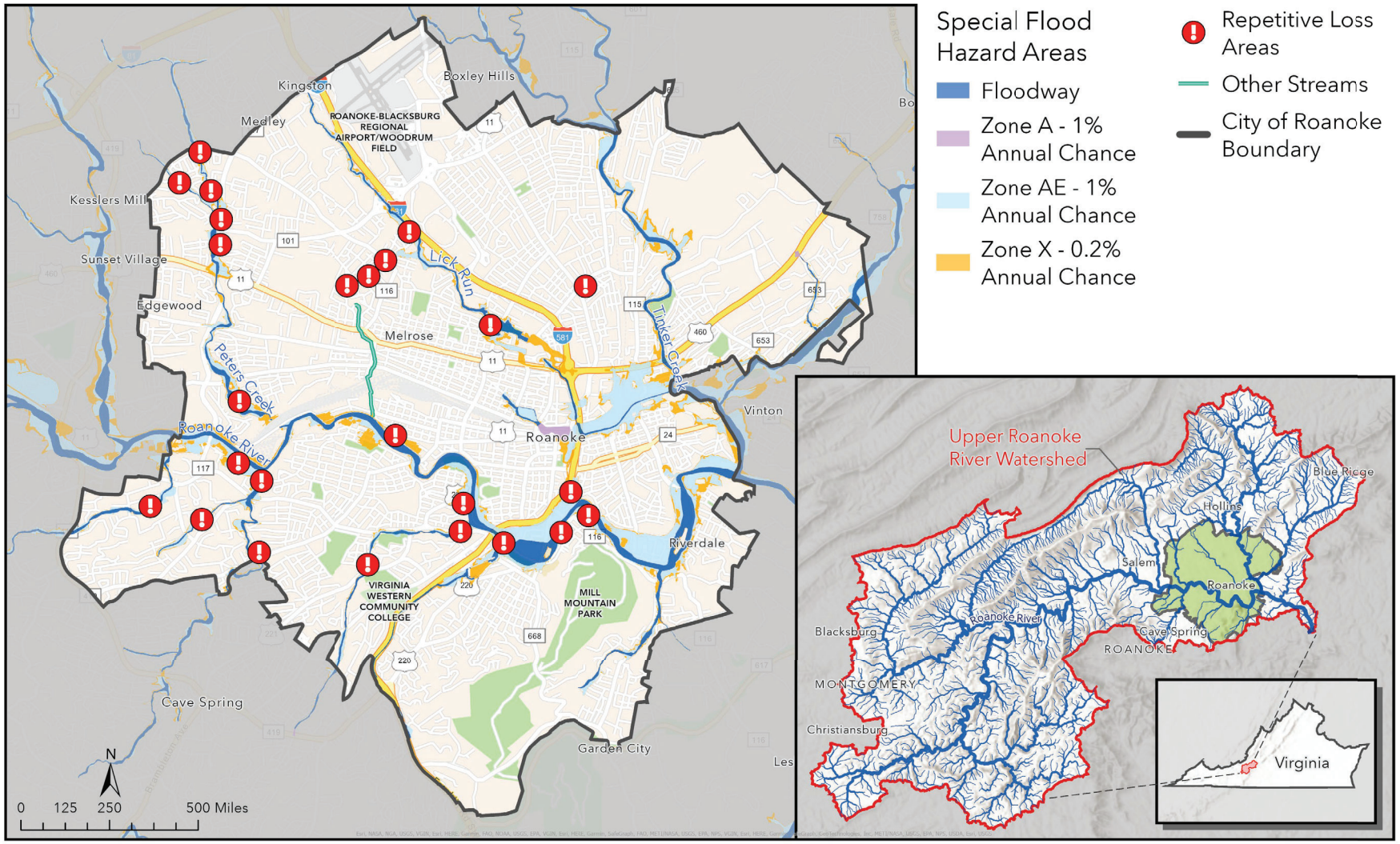

Figure 1 – The City of Roanoke (43 mi^2) in the context of the 513 mi^2 Upper Roanoke River Watershed and the broader Roanoke River Basin. Watershed boundary and stream lines from the National Hydrography Dataset (NHD) Plus v2.

The abundant availability of water resources was an important aspect of the settlement of the Roanoke Valley, and in particular the position of the City at the bottomlands of the river valley is due in part to the availability of three critical water resources at the time Roanoke (formerly Big Lick) was settled around the turn of the 20th century: (1) fresh drinking water springs, (2) a number of salt marshes near present-day Downtown Roanoke that provided hunting grounds, and (3) the ability to dispose of sewage via the multitude of streams in the area. Early settlement followed this pattern in numerous locales on the eastern seaboard, and while the proximity to water resources was critical to the City's early survival and continues to be a critical element of water resilience context in the Roanoke Valley, this proximity has become problematic as the City has expanded in footprint and population and because the City is the downstream recipient of runoff from most of the developed and developing land in the remainder of the Upper Roanoke River Watershed.

As of the date of this plan, it is estimated that the Upper Roanoke River Watershed is on average 24% developed and that the City's service area is 87% developed land and 38% impervious cover. As a result of this changing land cover and the related removal of vegetation and grading/compaction of soils, the hydrology of the Roanoke River and its tributaries has changed considerably from the early days of its settlement, and Roanoke is now subject to two separate but related flooding processes: riverine and pluvial. In general, riverine flooding is caused by longer duration rainfall (tropical storms or frontal systems) while pluvial flooding is caused by shorter duration but very intense rainfall (convective or "burst" storms) – the impacts of these two processes are further expanded in the following subsections.

2.1.1 Riverine Flooding

Riverine flooding occurs during longer duration precipitation events that exceed the infiltration limits of the soils in the Upper Roanoke River Watershed and cause flooding along the Roanoke River corridor. The most well-known example of riverine flooding is the flood of record in the Roanoke Valley - commonly known as the Election Day Flood of 1985, or simply the "**Flood of '85**". In this significant historical event, the remnants of Hurricane Juan moved slowly up the eastern seaboard and then stalled in the mid-Atlantic by a cold front from the west, resulting in five consecutive days of heavy rainfall. On November 4, the system produced a record-breaking 6.61 inches of rainfall over a 24-hour period, resulting in major flooding of the Roanoke River and its tributaries and causing ten deaths and an estimated $225M (1985 USD) in property damages in Roanoke alone[2]. While the Flood of '85 was the largest flood to date, riverine flooding is not unusual along the Roanoke River as the River has exceeded the National Weather Service's (NWS) "Major Flood Stage" of 16 ft. seven times in recorded history, with the most recent event related to the remnants of Hurricane Michael on October 11, 2018 (Figure 2).

[2] For further reading on the Flood of '85, see: Corrigan, P. (2020). *The Floods of November, 1985: Then and Now* (pp. 1–13). NOAA Central Region Headquarters.
https://www.weather.gov/media/rnk/past_events/Flood%20of%201985_Then-Now_2020.pdf

Figure 2 – The Roanoke River at S. Jefferson St. and Carillion Roanoke Memorial Hospital on October 11, 2018. Flooding resulted from the remnants of Hurricane Michael is it passed through southwest Virginia.

One issue of particular importance that was identified during the Flood of ’85 was the impact of flooding on **critical facilities** along the Roanoke River and tributaries – namely the flooding of the basement and first floor of Roanoke Memorial Hospital (now Carillion Roanoke Memorial Hospital, CRMH). A critical facility is one that functions as a community lifeline, and a disruption in service may lead to health and public safety issues – this includes hospitals, fire stations, police stations, storage of critical records, etc. While CRMH has implemented several flood-proofing measures since the Flood of ’85, there are still 22 critical facilities within the City’s SFHA that present a particular risk during Riverine flooding events and would benefit from additional flood protection efforts and well- documented/rehearsed flood-day operations manuals.

The extent and impacts of riverine flooding can generally be summarized using FEMA’s mapped floodplain – known as the “Special Flood Hazard Areas” (SFHAs, Figure 1) – as these areas portray the inundation extent along streams and rivers with drainage areas greater than approximately 1 mi^2. However, there are smaller tributaries that may experience flooding that are not mapped as a SFHA, including Horton’s Branch in the Loudon-Melrose, Shenandoah West and Villa Heights neighborhoods, and the western portion of Trout Run in the Gilmer neighborhood. Along with the SFHA, there are areas of repetitive loss and damage from flooding across the City that may or may not be in the SFHA (Figure 1). There are 67 repetitive loss properties in the City of Roanoke and 10 severe repetitive loss properties.

The floodplain boundaries are based on the extent of inundation during the 0.2% and 1% Annual Chance[3] floods (Previously known as the 500-year and 100-year floods) and the regulatory Floodway, which is the zone of highest flood risk. Most of the City’s known flooding issues – referred to as “repetitive loss” or “severe repetitive loss” areas are subject to riverine flooding and are therefore located in a mapped FEMA

[3] The 0.2% and 1% Annual Chance floods have historically been referred to as the 500-year and 100-year floods respectively,

SFHA. However, there are known flood prone locations throughout the City that are not adjacent to a stream or river, but nonetheless experience flooding during brief, intense rainfall.

2.1.2 Pluvial Flooding

In comparison to the long duration rainfall systems that cause riverine flooding, pluvial flooding is generally caused by short duration, localized, intense bursts of rainfall over more highly developed land. This type of flooding generally impacts the storm drain system and smaller tributaries as excess runoff generated from urbanized sub-watersheds exceeds their capacity and causes brief periods (5 minutes – 30 minutes) of surface flooding. While pluvial flooding is a different process from riverine flooding, the impacts of pluvial flooding can sometime be exacerbated if the river is at flood stage and therefore a downstream impedance to drainage of the tributaries. The impacts of pluvial flooding were especially notable in 2018 as the City's rainfall surpassed the average annual rainfall accumulation of 41.25 inches by over 20 inches, achieving a new historical record of 62.45 inches.

In particular, the Trout Run watershed which drains the City's Downtown is subject to recurring pluvial flooding, as are certain sections of the smaller tributaries and storm drain system. When intense rainfall occurs over the Trout Run watershed, the pipes and tunnel systems draining through the Downtown are overwhelmed with runoff because of (1) the intensity of precipitation; (2) the position of the Downtown atop a historical salt marsh and (3) the undersized tunnels that drain the Downtown dating back to the 1880's. Various other areas of the City are subject to pluvial flooding issues related to intense precipitation and legacy infrastructure that was not designed to modern day engineering standards.

2.2 Legacy Infrastructure and Standards

The City dates to the late 1880s with much of the City's growth occurring before the 1960s. The age of drainage infrastructure generally reflects the age of the development of the various areas of the City. Among other issues, this means that a large proportion of the City's flood-related infrastructure:

- May be undersized because it pre-dates modern-day (or any) hydraulic engineering methods or because it was sized based on a now-dated rainfall atlas.
- Was built using materials (e.g. vitrified clay, corrugated metal) that are susceptible to damage/at the end of their service life or methods (e.g. unsuitable backfill material, poorly formed connections, no maintenance access) that present significant maintenance burdens.
- Did not consider impacts on downstream channel erosion or surface water quality.

As of the date of this Plan, the City's Stormwater Capital Improvement Program (CIP) has a list of over 200 projects valued at over $150M that would address some of the flooding related to the issues listed above. In addition, a recent technical report proposed an additional $80-90M of projects to address Downtown flooding, beyond those listed in the CIP. Furthermore, the City's estimated capital outlay to build the required water quality projects (as required by the TMDLs, see Section 6.3.2) is in the $150M range amounting to a total estimated capital investment of approximately $380M – note that this does not include the substantial cost of maintaining existing storm drain infrastructure throughout the City. While the City has been working to address these legacy infrastructure issues, it is important to understand that the age, scale and right-of-way needed to address these issues means that the volume and rate of depreciation of aging infrastructure will continue to surpass the City's replacement capabilities (funding, staff, equipment, etc.) for the foreseeable future as the annual project delivery capability is in the $7 - 9M

range. This gap is further widened by the rapid inflation in the cost of construction products[4] and the potential impacts of climate change on pipe sizing calculations (see Section 2.3). These factors suggest that while traditional drainage improvement projects are still beneficial in certain circumstances, community-wide flood resilience cannot be achieved by simply replacing and updating legacy infrastructure - a more diverse portfolio of strategies will be needed.

The City's age also means that the development in much of the service area pre-dates modern day flooding-related development standards. A few examples of this are:

- Construction of buildings or other capital assets in the floodplain or floodway prior to the availability of floodplain maps (i.e. Flood Insurance Rate Maps, FIRMs) and prior to the National Flood Insurance Program (NFIP) in the 1970s.
- Land development prior to modern-day stormwater and erosion/sediment control regulations resulting in unmitigated discharges of runoff from developed land applying to development since the 1980s.

While the City has adopted floodplain, stormwater, erosion and sediment control regulations and other development standards to control runoff and/or reduce flood risk, older developments do represent a risk. That risk may be associated with buildings and structures on the immediate property or the effect of that development on downstream properties. As properties are redeveloped and modified over time, there is the opportunity to retrofit improvements to reduce runoff from properties and/or make the properties more resilient related to flooding. Over time some, but not all risk can be managed through redevelopment and renovation. The City actively works to reduce this risk through floodplain acquisition of highly flood prone properties, including demolition of flood prone structures.

In summary, the age of the City's infrastructure presents a particular challenge because of the complexity and cost of retrofitting legacy developed land to a disposition that reflects modern-day standards. An additional complication is that modern-day standards assume that historical rainfall and hydrology patterns are representative of present and future patterns. However, it is likely that this is not actually the case, and the specter of a warming climate further exacerbates the issues outlined in this Section.

2.3 Climate Change

In general, climate forecasts suggest that average temperatures in Virginia will increase by 4°F by the year 2100 and Roanoke's climate will feel more like the present-day climate in Tuscaloosa, Alabama[5]. These higher temperatures and corresponding moisture holding capacity of the atmosphere will likely cause more frequent and intense rainfall and flood events[6]. Expert guidance suggests that the City of Roanoke should expect an estimated 5% increase in average annual precipitation by 2035 and an 11%

[4] Concrete pipe (for example) has increased in unit cost by 13% since July 2022, 37% since July 2021 and 40% since July 2020 nationally. See U.S. Bureau of Labor Statistics WPU1332

[5] For more detailed information on temperature impacts in Virginia, see the National Climate Assessment, Southeast Region, the Climate Impact Lab and University of Maryland's Climate Analog Tool.

[6] See Intergovernmental Panel on Climate Change (IPCC) 2022 Report

increase by 2060, potentially increasing streamflow (i.e. the volume of water flowing through the City's streams during flood events) by 1.5 times present day streamflow[7].

While the total annual rainfall increase is substantial, the greatest impact to flood resilience is the increasing intensity and frequency of individual storm and rainfall events. To quantify this impact, the National Oceanographic and Atmospheric Administration's (NOAA's) Mid-Atlantic Regional Integrated Sciences and Assessments (MARISA) Team has developed a tool to predict rainfall intensities of future storm events. This tool can be used to predict rainfall for future design storms in Roanoke based on planning horizons (year 2070 or 2100) and two scenarios for level of action taken to reduce the effects of climate change (steady state RCP 8.5 or optimistic reductions RCP 4.5) and several storm events pertinent to hydraulic engineering are summarized in Table 1.

As the table shows, predictions can be complicated based on a range of factors. However, the projected increase in precipitation and storm events necessitates a new vision for managing stormwater and flood adaptation. Two highlights are:

- The 10-year storm (or 10% Annual Chance): This rainfall event is typically used for storm drain and culvert sizing, will increase in size by 14% - 19% by 2070 and by as much as 23% - 28% by 2100, making it more like the present day 25-year rainfall. This means that in fifty years, storm drainpipes that are sized to present day standards will no longer achieve the designed level-of-service and may flood on a more frequent basis than anticipated. (note, that because of the City's age, much of the City's drainage infrastructure was not even designed to a 10-year storm event, see Section 2.2).
- The 100-year storm (or 1% Annual Chance): Rainfall is projected to increase by 20-25% from present-day estimates, making it more like the present day 200 – 500-year rainfall event. While these storms may be infrequent, it means that major riverine floods would be larger and more frequent, and that flood risk would increase for floodplain properties.

Table 1 - Estimated Impacts of Climate Change on Rainfall Amounts

Rainfall Duration	Current Rainfall (in)	Projected 2070		Projected 2100	
		Rainfall (in)	Change from Current (in)	Rainfall (in)	Change from Current (in)
10-Year Return Period (10-Year Storm)					
10 min.	0.81	0.92	+ 0.11	1.04	+ 0.23
1 hr.	1.94	2.21	+ 0.27	2.48	+ 0.54
24 hr.	4.70	5.36	+ 0.66	6.02	+ 1.32
25-Year Return Period (25-Year Storm)					
10 min.	0.92	1.08	+ 0.16	1.23	+ 0.31
1 hr.	2.30	2.69	+ 0.39	3.08	+ 0.78
24 hr.	5.72	6.69	+ 0.97	7.66	+ 1.94

[7] See EPA's Streamflow Projections Map

Rainfall Duration	Current Rainfall (in)	Projected 2070		Projected 2100	
		Rainfall (in)	Change from Current (in)	Rainfall (in)	Change from Current (in)
100-Year Return Period (100-Year Storm)					
10 min.	1.07	1.31	+ 0.24	1.35	+ 0.28
1 hr.	2.85	3.48	+ 0.63	3.59	+ 0.74
24 hr.	7.50	9.15	+ 1.65	9.45	+ 1.95

Notes:

1. **Estimates for Roanoke Regional Airport for time periods 2020 – 2070 and 2050 – 2100 from NOAA's Mid-Atlantic Regional Integrated Sciences and Assessments Team.**
2. **Rainfall estimates based on a low emission scenario, RCP 4.5, are shown in this table. This assumes that was used for this table, RCP 4.5 is a moderate scenario in which greenhouse gas emissions peak around 2040 and then begin to decline.**

While the estimated changes to precipitation patterns are now available, it is more difficult to translate changes in precipitation patterns to impacts on infrastructure cost and floodplain structures. This is because the relationship between rainfall intensity and corresponding runoff, stream flows and flood depths are non-linear (i.e. a 14% increase in rainfall does not necessarily lead to a 14% increase in runoff or streamflow) and the cost of infrastructure and impacts to floodplain structures varies, depending on a wide number of factors. The complexity involved in understanding how changes in precipitation result in on-the-ground impacts means that the formulation of policies and protocols aimed at these long-term changes requires additional study. Recommendations with respect to hydraulic engineering calculations and floodplain management that address this complexity are provided in Section 7, though the reader should understand that the field of climate change adaptation for local flood resilience is still relatively new, and that best practice will evolve rapidly as communities experiment with different adaptation strategies.

In general, the best available practice that has formed around hydraulic engineering design for climate change is to shift from a principle of "protection" to that of "adaptation". While these concepts may sound similar, protection is focused on repelling and diverting flood waters, while adaptation acknowledges the eventuality and increasing probability of flooding with climate change and focuses on replacing risk with natural assets. Levees and concrete floodwalls are a simple example of a flood protection structure, as they are built to repel floodwaters from developed land up to their design flood; though the major issue is that when they overtop (which they are more likely to do in the context of climate change), the failure is typically catastrophic. The adaptive alternative to levees and floodwalls is called a riparian buffer, which replaces flood risk along the river with trees and other vegetation that will not be subject to damages if flooded. As previously mentioned, there is an economic tradeoff from the use of adaptive solutions, and their implementation requires careful weighing of benefits and costs – though it is critical that these types of adaptive, nature-based solutions be considered as a viable project alternative in the context of drainage improvements and other flood-related projects. This is discussed further in Section 5 and 7 of this Plan.

2.4 Related Hazards

A flood resilience plan would not be complete without addressing flood-related hazards. There are several flood-related hazards pertinent to the City that are considered here with respect to flood resilience. The proposed efforts in this Plan will also work towards City objectives related to water quality, dam safety and landslides.

2.4.1 Water Quality

It is well known that hydrology – the volume, rate, energy and frequency of flow – is a master variable that drives water quality. While the focus of this plan is flood resilience, it is anticipated that the principles and projects outlined here would also support the City's efforts to improve water quality in the Roanoke River and its tributary streams. In particular, the Roanoke River and several tributaries have been designated as "impaired" by the Virginia Department of Environmental Quality (DEQ) for aquatic life, bacteria and a category of organic chemicals known as polychlorinated biphenyls (PCBs). The DEQ has designated regulatory pollutant reduction requirements for all three of these impairments, known as "total maximum daily loads" (TMDLs), and as such, the City is required to demonstrate progress towards mitigation of these water quality impairments. A more thorough summary of these impairments and mitigation efforts are provided in the City's TMDL Action Plan documents[8].

More specifically, the aquatic life impairment results from long-term assessment of aquatic insects indicating an unhealthy lack of diversity. Excessive fine sediment from urban runoff is a primary cause of this issue. In general, efforts to mitigate the volume and rate of urban runoff that flows into the City's waterways will make the City more resilient to flooding and will improve the health of streams. Similarly, issues related to bacteria in the Roanoke River are multi-faceted, but at least part of this issue can be mitigated by controlling excess runoff during storm events. This is because excess runoff can infiltrate the sewer system during periods of heavy rainfall leading to overflows and contamination of downstream waterways.

2.4.2 Landslides

Another hazard related to severe rainfall and localized flooding is that excessive water can induce landslides in the high slope topography in and around Roanoke. While this hazard is more prominent in the areas surrounding Roanoke that have a significant amount of high slope land, the area around Mill Mountain and other parts of the City where the landscape has been steeply graded are also subject to this potential hazard. The risk of landslides can be reduced by minimizing disturbance and grading on existing steep slopes, and by establishment of suitable soil and slope stabilization methods where necessary.

2.4.3 Dam Safety

There are two 'High Hazard' dams upstream from the City of Roanoke that present the possibility of probable loss of life or serious economic damage in the event of dam failure. Both impoundments are owned and operated by the Western Virginia Water Authority.

The Carvins Cove Dam (1946) is located on Tinker Creek, a tributary of the Roanoke River, in Botetourt and Roanoke counties. The Clifford D. Craig Memorial Dam (1993) at the Spring Hollow Reservoir is

[8] The TMDL Action Plans are available at: https://www.roanokeva.gov/2275/Municipal-Separate-Storm-Sewer-System-MS

located in the Glenvar area of Roanoke County, adjacent to the Roanoke River. The dam at Spring Hollow is of a type that has never experienced a structural failure and is unaffected by rainfall or peak mean flow of any rivers or streams. However, if the dam would fail, inundation would significantly raise the Roanoke River levels in the City.

Figure 3 - The Spring Hollow Dam Break Inundation Zone and City of Roanoke Boundary. Zone boundary from the Virginia Department of Conservation and Recreation (DCR) Virginia Dam Safety and Inventory System (DSIS).

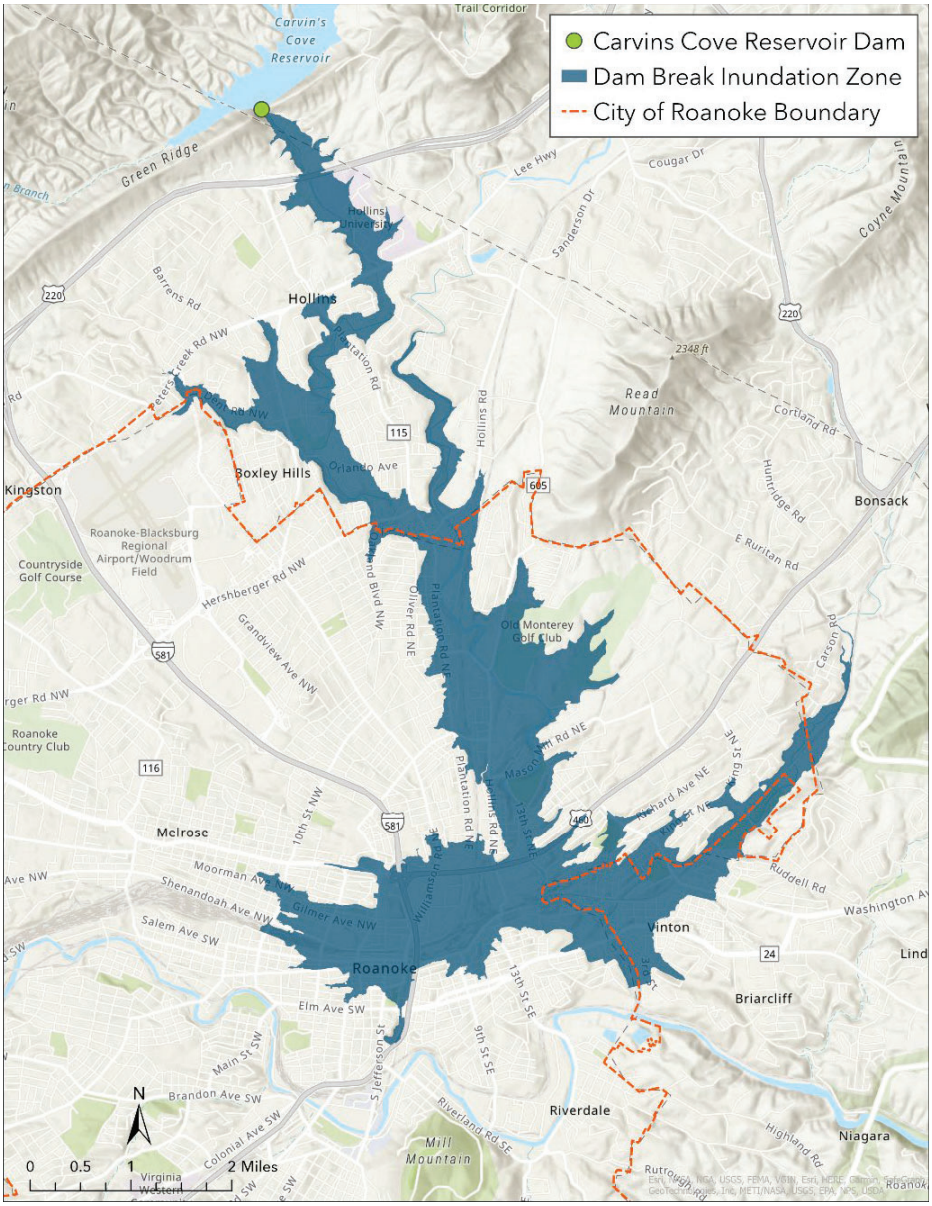

Figure 4 - The Carvins Cove Dam Break Inundation Zone and City of Roanoke Boundary. Zone boundary from the Virginia Department of Conservation and Recreation (DCR) Virginia Dam Safety and Inventory System (DSIS).

In addition, there are two smaller privately held dams within the City of Roanoke. Windsor Lake Dam (1960, with modifications in 2007) and Spring Valley Lake (1960) are both considered 'Significant Hazard' dams that, upon failure, might cause loss of life or appreciable economic damage. Dam owners are responsible for:

- Proper design, construction, operation, maintenance, and safety of their dams
- Reporting abnormal conditions at the dam to the Police Department, the City Manager, and the Coordinator of Emergency Management
- Recommending evacuation of the public below the dam if it appears necessary.

Owners of dams that exceed 25 feet in height and impound more than 50 acre-feet (100 acre-feet for agricultural purposes) of water must develop and maintain an Emergency Action Plan.

Procedures are in place between the City of Roanoke and respective Dam Owner/Operators to ensure timely notification of changes in dam condition or threat of failure. There are established procedures during different alert levels and the public will be notified of conditions at an affected dam. More information can be found in the Dam Safety Support Annex to the City Emergency Operations Plan.

Increased frequencies and durations of storm events create additional dam safety risk in a variety of ways. The increased volume of water that accumulates behind impounding structures puts more frequent and greater pressure on these structures, impacting the integrity of such structures, particularly for earthen structures or those that have not been properly maintained. The region has a number of dams on private property where responsibility for maintenance falls on the homeowner; these expenses can be difficult for such owners and maintenance is often postponed. Additionally, many impounding structures were designed and built before current day engineering requirements were in place and may have difficulty withstanding these effects. Increased storm events due to climate change and their hydrologic impacts result in additional dam safety risk.

2.5 Summary of Vulnerabilities

The following table summarizes potential risks and vulnerabilities associated with flooding and related hazards.

High Likelihood		
Type of Hazard	*Vulnerability*	*Potential Actions/Adaptations*
Riverine Flooding	High along Roanoke River and tributaries	The City has little ability to reduce floodwaters themselves but can adapt development regulations and the physical floodplain. Acquistion/restoration of flood prone land to contain flood waters and remove highly vulnerable structures. Adequately elevate or flood proof structures per development regulations/retrofits.
Pluvial Flooding	High for tributaries vulnerable to flash flooding and for development along former natural drainage.	Effects of pluvial flooding are localized, reducing direct discharges from impervious surfaces may reduce some flood risk. Acquistion/restoration of flood prone land to contain flood waters and remove highly vulnerable structures. Adequately elevate or flood proof structures per development regulations/retrofits.

Moderate Likelihood		
Type of Hazard	*Vulnerability*	*Potential Actions/Adaptations*
Aging Infrastructure	Moderate across the City but high in areas with aging or undersized infrastructure.	Green infrastructure/ infiltration and detention practices to reduce runoff. Upsizing pipes/culverts where bottle necks exist. Update design practices to account for future precipitation. Infrastructure can be adapted to handle larger flows based on available funds and impacts on other parts of the system (improvements in one area can create issues downstream).
Low Likelihood		
Type of Hazard	*Vulnerability*	*Potential Actions/Adaptations*
Dam Safety	High, similar to large scale flood event.	Monitor though state safety programs. The City does not own any of the dams and does not control inspection or maintenance.
Land Slides	Low	Periodically review standards/ regulations for best practices related to development on slopes. Slope issues on new developments can be evaluated as part of plan review process

3. PEOPLE, LAND, ECONOMY AND EQUITY

In addition to the City's history of development and hydrology, the community's character is a fundamental element of resilience planning including assessment of vulnerabilities. Residents' goals, issues, demographics, and economic situations all provide the context for project planning, funding and delivery. The purpose of this section is to contextualize any assessment of flood resilience and all proposed solutions with regards to Roanoke's local community – people, land and economy. While community information that is pertinent to flood resilience is presented in this section, this is not a comprehensive summary, and the reader is referred to the City's demographics analysis in City Plan 2040 and various resources noted in this section.

From the City's incorporation in the 1880s through the 1950s, Roanoke experienced rapid growth from a small community to a city of over 90,000 people. Recently, the population of the City has since been steady with a population ranging between 90,000 – 100,000 (Figure 5). From the 1960s to the 1980s, population growth was driven largely by land annexation, with actual population density decreasing. Since 2000, the City's population has gradually increased along with the desire for walkable neighborhoods and urban amenities, leading to slow but steady growth, and this moderate growth is expected to continue in the future.

The City is the most diverse in the region with a population as of the 2020 census that is 56% White, 27% African American, 5% two or more races, 2.5% Asian and 9% all others with 8.5% ethnic Hispanic/Latino. In general, the City's population is increasing in racial and ethnic diversity (Figure 5). Table 2 shows general socio-economic and demographic information for the City, region and the state for comparison, indicating that the City is diverse from racial, ethnic, and socioeconomic perspectives. The City has lower levels of educational attainment and lower household incomes compared to the Roanoke Region (i.e. metropolitan statistical area), and the entire City of Roanoke is designated as a low-income geographic area by DCR.

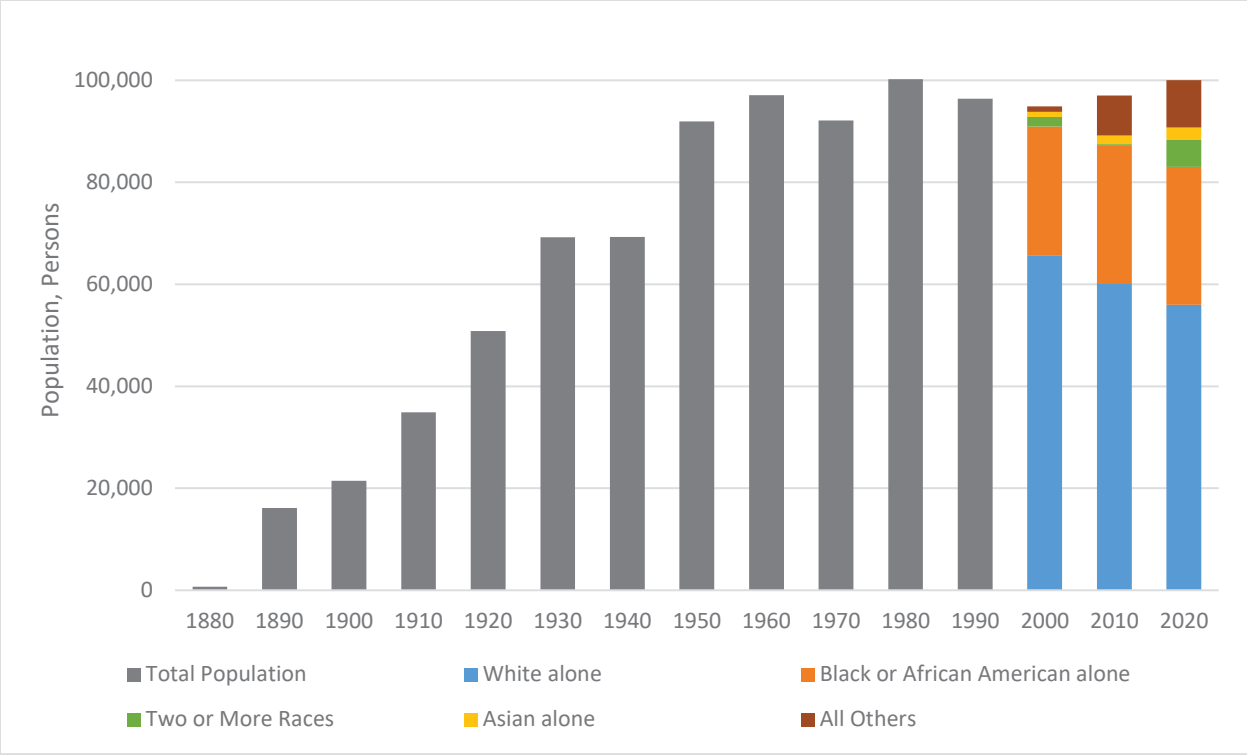

Figure 5 – The City of Roanoke's total population from 1880-2020 with demographic data generalized for available years 2000-2020. Note that the "All Others" category contains three additional categories that were aggregated because of their small size for visibility. Data abstracted from the following U.S. Census Bureau publication or data sources: "Census of Population: 1950" (1880-1950); "Census of Population: 1980" (1960-1980); Census Table PHC-T4 (1990); Census Table DP1 (2000); Census Table P9 (2010-2020).

Table 2 – Demographic characteristics of Roanoke City as compared to the Roanoke Metropolitan Statistical Area (MSA) and the Commonwealth of Virginia. Data from U.S. Census Bureau QuickFacts and from American Community Survey (ACS) via CensusReporter.org. Note that Roanoke City data are slightly different than that presented in Figure 3 and narrative, as ACS data is dated July 1, 2022.

U.S. Census Bureau Statistic	City of Roanoke	Roanoke Region	Virginia
Total Population	97,847	315,442	8,683,619
Racial/Hispanic Origin			
White alone, percent	60.1%	76%	68.5%
Black or African American alone, percent	29.3%	13%	20.0%
Asian alone, percent	3.2%	2%	7.3%
All Others, percent	7.4%	9%	4.2%
Hispanic or Latino, percent	6.6%	4%	10.5%
Educational Attainment			
High School Degree or higher	88.3%	91.2%	90.8%
Bachelor's Degree or higher	26.8%	30.8%	40.3%
Income and Poverty			
Per Capita Income	$30,379	$34,652	$43,267
Median Household Income	$48,476	$59,630	$80,615
% Below Poverty Level	18.4%	12.5%	10.2%

This increasing diversity along with the increasing immigrant and refugee population likely corresponds with a greater proportion of the City's population that is non-English speaking. With respect to flood resilience, this means that a language barrier may inhibit access to flooding information and resources (i.e. grant funding, technical support, post-disaster support). This is further exacerbated by a lack of internet connectivity, as approximately 16% of the City's population does not have internet access; three census tracts have 30-40% without access, and one tract has approximately 50% without access[9]. A number of recommendations are provided in Section 7 that would improve equitable delivery of flood resilience services to an increasingly diverse community that may not otherwise have access to these resources.

In general, the City's population is characterized by a wide variability of wealth, education, and employment indicators that factor into a community's social and economic vulnerability. A number of indices now exist that compile socioeconomic factors into a single index of vulnerability to hazardous events. For this plan, the Center for Disease Control's (CDC'S) "Social Vulnerability Index" (SVI) is used, which scores vulnerability on a 0 (low) to 1 (high) vulnerability scale[10]. The City's overall SVI is 0.92 (high), and within the City, there are three census tracts with low vulnerability, nine with moderate and thirteen with high vulnerability. This means that in general, the community's ability to respond to and recover from a hazardous event (flooding, for the purposes of this plan) are affected by several social conditions, such as poverty, mobility, health, etc. The community's vulnerability is of particular importance to flood resilience where high SVI overlaps with flood prone areas; this is manifest in several examples, listed below:

- Low-income households are less likely to have income or savings that could be used to recover from flood damage[11]
- Areas with high unemployment may have less access to paid time off or health insurance that would help cover costs during the time needed to recover from a flood[12]
- Lower educational attainment can mean that the practical and bureaucratic hurdles to cope with and recover from a flood would be more challenging[13]
- Households with a larger number of dependent children or elderly, single parent households and households with disabled persons would likely require additional financial support, transportation, medical care during and after a flood disaster[14]

In the City, areas of high social vulnerability intersect with flood prone areas along Peters Creek, Lick Run and limited parts of Hortons Branch and Trout Run (Figure 1); with this in mind, some

[9] See American Community Survey – Internet Access by Income Variables - https://hub.arcgis.com/maps/9edc0cbeeb2a4259910e158dfba01881/about

[10] https://www.atsdr.cdc.gov/placeandhealth/svi/index.html

[11] See Morrow (1999) and Cutter et al. (2003)

[12] See Brodie et al. (2006)

[13] See Morrow (1999)

[14] Flanagan et al. (2011)

recommendations on how to incorporate social vulnerability in flood resilience projects are provided in Section 7.5.

An equitable distribution of flood resilience investment in Roanoke should also consider the pertinent issues in the local housing market and business economy; these issues are generally summarized as follows. First, the availability and affordability of housing in the City appears to be a significant issue, with greater than one third of Roanoke's households categorized as "cost-burdened" with respect to mortgage or rent payments[15]. While this housing disparity may be due to a number of factors, a shortage in housing stock appears to be at least one major driver of this issue. An important aspect of the housing shortage that is pertinent to flood resilience is that 1,511 residential properties, or approximately 5% of all residential properties in the City are in one of the FEMA designated Special Flood Hazard Areas (SFHAs, i.e. "floodplains", Table 3). This suggests that the already at-risk local residential real-estate economy is subject to potential damages from flooding which could further exacerbate the housing shortage issue. Several recommendations to this end are provided in Section 7.4 of this Plan.

Table 3 – Summary of properties in the City within FEMA Special Flood Hazard Areas (SFHAs) by property type. Table was generated using July 1, 2022 parcel layer and PROPERTYDESC field.

Property Type	Citywide	Within Any SFHA	% of Citywide
Residential	31,422	1,511	4.8%
Commercial/Industrial	3,239	624	19.3%
Vacant or Other	9,644	1,492	15.5%
TOTAL	*44,305*	*3,627*	*8.2%*

Similar considerations apply to commercial and industrial real estate in the City, as 19% of all commercial/industrial parcels lie within a SFHA – which suggests that a major flood event would likely have significant impacts on the local economy by way of business damages, closures, foregone revenue, lost wages, etc. Inversely, reduction of flood risk at commercial/industrial properties would reinforce the local economy's ability to continue operations during and after a major flood event. Strategies for protection of commercial real estate depend on site-specific variables (e.g. topography, business model, development type, etc.), though in general, elevation of assets above flood elevations, relocating out of the floodplain, or flood-proofing are the three primary methods that can be used. With respect to equity, implementation of commercial flood-proofing can require a significant amount of capital and technical expertise that is probably not widely achievable for small or mid-sized businesses – although these businesses bring an important measure of adaptability to the local economy.

Finally, the age of the City means that most of the readily developable land has already been used in some fashion, and the housing shortage and commercial development needs mean that the remaining land will be needed to support the necessary growth of the local economy. This context and demand create a land issue for flood resilience, as most types of flood resilience projects require a significant land footprint to provide a material reduction in flooding (e.g. acquisition/demolition projects, land conservation, retention ponds, riparian buffer). On the one hand, there is a need to create additional housing units and working spaces, but the addition of more developed land could lead to more runoff and flooding, further diminishing the land needed to provide flood resilience projects. As such, the pathway to flood resilience

[15] https://housingforwardva.org/toolkits/sourcebook/affordability-costburden/

in Roanoke will likely need to integrate flood-resilient design into land development – the development of some technical resources is proposed in Section 7.4.

4. COMMUNITY ENGAGEMENT

The social, economic and demographic summary provided in Section 3 provides helpful high-level community context for this Plan, but it was imperative that the perspectives of individual community members be collected as part of this planning effort. As such, an extensive community engagement effort was performed that included both a survey and in-person meetings, to further develop the community's perspective on flooding and resilience. This section summarizes the methods and findings of the Resilience Plan Community Engagement effort and discusses how this new information supplements the significant engagement, education and outreach programs that already existed prior to this planning effort; these existing efforts are summarized in Section 6.2.4 .

Figure 6 – Images of public outreach events during community engagement efforts, March 2023.

4.1 METHODS

Public outreach for the 2023 Roanoke Flood Resilience Plan was done primarily with public survey followed by in person public meetings. A 10 minute survey on flooding was created by the City, available in English and Spanish, on a dedicated Resilience Plan website. The survey was promoted through social media, five local news segments (television, radio, and RVTV filmed videos), local partners and non-profit groups, and with signs with QR codes placed in public areas such as the greenways and parks. Additionally, a flyer was created to promote the in person meetings, which was mailed with the City's annual Repetitive Loss Area outreach letter to 345 residents.

The public survey received 146 responses. Of the survey respondents a majority were under 65 and over 18 (33% 18-39, 43% 40-65), white (84%, 6% African American, 7% did not say), City residents (88% live in City of Roanoke), and half live in the southwest quadrant of the City (55.5% in either 24014, 24015, or 24016 zip codes). The most common occupational status was full time employment (62%) followed by retired (24%).

In person public meetings were held at 5 of the City libraries in March 2023 along with one virtual Zoom meeting option. At these meetings, a brief presentation was given providing general information about flooding and flood resilience, followed by an open forum for the community to ask questions, express concern, and discuss flooding with staff and consultants. Public meetings garnered a total of 12 participants, however the level of interaction of the participants was high and beneficial. Follow up public outreach is planned to allow for dissemination of plan results and to answer community questions after adoption of the plan document. Future feedback will inform plan updates.

4.2 Supplemental Outreach

The project team also developed a custom GIS-based online survey and mapping application. This GIS mapping application was designed to facilitate automated capture of basic flood occurrence data and visualization of issues in a geographical context. The application employed a crowdsourcing workflow to create an accessible and easy to use survey application to obtain flooding occurrences from City residents. The tool offers a means for residents to provide basic information and attach photos documenting areas of concern. The public facing interface allows residents to see where issues are occurring, while allowing City staff to catalogue and archive reports of flooding while controlling access to detailed source information. The tool was provided on the project website and also brought to the public through radio and television, including a brief segment on the local evening news.

During this Resilience Plan outreach it received 14 reports of flooding issues from the public. Reports included street flooding, local drainage issues, and stream or river flooding. The reports were largely from the North and southwest areas of the City. A few responses were from outside of City boundaries at Smith Mountain Lake, these were passed along to appropriate organizations as necessary; they also illustrate downstream flooding impacts. The mapping application will be kept open beyond the plan development phase to allow for ongoing reporting.

4.3 Summary of Responses

This section provides a summary of the findings of the Resilience Plan Community Engagement effort, though the full survey results are included in Appendix E of this Plan. Over two thirds of respondents felt flooding currently poses a moderate (55%) or serious (24%) challenge to their community with only 5% feeling it is an extreme challenge. When looking at the risk flooding poses in the next 20-40 years, 17% felt flooding will pose an extreme challenge.

About one quarter of respondents' homes have flooded (27%) while only a minority reported flooding of a business (7%). The most common commentary on flooding experienced was basement or land (backyard or street/driveway/sidewalk) due to either large storms, drainage issues, or stream overbanking. One third have not experienced any type of property damage from flooding, but when damage occurred, the most common damage was to basements (38%) followed by street flooding (34%) and debris/trash deposits (26%). Relatedly, the most common negative impact reported was damage to transportation (62%) as well as trash and debris (41%).

Most respondents are not interested or concerned about moving due to flooding; however, 21% are considering relocation due to flooding issues and 7% of those have issues that prevent them from relocation. For those that have put in mitigation measures on their homes, the most common is a sump pump (24%), french-drains (21%), or elevation of property/utilities (19%). About an equal number do not have any mitigation measures on their homes (27%).

As far as solutions, the most popular suggestion was the persevering/creating natural space for flood water storage (80%). Other options such as buy-outs, changing design standards, increasing capacity for drainage, funding for flood-proofing, increased outreach, and real estate disclosures for flood prone properties were all equally popular.

The main discussions at in the in person meetings were regarding existing, long term flooding issues from residents and how they might find solutions or be helped by the Resilience Plan. There was overall excitement for a focus on flooding and resilience but disappointment in the length of time for meaningful

solutions to be implemented for complex flooding issues. Additional understanding of specific flooding problems were relayed to City staff as well as the emotional and financial burden on those residents.

Even though somewhat limited in responses, this feedback from the community survey supports the City's Resilience Planning efforts, as flooding is clearly expressed as a real threat to its residents and nature based solutions are positively received. The responses also help this plan to focus on local solutions for property damage and street flooding that residents commonly experience. Using community feedback helps align this plan with the community's needs and desires.

While responses to this initial outreach effort were limited, past efforts at engagement and outreach also support the City's understanding of the community. Robust educational and engagement efforts, outlined in 6.2.4, help guide the City's plan for flooding resilience. The City highly values incorporating education, engagement, and outreach with the community as a fundamental part of building resilience. Direct community engagement encourages accountability, creates connectedness between city and citizen and instills a sense of ownership and pride in one's community.

5. PRINCIPLES OF FLOOD RESILIENCE

In this section, the background context related to flooding, community vulnerabilities and equity provided in Sections 2 and 3 are combined with the information gained from the Community Engagement survey for this Resilience Plan effort in Section 4 to support Roanoke's five basic principles of flood resilience. These principles acknowledge and internalize the nature of flooding in Roanoke (i.e. a combination of pluvial and riverine), with the challenge of retrofitting legacy land with modern day infrastructure and standards in the face of a changing climate. The principles also acknowledge the large variability in social vulnerability in the City and incorporate social equity as one of the principles. The principles are derived from parameters given in DCR's 2023 Community Flood Prevention Fund Grant Manual but are adapted to Roanoke City's specific context based on the extensive work performed in the previous Sections of this Plan. The five key principles are described as follows; note that in each principle the term "effort" is used, as it includes any type of planning document, internal protocol or program, policy or technical/construction project that the City may perform.

1. **Climate Change** – Does the effort internalize the potential impacts of climate change, such as increased rainfall intensity and temperature into planning, design and implementation of efforts?
2. **Social Equity** – Does the effort acknowledge community vulnerabilities and work towards equitable outcomes in its conception? Will the effort improve or strengthen the social fabric in vulnerable parts of the community?
3. **Community Scale Benefits** – Will the effort render benefits at a U.S. Census Block scale or larger? Will at least 10% of the City's population benefit from the project? Is the effort consistent with regional efforts?
4. **Economy and Land Use** – Does the effort acknowledge fiscal realities and focus on cost-effectiveness? Does the effort encourage the usage and development of land that internalizes present and future flood risk? Is it consistent with best practice for floodplain management?
5. **Nature-Based Approach** – Will the effort use or leverage environmental processes and natural systems including (but not limited to) vegetation, soil, biota to minimize flooding and mitigate flood impacts? Will the effort encourage a reduction in key pollutants of concern for Roanoke's waterways, including fine sediment, pathogens and organic chemicals?

Resilience Principle	CFPF Program Perspective	Related City Vision
Climate Change	Potential impacts of climate change, such as increased rainfall intensity and temperature into planning, design and implementation of efforts	The City Plan 2040 and the City's Climate Action Plan recognize that our climate is changing, and action is needed. This plan lays out the provision for the City to adapt to and mitigate impacts of climate change as they relate to increases in rainfall and potential for flooding.

Resilience Principle	CFPF Program Perspective	Related City Vision
Social Equity	Efforts acknowledge community vulnerabilities and work towards equitable outcomes in their conception. Efforts will improve or strengthen the social fabric in vulnerable parts of the community.	City Plan 2040 recognizes that equitable outcomes need to be evaluated in all City Actions. The Department of Public Works Equity Action Plan further recognizes the need to understand community needs as projects are planned, developed and implemented.
Community Scale Benefits	Will the effort render benefit at a U.S. Census Block scale or larger? Will at least 10% of the City's population benefit from the project? Is the effort consistent with regional efforts?	The Stormwater Utility recognizes that stormwater and flood projects need to be evaluated within the overall context of the watershed and community they are planned in. Projects need to account for the watershed so that a project does not create upstream or downstream issues. More importantly, projects need to be assessed holistically based on the community and how a resilience project can be part of broader community development efforts.
Economy and Land Use	Does the effort acknowledge fiscal realities and focus on cost-effectiveness? Does the effort encourage the usage and development of land that internalizes present and future flood risk? Is it consistent with best practice for floodplain management?	City Plan 2040 recognizes the need to adapt to climate change will creating a more resilient community. Resilience efforts will focus on effective use of City and leveraged resources and other community resources to adapt to a changing climate. Efforts will include land use practices including preservation and restoration of highly flood prone areas, reduction of flood risk though appropriate projects, and adapting to climate change through appropriate development standards.
Nature-Based Approach	Will the effort use or leverage environmental processes and natural systems including (but not limited to) vegetation, soil, biota to minimize flooding and mitigate flood impacts? Will the effort encourage a reduction in key pollutants of concern for Roanoke's waterways, including fine sediment, pathogens and organic chemicals?	City Plan 2040, Stormwater Utility monitoring efforts and general best practices for flood resilience all point to the value of flood plains and use of natural process, such as infiltration, to help reduce the impacts of flooding and increased rainfall/runoff. Use of nature–based solutions, at least in part, are preferred for projects. It is recognized that in a compact urban environment, traditional engineering practices are still necessary as part of a holistic process to be resilient community.

It is important to understand that these principles are focused on flood resilience – the scope of this plan. While these principles do not explicitly internalize other known threats and hazards or the complex interdependencies between different types of critical infrastructure during an emergency event, they are crafted carefully to support a broader application of resilience thinking across these domains.

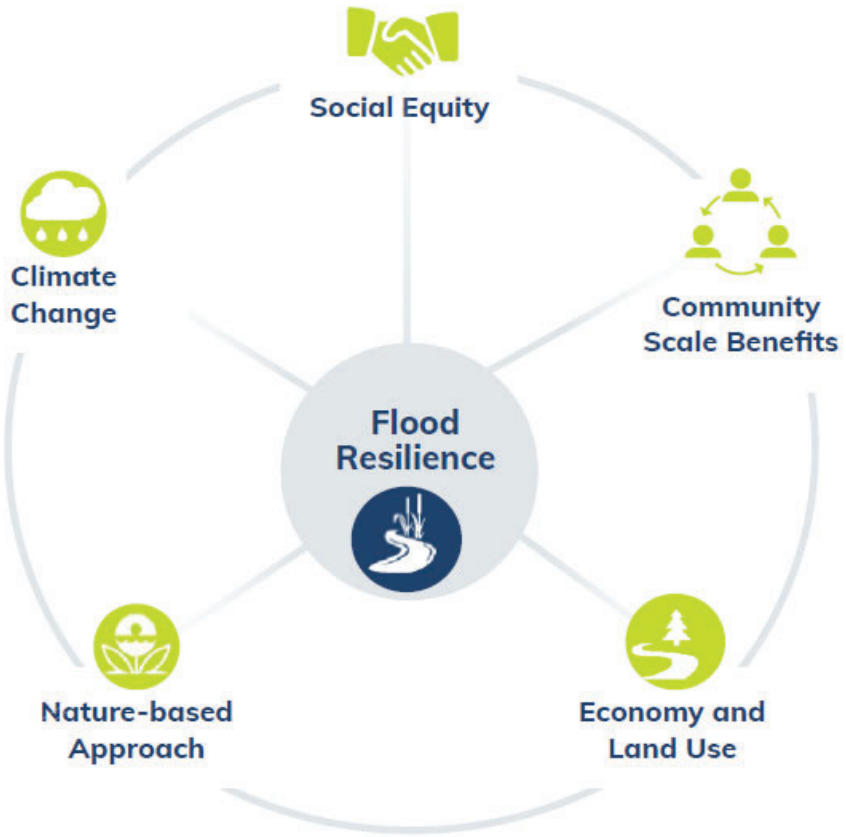

Figure 7 - The Five Principles of Flood Resilience

The following Sections use these principles to evaluate efforts to date related to flooding (Section 6) and to propose recommendations that would further advance Roanoke as a flood resilient community (Section 7). While these principles represent knowledge of the community and best practice with respect to flood resilience as of the date of this plan, it is anticipated that these principles could be revised in future versions of this plan, as community dynamics shift and flood resilience practice evolves.

6. EFFORTS TO DATE

In this section, the five principles of flood resilience are used to evaluate existing City efforts to date related to flooding and flood resilience. City efforts are organized into the categories of planning documents, internal protocols and programs, external facing policies, and engineering/construction projects. Each section contains a summary of the effort, a description of how the effort relates to flood resilience, and an analysis of the degree to which each effort incorporates the five key principles of flood resilience. As existing efforts are evaluated, a gap analysis is performed to identify if and how the key principles of flood resilience may be missing from individual efforts or from the collection of effort. As gaps are identified, future work is proposed in the following Recommendations Section (Section 7) and links to specific recommendations are provided throughout.

Efforts to address flood resilience can be broken into five categories:

- Plans - Documents that outline issues and establish policies and propose actions to address those issues.
- Practices and Programs – Represent best practices, studies or programs that the City implements to reduce flood risk and increase resilience and/or to help prioritize efforts.
- Regulations – Specific requirements that the City is required to follow or that the City requires of its residents/businesses.
- Projects – Actions to address flooding issues and increase resilience
- Funding – Providing monetary resources to execute work.

This section concludes with a gap analysis of current efforts and the City's vision to become more flood resilient.

6.1 PLANS

There are existing City planning documents that have undergone extensive authorship, editing, review and approval processes that have a bearing on flood resilience. The universe of documents evaluated in this section include only those documents that have been approved by City Council for adoption; other planning-type documents that have not been approved by Council are found in Section 6.2 - Practices and Programs, as these documents are primarily for internal use and prioritization of projects and are subsidiary to any Council-approved Plan.

6.1.1 City Plan 2040

The City Plan 2040[16] is the City's Comprehensive Plan adopted in 2020 and provides a broad vision for the ideal future for Roanoke with recommendations for implementation over the next 20 years. The City Plan enumerates ideas, themes, design principles and land use principles at a high level and provides a pathway for implementation.

With respect to flood resilience, one of the themes that Roanoke's City Plan for 2040 promotes is "Harmony with Nature", described as "resilient practices for a resilient environment that nurtures

[16] https://planroanoke.org/city-plan-2040/

community health and protects natural resources." Some of the practices mentioned in this City Plan that directly relate to flooding are:

- Adapt the City's approach to stormwater management with climate change in mind.
- Promote regional collaboration for stormwater and flooding goals and develop a comprehensive approach to floodplain management.
- Promote green infrastructure.
- Improve stormwater management for all development projects.
- Improve conditions of the Roanoke River.
- Promote tree stewardship by increasing tree care, increasing the percentage of tree canopy, and community education in the city.
- Sustainable land development involving policies and codes to support green building, incentivize pre-existing development to adapt green features, and reduce impervious surfaces.

Another key theme is "Interwoven Equity' and also corresponds with this plan's focus on addressing flood resilience needs of all parts of the locality, especially underserved populations. Practices identified within the plan are:

- Equity involves the fair distribution of investments and services and the removal of institutional or structural policies that can be barriers to success.
- It is crucial that services are provided equitably and in ways that are accessible to all residents.
- Provide financial resources in neighborhoods that were formerly redlined.
- Provide quality education for all residents.
- Provide supportive interventions strategically.

Overall, the ideas, themes and action items enumerated in the City Plan are highly consistent with the five key principles of flood resilience in this Resilience Plan.

6.1.2 Downtown Roanoke Plan

The Downtown Plan (2017) was created to enhance and direct public and private sector investments in Roanoke's downtown area and to identify policy and actions towards those goals. The plan recognizes that Downtown was built above a channelized stream (Trout Run) and springs/marshland. Policies to make Downtown more flood resilient are like those in City Plan 2040 and are as follows:

- "POLICY 2-G: Support appropriate floodplain management".
- "POLICY 2-H: Reduce flooding by encouraging stormwater and green infrastructure projects in downtown".
- "POLICY 2-B: Repair voids in the streetscape and improve the pedestrian realm, while supporting infill development".

A more detailed flood study has been completed since the adoption of Downtown Plan 2017 and that information is currently being adapted into new FEMA maps expected in 2025. Downtown is an area where flood resilience can best be improved through public and private initiatives. Projects identified in the flood study can remove bottle necks and achieve some detention to help manage the current 25-year storm event. Private property owners can further enhance their resilience with adaptations and protections such as flood shields that can be deployed during large storm events.

6.1.3 Climate Action Plan

The City's Climate Action Plan for 2015-2020 (n.d.) identifies a broad range of policies to reduce the City's emissions of greenhouse gasses and reduce the impacts of climate change on the City. This document included the current status summary and recommended goals and targets to:

- "Promote and strengthen green infrastructure and natural systems".
- "Sustain and enhance the integrity of the Roanoke Valley water resources and waterways through innovative water management practices".
- "Work to ensure sustainable land use and urban development".
- "Continue to expand the urban tree canopy and achieve an equitable percentage of tree canopy across residential neighborhoods, City parks, street medians, school properties".

6.1.4 TMDL Action Plan (revised September 2022)

The Action Plan speaks to the City's MS4 permit and provides information on the effects of sediment loading caused in part by stormwater runoff. It also outlines the City's processes to address pollution in its impaired streams. Water quality efforts focus on reducing the volume of stormwater runoff from smaller storms affecting sediment load. Reducing runoff and sediment deposition reduces risk from flooding, at least during smaller storm events, and potentially larger storms if sediment block stormdrain systems.

6.1.5 Urban Forestry Plan (2003)

This document provides a more in-depth look into the City's urban canopy and discusses how trees and vegetation can help to mitigate flooding.

6.1.6 Parks and Recreation Master Plan

The **Parks and Recreation Master Plan (2019)** – With plans to be updated sometime this year, this master plan report highlights the current and planned park systems, which includes green spaces, greenways and trails. The City works with planners, consultants, and residents to improve tree canopy, innovative use of impervious surfaces and natural vegetation, and promotes a more fostering relationship to local rivers with sustainably designed access (City of Roanoke, 2019). All of these factors can help to inform the current and future direction of flood planning within the City.

6.1.7 Neighborhood Plans

A helpful resource in conceptualizing future urbanization, neighborhood and area plans have been written and are at various stages of implementation since 2002 (City of Roanoke, 2020). These plans depict finer details of the greater land use vision of the City as a whole and can give us a glimpse of future resiliency measures in the form of stormwater improvements, streetscape improvements (involving the use of more street trees), and recommendations of more green space.

6.1.8 City-Wide Brownfield Redevelopment Plan

City-Wide Brownfield Redevelopment Plan (2008) – Adopted by the City in 2008, this plan informs the Roanoke River Corridor, amongst others, on implementation of green space development and promotes more efficient land use in areas that likely contain brownfield sites. A brownfield is a property,

redevelopment or reuse of land which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant (EPA, n.d.).

6.1.9 Roanoke Valley Greenway Plan (2018)

This plan incorporates surrounding municipalities and localities that assess the current interconnected greenway routes of the Roanoke Valley and reports progress on goals for development and improvements, compared with the originally Conceptual Greenway Plan from 2007 (Roanoke Valley Greenways, 2018). The improvement of greenways and trails within the City helps to inform progress of new green space and natural trail innovation against the challenges of development.

6.1.10 Various Flooding Impact Documents

Helpful research and analysis pertaining to the preparation of flooding events is the City's Repetitive Loss Area Analysis, issued in 2021. This analysis provides community members with information about the National Flood Insurance Program's Repetitive Loss Areas per FEMA criteria, the Community Rating System (CRS), and project recommendations to help reduce the effects of these Repetitive Loss flooding areas. Similarly, Roanoke Valley's Alleghany Regional Hazard Mitigation Plan, issued September 16, 2019, captures past flood events, provides CRS and Repetitive Loss statistics, provides past flooding data, and provides a comparison of this data to Roanoke County and several neighboring counties.

The City of Roanoke not only informs the public of how to stay prepared for flooding events but has its own internal and-state approved procedures in place when a hazardous flooding event occurs. In 2022, Roanoke approved an updated "Basic Plan" Emergency Operations Plan that describes the City's hazard vulnerabilities, including flash flooding, and the distribution of City and agency-based responsibilities in case of an event. Like the Basic Plan, two annex documents were issued by the City relating specifically to flood emergency response. The Flood Incident Annex was aimed at describing public health and safety measures in the event of flooding such as training, equipment, and technology involved in an emergency process. For dam flooding or failure emergencies, the Dam Safety Support Annex determines procedures for evacuation of downstream residents if there is imminent or impending dam failure. The Western Virginia Water Authority is also responsible for preparing an Emergency Action Plan applicable to dams throughout the Western Virginia Region.

6.1.11 Summary

The existing planning documents summarized in this Section represent a significant body of work directing the City's efforts towards major themes, ideas and principles. Together the results of the City's flood resilience planning and study cover the entirety of the City's watersheds.

In general, the five key principles of flood resilience presented in Section 5 of this plan already appear in existing planning documents in various forms. However, as the scope and level of specificity of these other plans varies widely, the value of this Resilience Plan is that it collates flood related ideas that are already enumerated in other existing documents into a single document which can then provide helpful categories to scope and direct specific projects to make progress towards the high-level goals and ideas. With that in mind, several construction projects and technical studies are proposed in Section 7 to advance the themes that were already approved in other planning documents but are repackaged here with a focus on flood resilience.

6.2 Practices and Programs

Protocols and programs help to create structure for City staff for implementation of flood prevention and mitigation strategies and also provide guidance when flooding and the associated hazard of an event

impacts the community. Roanoke continues to advance flood resilience through the issuance of these various procedures, protocols and policies as seen in the City's development procedures, and their flood-related protocols. This continuously evolving process demonstrates that stormwater management and flood prevention remain high priorities for Roanoke.

6.2.1 Flooding Assistance Protocols

The City has established flooding assistance protocols to safeguard its residents during flood events. The first step of flooding assistance is keeping the community informed of the flooding event. The City has provided public information and outreach to the community regarding severe weather preparedness and preparation, in addition to more in-depth hazard information that can be found in the Roanoke Valley-Alleghany Regional Hazard Mitigation Plan. The City maintains several flood warning gauges throughout the City – known as the Stream Hydrology and Rainfall Knowledge System (SHARKS, see also Section 6.2.4) – and uses the Star City Alerts system to issue important warnings[17] Additionally, information on evacuations and designated shelters for displaced individuals have been published on the City's website. After a flood has occurred, federal flood relief support for the City has been established through the City's participation in the National Flood Insurance Program (NFIP) and Community Rating System Program (see next section for more details).

6.2.2 FEMA Community Rating System Program

FEMA provides flood mitigation and flood event relief assistance through federal grants and programs, one of these is the National Flood Insurance Program's (NFIP's) Community Rating System (CRS). The CRS is a national flood readiness rating system that identifies various best practices that a locality can implement to improve responsiveness to flood events and reduce the impacts of floods when they occur. Based on the City's participation in this program, property owners receive discounts for NFIP insurance premiums. A few examples of flood risk reduction activities that contribute to a community's CRS score are:

- Requiring permits that assess if new development is located within flood-prone areas
- Requiring that new or improved developments are elevated above "base flood level"
- Ensuring proper flood-proofing measures are in place for new or improved development within certain zones
- Ensuring the "prohibition of encroachments" for any kind of development within a floodway (with a few exceptions)
- Ensuring that the central portion of a riverine floodplain carries deep and fast-moving water
- Enforcing requirements to protect buildings from intense rainfall and storm surges
- Ensuring that all other permits associated with new development have been approved

The CRS ranks participating communities on a 1-10 scale, with 1 designating the highest level of effort with respect to floodplain management and risk mitigation. As of October 1, 2023, the City will advance from a Class 7 to a Class 6 community, which will provide a 20% discount for properties within the

[17] https://www.roanokeva.gov/2788/Star-City-Alerts

SFHA and a 10% discount for properties outside of the SFHA[18]. This advancement was the result of improved floodplain management activity and the documentation thereof by City staff.

6.2.3 Watershed Master Plans

The City's Stormwater Division was formed in 2014 to address issues related to flooding and water quality in the City, and at the time of its inception a strategic plan was needed to (1) summarize the numerous regulatory requirements related to stormwater; (2) characterize the City's streams and watersheds based on data to-date; (3) propose a portfolio of projects that would lead to improved water quality and reduce flooding. As such, the Division funded Watershed Master Plan (WMP) documents that provided guidance to this end, though it is important to note that these documents are internal strategy documents only and have not been through a public engagement or Council review process.

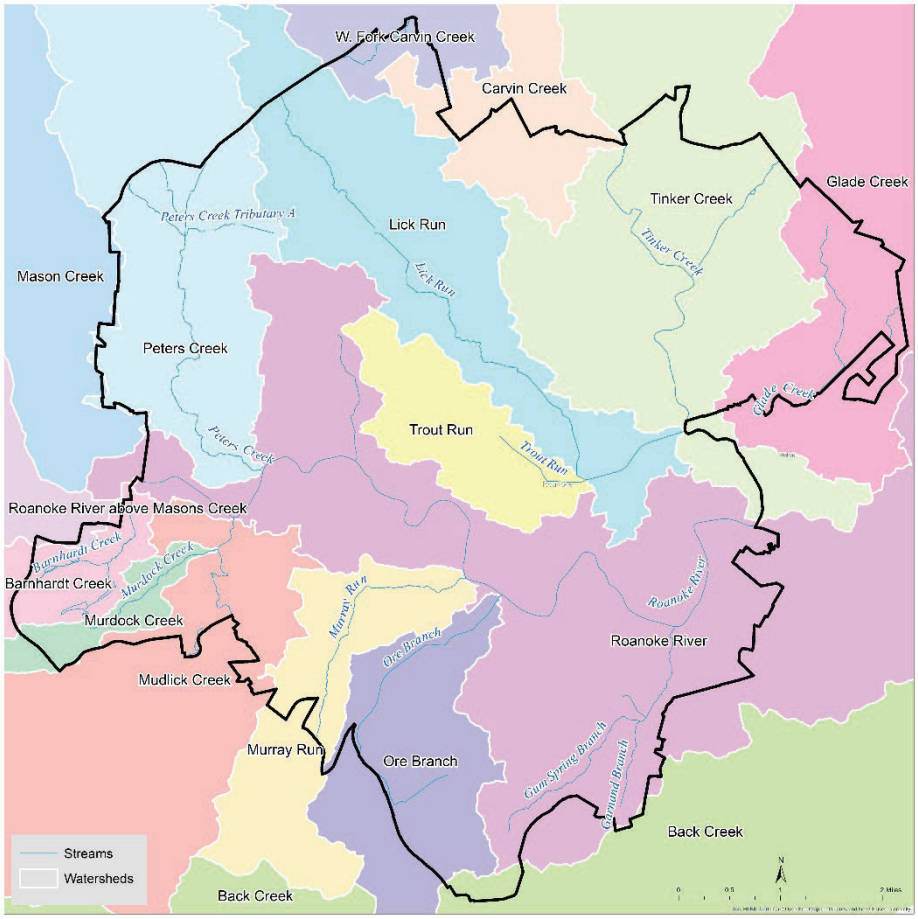

Figure 8 - City of Roanoke Watershed Map.

[18] The City had been a Class 7 community since 2008, which provide 15% and 5% discount for properties within and outside the SFHA respectively.

These plans focused on individual watersheds or groups of watersheds, and thus far plans for Lick Run, Trout Run, Carvins Creek, Tinker Creek, Glade Creek and Peters Creek have been completed. More recently, staff have changed the strategy to evaluate projects across all watersheds in a single plan, as this would allow for a comprehensive City-wide project identification and ranking system. In general, the principles and objectives of the WMP documents are consistent with the five key flood resilience principles in this Plan; the WMP goals are copied verbatim below for reference:

1. **Maximize watershed resiliency and sustainability**
   A. Restore more natural surface water processes (abiotic hydrology, geomorphology, and chemistry)
   B. Revitalize ecosystem health (biotic species habitat and diversity)
   C. Augment capacity to endure and recover from short term hazards (drought and flood)
   D. Enhance adaptability to long-term hazards (land development and climate change)
2. **Minimize watershed hazard to public health, safety, and property**
   A. Prioritize and construct Capital Improvement Projects that both mitigate neighborhood flood hazards and improve downstream water quality (ISI Envision checklist)
   B. Increase Community Rating System (CRS) ratings for progressive floodplain management activities
   C. Delist from the 303(d) report all impairments including bacteria, sediment, PCBs, and Mercury in fish tissue
3. **Connect residents, businesses, students, and other stakeholders to their watershed**
   A. Provide the community with life-long learning opportunities about their watershed (natural processes, ecosystem health, and pollution prevention)
   B. Engage the community in revitalizing watershed ecosystem health (BMPs, green infrastructure, and low impact design)
   C. Coach the community to participate in outdoor recreation and stewardship opportunities within their watershed

As the goals of the WMP are similar to and consistent with the principles enumerated here, the projects that were proposed in the WMPs are also generally consistent with the principles here. However, one important gap in the WMPs is that the proposed projects were identified and prioritized based on hydrologic and water quality assessments and the WMPs did not explicitly consider social vulnerabilities or equity in the planning scheme. Another shortcoming of the WMPs is that they use GIS analysis to identify potential projects, but do not leverage hydraulic/water quality modeling or structural condition assessment information as these data were not available at the time the WMPs were written.

6.2.4 Flood-Related Community Education, Outreach and Engagement

The City prioritizes community engagement, education and outreach as part of building a resilient City for those that live, work, learn, and play in the City of Roanoke. This Resilience Plan is only part of the ongoing efforts the City has undertaken for community engagement. A variety of engagement tools or strategies are utilized to help residents connect with and help shape their own community including councils and committees, educational events or programs, and curated outreach materials. See Appendix C for a more detailed summary of the City's outreach and educational efforts.

6.3 REGULATIONS

Like all municipalities and localities, the City of Roanoke is subject to regulatory measures that aim to protect, and improve the well-being of its residents, infrastructure, and the environment. Fortunately, local, state and federal regulations are intersecting with flood resiliency objectives increasingly as our society begins to see the importance of natural events amidst the built environment.

The City's Zoning Code (Section 36.2 of the City code) plays a major role in how land is developed in Roanoke and includes provisions to promote flood resilience and the conservation of open space along the Roanoke River and its tributaries. This is strongly demonstrated in Roanoke's Floodplain Overlay District and River and Creek Corridors District ordinances, as well as in general development standards that apply to all projects.

6.3.1 Floodplain Management

As previously described, Community Rating System and NFIP are two federal programs under FEMA that assists Roanoke through federally back flood insurance and discounted rates based on applying best practices. While participation in these programs is voluntary, they are important as they:

- Provide a significant risk-management tool for property owners in the floodplain through flood insurance
- And significant cost savings on that insurance based on the federal backing and CRS discounts.

The NFIP Community Rating System Repetitive Loss Area (RLA) Analysis has been instrumental in visually depicting the City's RLAs and providing recommended property owner actions to mitigate flood risk. Although this analysis directly targets these RLA regions, flooding or mitigation measures in the form of specific project recommendations were not specified. Generalized recommendations include redeveloping structures with higher elevation, utilizing flood proofing techniques, improving road drainage, and planning additional stormwater infrastructure within certain RLA regions (Roanoke Stormwater, 2021). The City of Roanoke has extracted these recommendations and assessed the logistical feasibility of implementation within certain RLA regions.

By participating in the NFIP, the City uses the FEMA Flood Insurance Rate Maps (FIRMs) as the primary tool to assess flood zones and flood elevations. The FEMA regulations associated with the NFIP includes minimum standards related to development in flood zones, such as building elevation and flood proofing standards. It should be noted that the Uniform Statewide Building Code requires construction consistent with FEMA and related standard. FEMA regulations are administered at the state level by the Virginia Department of Conservation and Recreation (DCR) and at the local level through the City's Zoning Ordinance at Section 36.2-333. - Floodplain Overlay District.

The Floodplain Overlay District (i.e. the "floodplain ordinance") reinforces the basic principles of FEMA's NFIP federal program, defining flood zones based on the applicable FIRMs designating how often a flood may occur in that area, what kind of flooding may occur, and to what extent. The section outlines the minimum standards of the NFIP including:

- Standards for flood proofing and/or elevating new structures.
- Requirements for improvements to existing structures (to bring those structures into NFIP compliance or closer to compliance).

- Criteria to limit filling/encroachments in the floodway.
- Requires that decisions related to development are based on the height of a 1-percent chance storm (100-year storm).
- Requirements for substantial improvements to structures in the floodplain.

The Floodplain Overlay District includes provisions that are more conservative than the NFIP program such as:

- Requires structures be elevated or flood proofed to two feet above base flood elevation (free board).
- Restricts permitted uses in the floodway, the most flood prone portion of the flood plain with typically the highest flow velocity.
- Requires substantial improvement determinations be evaluated based on work over a five-year period.

These more restrictive regulations help to reduce the potential for a rise in flood elevation from placing fill in the floodway and the free board requirement provides some safety to structures should fill occur and allows some factor of safety for increases in rainfall or storm events that are larger than the current 1-percent chance storm.

A permit from the Zoning Administrator is required for all development occurring within a flood zone. These permits require various types of information including site plans, flood elevation data, and sometimes verification from a licensed surveyor or engineer in order to be accepted. The permit is then reviewed and approved by the City before the development can proceed. Detailed procedures for floodplain review including substantial improvements are enclosed as Appendix B.

6.3.2 Stormwater Management

The City of Roanoke's stormwater management program is regulated and implemented through programs that are derived from the federal Clean Water Act and administered through the Virginia Department of Environmental Quality (DEQ). These programs include:

- Municipal Separate Storm Sewer System (MS4) - regulates City owned and operated stormwater infrastructure and permits discharge from the City's MS4 into the Roanoke River and its tributaries.
- Virginia Stormwater Management Program (VSMP) - provides standards for managing stormwater quantity and quality at land development sites once construction is complete
- Total Maximum Daily Load (TMDL) - designates specific pollutants of concern and requires the City to report steps taken to reduce transport of these pollutants into waters of the United States in the City's annual MS4 permit report and TMDL Action Plan.

The MS4 program is a water quality program and is not specifically focused on flooding, though it is well understood that a reduction in stormwater runoff magnitude, volume and frequency improves both water quality and reduces flooding. The City's MS4 permit requires demonstration of progress towards six programmatic Minimum Control Measures (MCMs) designed to reduce stormwater pollutant loads into the MS4. Three of these MCM are largely requirements of the City to Provide public education and outreach (MCM #1), public participation (MCM #2) and to carry out good housekeeping in municipal operations (MCM #6).

The other three MCMs are outward facing. MCM #3 relates to illicit discharge detection and elimination. This is regulated through Chapter 11.3 - Stormwater Discharge Requirements of City code. This section restricts non-stormwater discharges into the City's MS4 and provides penalties for violations. While illicit discharges may be associated more with pollution (e.g., allowing chemical to flow into a drain), dumping debris and trash into drains can create flooding issues. Such debris, sediment or material can clog drains that leads to flooding conditions.

MCM #4 and #5 relate to managing runoff from construction activities and then maintaining and installing stormwater management facilities at new and re-development sites. This is administered through the City's adoption of the VSMP (Chapter 11.6 - Stormwater Management of City code). The most important element of the VSMP with respect to flood resilience, is the requirement that downstream channel adequacy be evaluated, and that detention is provided to manage downstream erosion and flooding. These requirements apply to development sites that disturb more than 10,000 square feet of area. These facilities are periodically inspected to make sure they are properly maintained. Reducing runoff from property as it is developed or redeveloped is an important element of the City flood resilience.

The final pertinent stormwater management program is the TMDL program which limits the amount of sediment, bacteria and an organic chemical known as polychlorinated biphenyls (PCBs) that can be discharged to the Roanoek River and its tributaries. The City is required to reduce the presence of sediment, bacteria, and PCBs and to annually report progress towards meeting these goals in an annual MS4 report. As previously noted, efforts to improve water quality align with flood resilience goals of reducing the amount of runoff.

6.3.3 Erosion and Sediment Control

City Ordinance, Chapter 11.7 - Erosion and Sediment Control focuses on the control of soil erosion and sediment transport during construction and related activities that disturb more than 2,500 square feet of land. As with the City's stormwater management regulations, this program derives from state and federal regulations. The disturbance of land leaves exposed or stockpiled soil and similar materials exposed to runoff that can carry the material into the storm drain system and on to the Roanoke River or its tributaries. Sedimentation can affect water quality (impair habitat for fish and insects) and can also accumulate and create clogs or flow constrictions that can create or exacerbate flooding conditions.

6.3.4 Riparian Buffer Standards

The City's Zoning Ordinance, Section 36.2-335 - River and Creek Corridors District (RCC) establishes development standards for the protection/re-establishment of riparian buffers along the Roanoke River and its tributaries, where mapped (not all tributaries are mapped as part of this district). This section contains rules that establishes riparian buffers in mapped areas where the district applies. The intent is to primarily protect water quality and has the benefit of limiting fill and disturbance in buffers that typically coincide with the floodplain. This provision serves to maintain or reestablish natural functions along the Roanoke River and its tributaries and helps reduce flooding through natural vegetation and buffers and encourages proper soil drainage and decreased impervious surface cover through limited and strategic land use.

6.4 PROJECTS

This section presents the five broad categories of flood resilience projects that the City currently undertakes and is likely to continue to implement under this plan. These types of projects are listed in the following Table with brief description of the type of work and examples of recent completed projects.

It is important to note that project scopes can be broad and can fit into more than one category. An example is the recent acquisition and demolition of the former Ramada Inn on Franklin Road. That project falls into the acquisition and demolition category. The project also includes restrictions on land use and a future phase of work to further enlarge the flood plain on the property. That part of the work falls into the land preservation and restoration category. There are other instances where projects could fall into multiple categories, such as:

- Acquisition of a highly flood prone property with the intent that the flood prone structure could be removed and the property redeveloped in a more resilient fashion (Acquisition and Demolition and Adaptation).
- Constructing traditional storm drain systems that include bioretention area, vegetated swales, etc. to reduce runoff (Gray and Green Infrastructure)

Acquisition and Demolition	
Description	*Recent Examples*
Acquisition of highly flood prone property, typically repetitive loss, and the demolition or removal of structures form the property to remove flood risk.	• Ramada Inn property acquisition • Cee Breeze property acquisition • Property acquisition along Garnand Branch, Peters Creek and Mud Lick Creek.
Land Preservation and Restoration	
Acquisition of property or easements to protect open space that is valuable for future flood resilience. Typically, this is flood plain and riparian areas along the Roanoke River or a tributary. The intent is to remove obstructions, high-risk structures, and restore flood storage capacity, thereby reducing flood risk.	• Stream restoration on Lick Run at Washington Park, Highland Farms and Blacksburg Roanoke Regional Airport • Glade Creek Stream Restoration • Peters Creek Constructed Wetland • Roanoke River Flood Reduction Project (property acquisition and bench cuts) • Property acquisition along Garnand Branch, Peters Creek and Mud Lick Creek. • Cee Breeze and Ramada Inn property acquisitions and restorations.
Adaptation	
Includes a range of measures to protect new or existing structures from flooding or reduce the risk from flooding	• Flood proofing measures at the City Market Building • Roanoke River Flood Reduction Project – berms/training walls

Green Infrastructure	
A wide range of practices for encouraging infiltration and/or collection and reuse of stormwater. Measures can range from a rain barrel to park land that functions as a stormwater facility.	• Permeable pavement/paving systems on Bullitt Avenue at Elmwood Park, Norfolk Avenue at the Amtrak platform, Raleigh Court Library parking, Garden City Greenway • Bioretention/bioswales at Williamson Road Library, and Fire Station 3 • Green Roof at Municipal Building • Narrows Lane channel improvements • 24th Street drainage improvements (permeable pavement)
Gray Infrastructure/Traditional Engineering Practices	
Traditional storm drainage facilities such as pipes, ditches and basins.	• Sample/Crown Point, Westover Avenue, Templeton Ave, and Sweetbriar Ave drainage improvements • Deyerle Road drainage improvements (hybrid, includes a natural channel along with a piped conveyance • Chapman and 19th Drainage Improvements (include bioretention area along with traditional drainage measures)

Special considerations apply when the City considers acquisition of property for flood mitigation purposes, either for demolition or for preservation purposes. Broadly, there are two mechanisms the City can use. One would be an involuntary acquisition through a condemnation process. It is unlikely that the City would take such an approach and determining the acquisition price would be subject to federal and state requirements to ensure that compensation is fair and equitable.

Generally, the City acquires food prone property through voluntary acquisition working with property owners who are willing to sell. In developing an offer for such property, the City evaluates the property including land area, type of structures and condition of the property and structures to assess the value. From there, a price is negotiated with the owner. If the City and owner come to a mutually agreeable price, the acquisition can move forward. If a property is occupied by a tenant, federal relocation practices are followed to make sure the tenant has access to equivalent, safe housing.

Voluntary acquisition at a mutually agreed price is consistent with the City's vision of interwoven equity and being fair in our processes. Appendix D contains the Stormwater Division’s standard procedures for property acquisition.

6.5 FUNDING

To create a sustainable funding source to address issues related to stormwater management and flooding, the City created a Stormwater Utility. The utility is funded by a dedicated stormwater utility fee as outlined in Chapter 11.5 - Stormwater Utility of City code. The Stormwater Utility is a Division of the City’s Department of Public Works and the fee provides the utility with a dedicated funding source to carry out its work which generally includes mitigation of flooding, improvement of water quality and maintenance of the storm drain system. The fee provides operating budget that allows for progress

towards these three goals, compliance with regulations described in this Section, equipment, planning and research, etc.

It is important to understand that the fee only provides a small amount of funding for capital construction projects – these are typically funded using bonds leveraged with external grant funding. The Stormwater Utility's current budget for capital projects includes $3,500,000 in cash and bonds with a goal to match that with grant funds for a targeted capital budget of $7,000,000/ year. Typical grant programs include:

- Virginia Department of Transportation Revenue Sharing – improvement related to City streets and runoff to/from streets (addresses localized flooding issues)
- DEQ Stormwater Local Assistance Fund – Water quality projects including stream restoration that can preserve and restore floodplain areas and provide for other improvements.
- FEMA Hazard Mitigation Grant Program – Allows for acquisition of highly flood prone property and other related projects to reduce flood hazards.
- FEMA Building Resilient Infrastructure and Communities program – Allows for various projects that reduce flood risk through a wide range of project types.
- DCR CFPF grants - Allows for a wide range of projects to reduce flooding and increase resilience.

The fee itself is based on the total amount of impervious cover on a given parcel and the fee structure also includes a credit system which allows fee payers to reduce their annual fee by implementing flooding or water quality best practices on their parcel. The credit program and outreach and education efforts can lead to reductions in runoff that can become significant as these practices become accepted/adopted in the community.

In general, the structure of the fee and the operations of the Stormwater Utility is consistent with the five key principles provided in this document, and it is likely that most of the proposed flood resilience work will be carried out by staff in the Utility. The Utility's operating budget is reviewed as part of the City's annual budget adoption process. The operating budget is based on expected revenues and services needed to meet regulatory requirements, debt service and overarching City goals.

The Utility's capital improvement program identifies large construction type projects, such as those listed in Section 6.4, that will be undertaken in a five-year window. The CIP outlines expected capital expenditures over the five-year window and the projects that are expected to be executed. The operating budget and CIP are both reviewed and approved by City Council.

As noted earlier in this plan, the backlog of stormwater related projects is substantial. To advance the City's vision of flood resilience. A holistic approach to managing stormwater runoff and improving flood resilience must be holistic. Projects, to the extent possible need to address multiple facets of stormwater management/flood resilience and be developed in a way that supports broader community growth as illustrated in the figure below. This mindset recognizes that there are often multiple engineering solutions to a problem. The methods that best addresses broad community objectives should be pursued.

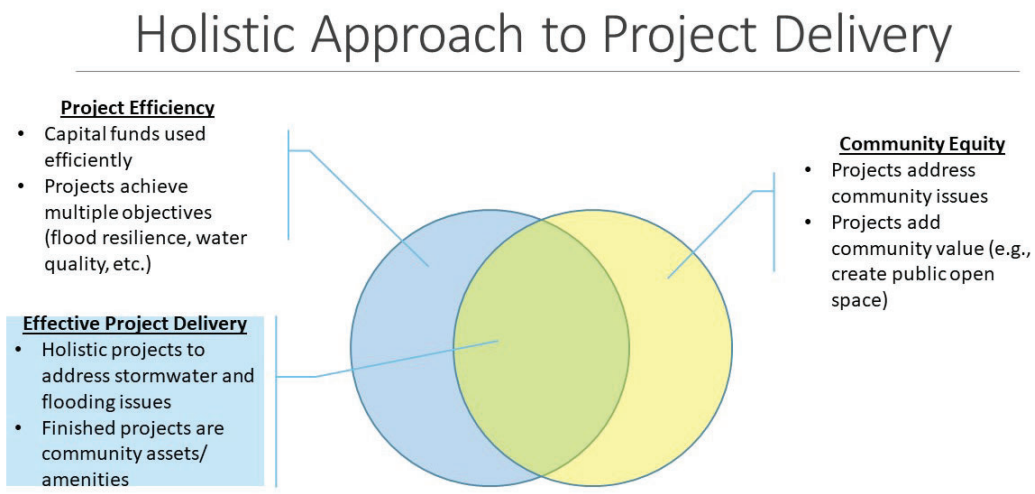

Figure 9 – City of Roanoke approach to Project Delivery.

6.6 Gap Analysis

Based on the City's vision and current efforts there are some logical next steps that can be considered. These efforts are outlined in the Table below with more specific recommendations in the following section. Generally, these gaps and next steps are logical extensions of implementing the recently adopted City Plan 2040, continuing to assess likely impacts of climate change and how that influences City programs and continuing to move forward with holistic stormwater projects to reduce flood risk.

Current Efforts	Gaps	Potential Actions
Plans	• City Plan 2040 and related planning documents outline broad strategies to increase flood resilience. Specific implementation steps need to be developed.	• Studies to define mechanisms to balance floodplain and riparian area preservation/restoration with urban development patterns and identify programmatic updates.

Current Efforts	Gaps	Potential Actions
Practices and Programs	• Monitoring efforts are ongoing with USGS and others. Identify means to use data for local predictions and decision making. • Watershed master plans completed for some watersheds, not all and currently do not incorporate climate change. • Assess outreach efforts for usefulness for all segments of the community.	• Continue working with partners (USGS, etc.) on predictive data tools and tailored decision making based on local data. • Continue to evaluate flood resilience best practices through the CRS program and programs of other localities and agencies. • Complete watershed master planning process for the City including assessment of climate change impacts. • Continue outreach efforts that maximize impact and usefulness for all segments of the community.
Regulations	• Regulations generally derive from state code requirements. These state codes currently do not account for climate change/increased rainfall/flooding.	• Assess options for accounting for climate change in regulatory programs balancing current and future costs and impacts.
Projects	• The City implements a wide range of infrastructure and other projects that can benefit flood resilience, ensure strategies are in place to program work in the Capital Improvement Program and have flexibility to take advantage of unexpected opportunities.	• Continuous assessment of ranking and selection criteria to ensure projects that have the most impact are implemented (multiple benefits for flooding, water quality, etc. And for impact on vulnerable communities) • Develop CIP to allow some flexibility to adapt to opportunities to address resilience (need funding sources, opportunities to partner with other entities, etc.)
Funding	• The backlog of stormwater management and flood resilience work is substantial compared the City's annual maintenance and capital budgets.	• Continue to assess project selection and scoping to maximize project value. • Assess a variety of funding sources to leverage City funds. • Look at programs and partnerships to ensure that development activities and day-to-day maintenance of property aligns with City efforts.

7. RECOMMENDED PROJECTS FOR FLOOD RESILIENCE

In this final section, studies, planning efforts and capital projects are proposed that will advance the City's existing efforts towards flood resilience consistent with the five key principles designated in this plan.

7.1 IDENTIFIED PLANS STUDIES AND PROJECTS

Several studies, plans and projects to improve the City's flood resilience are already identified and are listed in the summary table of projects describing the project and flood resilience benefits in general terms. Each project is evaluated against the five key resilience principles from this plan, and a cost opinion and estimated timeframe for each project is provided.

Proposed studies and planning efforts are based on broad recommendations from existing City policy, largely from City Plan 2040, that can be further developed into actionable measures. These studies and planning efforts may be funded through annual operating budget with potential support funds from grant sources.

Proposed projects include those specifically identified in the current Capital Improvement Plan (CIP) as well as other efforts that are more general. These general items include funds that are programmed for acquisition of flood prone properties and for green infrastructure work that can be incorporated as part of the City's annual street paving program (repaving), streetscape projects (construction of new curb, gutter and sidewalk), or other capital projects (e.g., new building construction).

7.2 INCORPORATING NEW PROJECTS, PLANS AND STUDIES

Much of resilience relates to being best prepared for events that can happen unexpectedly. While the City carefully plans its funding, unexpected opportunities do present themselves that need responses. Such items could include new project priorities identified in watershed plans, unexpected issues that arise that are not programmed into a capital program, an owner of a highly flood prone property that is willing to sell, or simply an opportunity to build flood resilience efforts into another effort or project. In these instances, the City needs to be prepared to assess these opportunities and act as appropriate. The following tables provide decision trees for assessing the type of work that may make sense and determining if the work is urgent or represents an opportunity that warrants a timely action or if the project should be ranked and programmed with other capital projects.

The following graphics provide guidance on how a new project can be assessed for programing into the City's CIP or considered for a quicker action when the opportunity to address an issue arises unexpectedly. The first tool (Figure 10) is decision tree for project screening and the second tool helps define when different approaches to a project can be considered.

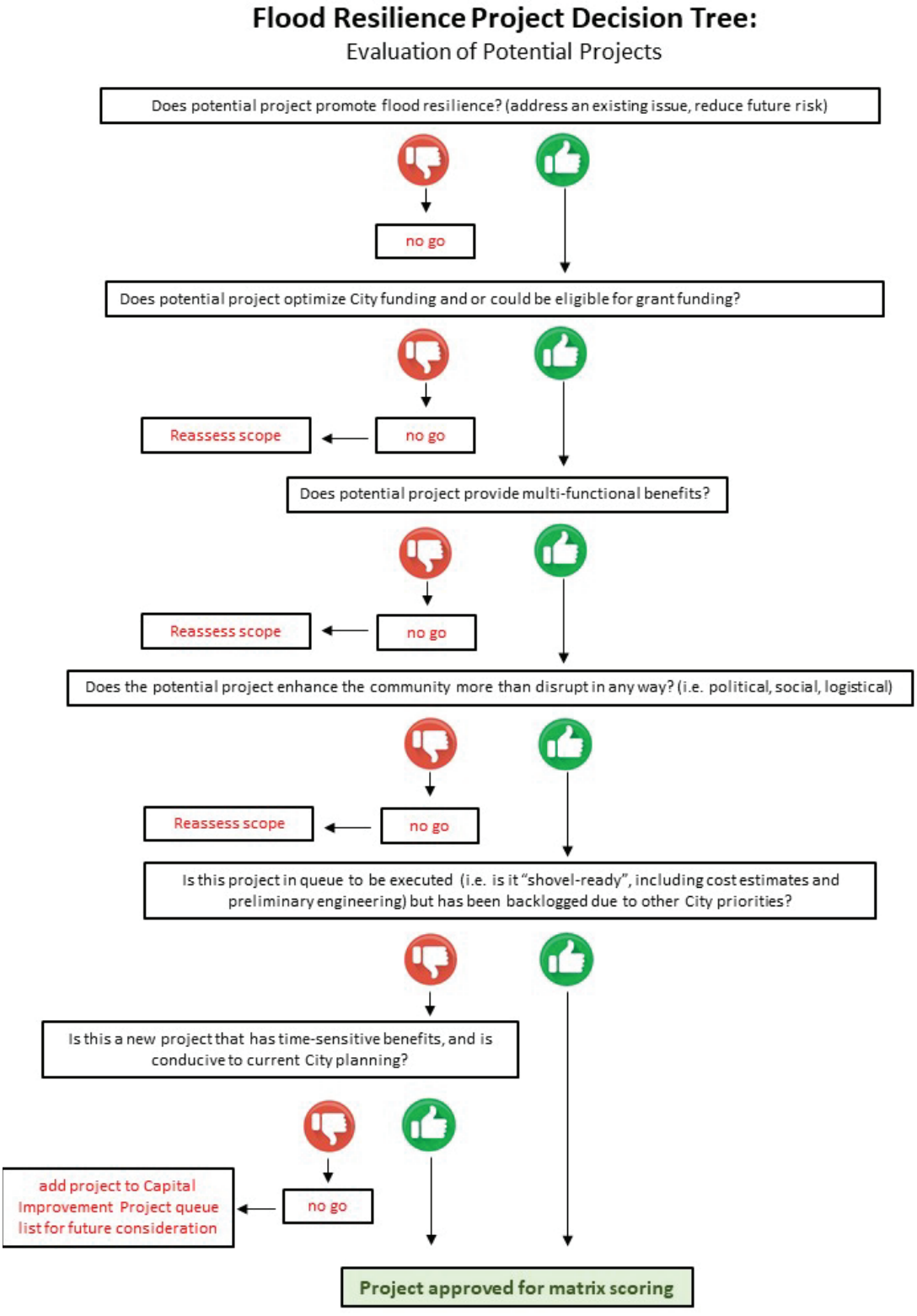

Figure 10 – Decision tree for guidance on how projects could be assessed for programming and City action.

Potential Project Scoping Decision Tree for Flood Resilience

Project Type	Evaluation Criteria	Descriptors
Acquisition and Demolition	Description	• Acquisition of property with the intent of demolishing existing structures
	Applicability	• Typically for areas of riverine flooding, may apply to other property with major drainage issues • Highly flood prone, protection/adaptation not feasible
	Other factors	• Potential for use of site after demolition – open space or possible reuse
	Who initiates Description	• Property owner or City may initiate a request • Acquisition likely by City when use is for open space • City or a private entity may initiate acquisition is there is a reuse option.
Land Preservation and/or Restoration	Description	• Acquisition of property or easement to protect open space that is valuable for future flood resilience
	Applicability	• Typically for areas of riverine flooding • Highly flood prone • High environmental value (flood plain or riparian area) • Low development/economic value (high risk)
	Other factors	• If structures are present, consider demolition if high risk or possible preservation if adaptation or protection is feasible. • Hybrid option could allow for preservation of high risk/high environmentally valuable areas while the balance of the property remains available for appropriate development. • Availability of nearby land to support community needs
	Who initiates	• Acquisition likely by City • Easement would be initiated by a land holder through the City or a third party.
Adaptation and Protection	Description	• Includes a range of measures to protect new or existing structures from flooding/reduce the risk from flooding
	Applicability	• Existing flood prone structures that have historic, economic or cultural value. • New facilities that are constructed in flood prone areas in a manner to minimize risk • Other structures that can be reasonably adapted to reduce flood risk.

Project Type	Evaluation Criteria	Descriptors
	Other factors	• Incorporation of protections that consider historic characteristics of a building • Maintaining neighborhood character/appeal
	Who initiates	• Typically building owner or developer to comply with development regulations, to reduce risk, and/or reduce insurance costs.
Green Infrastructure	Description	• A wide range of practices for encouraging infiltration and/or collection and reuse of stormwater. Measures can range from a rain barrel to park land that functions as a stormwater facility
	Applicability	• Scalable based on the space available and intended result • Work well in a compact, urban areas where space is at a premium • Protect existing infrastructure from increasing flows/reduce pollutant loads
	Other Factors	• Can be incorporated as part of most development projects when planned • Details of implementation can be tailored to preferences of immediate neighbors/community • Routine maintenance required to maintain function. • Can be designed to serve multiple functions (e.g., public space, landscape/aesthetics)
	Who initiates	• City as part of public infrastructure and public facilities • Property owners as part of development projects or retrofits
Grey Infrastructure / Traditional Civil Engineering Practices	Description	• Traditional storm drainage facilities such as pipes, ditches and basins.
	Applicability	• Issues related primarily to capacity and volume. • Drainage problem that can be readily solved by connecting to an existing storm drain system (e.g., adding an inlet along an existing drain) • Undersized infrastructure causing property damage • Tight spaces limit other options.
	Other Factors	• Upsizing infrastructure can exacerbate downstream drainage issues/flooding
	Who initiates	• Generally, city initiated to address drainage issues. • Can be part of development or redevelopment projects

Table 4: Summary of Recommended Projects – LF = linear feet, ac = acre

Project	Description and Flood Resilience Benefits	Flood Resilience Principles	Cost Opinion	Estimated Timeframe	Priority
Capital Projects					
Acquisition and Demolition					
Peters Creek Rd. NW & North Rd. NW (PC-4)	Mitigate floodway structures through acquisition and demolition or relocation. Acquistion, abatement, and demolition of 7 structures and 1 outbuilding. All floodway properties. Large scale floodplain benching and riparian planting in the 3.5-acre open space.	1, 2, 3, 4, 5	$1,481,385	Potential	Score: 65
Land Preservation and Restoration					
Ore Branch Stream and Site Restoration	350 LF of stream restoration using natural channel design; 2.4 acres of pollinator meadow, tree plantings. Increase floodplain storage capacity; improve green space, tree canopy, stream ecology	1, 2, 3, 4, 5	$830,000	FY 2025	Score: 65
Garnand Branch Stream Restoration	1,000 LF of stream restoration using natural channel design; Increase floodplain storage capacity; improve green space, tree canopy, stream ecology; reduce stream bank erosion	1, 2, 3, 4, 5	$1,305,000	FY 2025	Score: 70
Peters Creek at Strauss Park Stream Restoration	2,100 LF of stream restoration using natural channel design; Increase floodplain storage capacity; improve green space, tree canopy, stream ecology; reduce stream bank erosion	1, 2, 3, 4, 5	$2,600,000	FY 2028	Score: 75
Countryside Riparian Buffer	1,200 LF of riparian buffer invasive species removal and tree planting along Lick Run within City-owned Countryside property, consistent with Countryside Master Plan	1, 2, 3, 4, 5	$75,000	Early Concept	Score: 70
Green Infrastructure					
Campbell Avenue Upper Watershed Improvements	Identify, design and build a combination of small detention storage, bioretention, permeable pavement, underground storage along Campbell Ave. west of Downtown to mitigate Downtown flooding at 25-yr. flood.	1, 2, 5	$9.5M	2030	
Luck Avenue Upper Watershed Improvements	Identify, design and build a combination of small detention storage, bioretention, permeable pavement, underground storage along Luck Ave. and Franklin Rd. south of Downtown to mitigate Downtown flooding at 25-yr. flood	1, 2, 5	$21M	2035	
Melrose Avenue Crossing Improvements	Study flooding at Melrose Ave @ Forest Park Blvd; design and build combination of detention storage, culvert upsizing, stream restoration to reduce roadway flooding and structure damages	1, 2, 3, 5	$3M	FY 2026	Score: 75
Moorman Avenue/Trout Run Green Infrastructure	Work with Gilmer and Harrison neighborhoods to identify projects along Trout Run to complement an upcoming streetscape project along Moorman Avenue. The streetscape itself will include bioretention areas and new trees. Additional wok could include day lighting parts of Trout Run and restoring portions of the floodplain/creating public spaces.	1, 5	$2-5M	2030	
Annual Green Infrastructure Projects	Install bioretention bump-outs; tree lawns and other green infrastructure coincident with annual street paving and streetscape projects; increase flood storage, improve water quality	1, 2 ,3, 5	$500K/yr.	Annual	Score: 75
Gray Infrastructure/Traditional Engineering Practices					
Salem Ave. & 1st Street “L-Tunnel”	Upsize 15 – 36" storm drain to 4’H x 6’W rectangular tunnel to reduce flooding in Downtown at 25-yr flood. Improve maintenance access; move primary drainage from present location underneath existing building.	1, 5	$2.0M	FY2024	Score: 60
Trout Run Watershed Detention Storage	Identify, design and build approximately 81 acre-ft of detention storage in Trout Run watershed; project will significantly mitigate Downtown risk at 25-yr flood; improve water quality; incorporate nature-based strategies	1, 5	$45M	2030 - 2050	
Shenandoah/Jefferson Diversion Tunnel	Divert runoff around core of Downtown by constructing 1,000 LF of new storm drain tunnel and repurposing existing pedestrian tunnel; mitigate Downtown risk at 25-yr. flood	1, 5	$12M	2025-2030	
Downtown Tunnel Operations Upgrades	Install nine oversized maintenance access vaults with sump pits at key hydraulic locations in Downtown tunnels to allow for safe entry and periodic removal of sediment, trash and other debris.	1, 5	$4.2M	2030	
Peters Creek Rd. NW & North Rd. NW (PC-4)	Mitigate floodway structures through acquisition and demolition or relocation. Acquisition, abatement, and demolition of 7 structures and 1 outbuilding. All floodway properties. Large scale floodplain benching and riparian planting in the 3.5-acre open space.	1, 2, 3, 4, 5	$1.5M	Potential	Score: 65
Technical Studies and Programmatic Approaches					
Watershed Master Plans	City wide master planning to replace original, individual watershed planning. City-wide master planning takes in account USGS and Virginia Tech research. Focusing on processes and project types that can applied to all watersheds. Effort may be coordinated with Neighborhood Planning efforts to evaluate land use, etc.	2, 3, 5	$80,000	Potential	Score: 75
Evaluation of Floodplain, Riparian Buffer and Other Land Preservation Practices	Evaluate flood prone lands across the City including floodplains and associated riparian buffers to assess a range of practices to preserve and/or restore such areas, where possible. The study would consider various economic impacts and land use and development practices to support flood reduction through the beneficial effects of managed flood plains and buffers and balanced needs of our urban community. Evaluate the economic, social, and environmental impacts and potential hydrologic effects of applying different land conservation policies.	2, 3, 5		Potential	Score: 75
Evaluate Predicted Precipitation and Design Practices and Standards	Evaluate predicted rainfall and determine how that impacts our current design standards, practices and regulatory programs. Identify options to consider for how those standards, practices and programs can be updated so that planning efforts, infrastructure and development is resilient considering future rainfall and flood potential. The effort could include a review of the City’s infrastructure to assess bottlenecks and flood potential under increased	5			Score: 70

	rainfall to further assist in decision making with infrastructure and development. The study could provide an economic evaluation of short-term cost of improvements compared to long-term costs associated with increased rainfall and flooding.				
Evaluate Land Management/Green Infrastructure Strategies	Evaluate the costs and benefits of strategies that can be used to minimize impervious surface while encouraging resilient, compact urban development in the City. The evaluation would look at options to encourage use of applicable practices and would cover a wide range of actions from increasing tree canopy to various urban BMPs based on natural processes or collection and reuse of harvested water. The study would look at example programs in other jurisdictions and how they were implemented.	2, 3, 5			Score: 70
Review Stormwater Utility Fee Credit Program	Evaluate the utility fee structure to determine if the credits reward efforts that provide the most benefits for water quality and runoff reduction. In particular credits for the protection/restoration of riparian buffers or conversion of paved surfaces and manicured lawns to natural cover (land cover conversion).	2			Score: 70

*DCR Criteria: (1) Project-based, focused on flood control and resilience; (2) Incorporates nature-based infrastructure; (3) Enhances social equity; (4) Includes local and inter-jurisdictional coordination and a schedule; (5) Based on climate change science.

**In Progress indicates a project has already been approved by the City and is in various stages of completion: planning, design, or construction.

7.3 Construction Projects

There are several specific construction projects evaluated in this plan. These projects advance the City's flood resilience goals and are already identified in the Stormwater Utility's capital improvement program and/or in watershed master plans. New projects are regularly identified based on watershed studies, resident complaints, opportunities to collaborate on other City projects etc. This section provides more detail on currently identified resilience projects and further describes how future projects will be assessed for feasibility/inclusion in the Resilience Plan and the City's capital improvement program/processes.

Figure 11 – Map of projects currently identified for resilience. Summary of each project in Section 7.1.1.

7.1.1 Existing Construction Projects that Advance Resilience Objectives

Demolition/Acquisition

Peters Creek Rd. NW & North Rd. NW (PC-4)

Peters Creek is subject to flash floods and repetitive losses at Peters Creek Road, NW and North Road, NW, an area with moderate to high social vulnerability. Peters Creek has 26.9% tree canopy and very few parks and greenways to help absorb floodwaters. There are 9 commercial structures, including a car repair business, located in the 100-year floodplain (1% annual chance flood), and at least one business has closed due to flooding in this

area. At least one privately owned building has a connected structure that is dangerously close to an eroding stream bank. A nearby City-owned Fire/EMS facility is also affected by flooding.

The City plans to seek funding to mitigate floodway structures through acquisition and demolition or relocation. Acquisition would allow for future floodplain benching and riparian planting in a 3.5-acre open space. A gray infrastructure project is proposed at the 1600 block of Peters Creek and North Road to upsize the existing drainage system and relocate new inlets at ponding locations and recreate the roadside ditch along North Road to maximize runoff capture. This project is in the preliminary design phase and no project date has been established yet. Note - The City is currently underway on a project just upstream of this area which will increase floodplain storage capacity and ecological function in the area north of the confluence of Peters creek and Tributary B.

Preservation and Restoration

Ore Branch Stream and Site Restoration

Ore Branch is a flood-prone river, and Wiley Drive is a flood-prone road in an area with low to moderate social vulnerability. Stream and site restoration on Ore Branch, upstream of Wiley Drive, will support flood protection efforts, reversing some of the negative effects of development on biodiversity and downstream receiving waters. The riparian corridor improvements will add additional tree canopy, greenspace, and improved habitat for terrestrial and aquatic species. To help reduce repetitive flooding, the project includes the purchase and demolition of the former Ramada Inn. The project will cost $830,000 and is planned for Fiscal Year 2025.

Garnand Branch Stream Restoration

Garnand Branch is a flood-prone river in the Roanoke River watershed in an area with moderate social vulnerability. The stream restoration project will repair current and reduce future channel erosion, eliminate slope failures of the stream banks, reestablish native vegetation along the riparian edge, and restore floodplain connection to the previously acquired floodplain lots. The project will help alleviate the frequent flooding in Garden City Park and along the Garden City Greenway, both located along Garnand Branch. The current project will cost $1,305,000 and is planned for Fiscal Year 2024-2025.

Peters Creek At Strauss Park Stream Restoration

Peters Creek is a flood-prone river with a repetitive loss area located just downstream of Strauss Park. The stream restoration project will increase flood capacity and help alleviate flooding in an area with medium to high social vulnerability. The project helps achieve the recommendations in the Peters Creek watershed management plan, which call for stream projects that provide flood mitigation and water quality benefit to add flood storage and mitigate flash flooding, reduce bank erosion, and improve overall stream function. This project will restore and protect important environmental assets in a watershed that has only 26.9% tree canopy and is somewhat lacking in greenways and parks other than Strauss. Construction on this project is planned for Fiscal Year 2028.

Green Infrastructure:

Campbell Avenue Upper Watershed Improvements

In this project, “green streets” are proposed in the West End Neighborhood extending into Downtown. This upper watershed project will alleviate localized flooding in West Ene (10th and Campbell), detain runoff and then tie into an existing 36” RCP along Rorer Avenue SW. This potentially includes a detention basin (7.0 acre-feet) in the vicinity of the former fire station at Rorer Avenue SW and 6th Street SW, and a smaller detention basin (2.6 acre-feet) at the intersection of Patterson Avenue NW and 8th Street SW. The combination of “Green

Streets" from 10th Street SW to 6th Street SW includes permeable pavement, curb extensions with bioretention, and street trees with check dams under the pavement to detain peak discharges from the upper watershed for Campbell Avenue, thereby reducing peak discharges in the Roanoke CBD downstream. This project also provides substantial water quality and runoff reduction benefits as a demonstration project for Green Streets in the City of Roanoke, and it can be integrated into planned corridor enhancements for this neighborhood plan. The project budget is estimated at $9.5M

Luck Avenue Upper Watershed Improvements

In this project, detention of stormwater runoff is proposed in three locations identified as flood prone areas within the upper watershed for Luck Avenue. This includes detention (5.6 acre-feet) centered on the city parking lot across the street from the YMCA and along 5th Street between Luck Avenue and Marshall Avenue, where detention is provided by permeable pavement with a series of concrete vaults underneath. It also includes detention in two private parking lots and 2nd Street, centered on Luck Avenue, where detention (13.25 acre-feet) is provided by permeable pavement with a series of concrete vaults underneath. It also includes detention near Elmwood Park on S. Jefferson Street, where storage is provided by underground vaults and by converting a turf grass plaza into a combination of bioretention basin and pervious concrete sidewalks (4.07 acre-feet). Details will need to be evaluated based on availability of property, need for phasing and adapting to site specific details. The primary benefit of this project is to detain peak discharges from the upper watershed for Luck Avenue, thereby reducing peak discharges into Downtown itself. This project also provides water quality and runoff reduction benefits through permeable pavement and bioretention areas for treating local runoff. The project budget is estimated at $20.1M.

Melrose Avenue Crossing Improvements

This previously identified project aims to reduce repetitive flooding in areas with medium to high social vulnerability by increasing culvert size and improving channel conditions up and down stream of Melrose Avenue at Hortons Branch. Specifically, this Capital Improvement Project will increase flow capacity under Melrose Ave. The existing 6' x 3' concrete box culvert and upstream and downstream channels are not adequate to convey stormwater that concentrates in these areas. There are signs of bank erosion and undercutting. Several homes experience flooding upstream of Melrose Avenue due to the backwater from the undersized culvert. Any culvert capacity modifications associated with this project should include a careful assessment of the capacity at the downstream end of the open channel section of Horton Branch to ensure that flooding of the neighboring development (Goodwill, library, etc.) is not exacerbated. This project may also provide a unique opportunity for enhanced education and outreach due to the advocacy and participation by a local Kiwanis club.

Moorman Avenue/Trout Run Green Infrastructure

Short-term work with the with Gilmer and Harrison neighborhoods to include green infrastructure elements in the Moorman Avenue streetscape project such as bioretention areas and new trees. Longer-term effort includes working with the communities to look at flood reduction effort s along Trout Run, which generally parallels Moorman Avenue. Additional wok could include day lighting parts of Trout Run and restoring portions of the floodplain/creating public spaces.

Annual Green Infrastructure Projects

This activity involves assessing annual streetscape (additions of sidewalk, curb and gutter to existing streets) and repaving programs to identify opportunities for green infrastructure elements such as bioretention bump-outs, tree lawns, bioswales and other urban infiltration practices. These measures can be installed cost-effectively as part of large street projects. In addition to providing flood storage and improved water quality, they can also provide public gathering spaces.

Gray Infrastructure

1st and Salem Drainage Improvements

The 1st and Salem Drainage Improvements project is the first of several proposed projects designed to reduce flooding in Downtown Roanoke. The project includes upsizing existing 15 – 36" diameter storm drainpipes to 4' H x 6' W tunnels, using an alignment that is more hydraulically efficient and that directs flow away from existing structures. The project, by itself, is designed to reduce flood depths in the area by approximately 6" during the 25-year flood and will also improve maintenance access to the downtown stormwater tunnels to assure that the pipes continue to flow as designed. (Future projects will detain and/or divert water upstream to further reduce flooding as they are implemented.) The proposed work will also include improvements to the aging water mains within the project footprint in order to provide additional benefits to the community with a single project.

Shenandoah/Jefferson Diversion Tunnels

The primary benefit of this project is to divert flow from the Trout Run watershed away from the Norfolk Tunnel at the Warehouse Row diagonal tunnel and convey runoff further downstream in the new tunnel before tying back into the Norfolk Tunnel at N. Jefferson Street. The new diversion tunnel will tie into the tunnel that was previously used by the Hotel Roanoke to provide pedestrian access downtown, below the Norfolk Southern railroad tracks. The second part of this project includes a new 20' x 16' junction box over the Norfolk Tunnel in the alley behind Warehouse Row for improved access to the existing Norfolk Tunnel. The work will remove accumulated sediment and debris from the tunnels in that area and plug a broken weir wall that previously restricted runoff into the diagonal tunnel going towards Salem Avenue. The project is anticipated to be built entirely within city rights of way (city streets) except where it crosses under the NS railroad yard. In order to coordinate the shared use of the existing pedestrian tunnel at N. Jefferson Street to convey stormwater runoff, an access agreement will need to be acquired from the WVWA outlining construction modifications to the tunnel and long-term maintenance responsibilities for each party. The project budget is estimated at $4.6M.

Norfolk Southern Railroad Yard Diversion

In this project, two sediment basins are proposed to be constructed on railroad property to help collect runoff from the surrounding tracks in the railroad yard. The primary benefit of this project is to divert flow from the railroad yard to the CCBC detention basin. The sediment traps in the railroad yard at the upstream end of the pipe diversion will help reduce downstream maintenance needs in the 66" RCP and the CCBC detention basin from the railroad runoff. The project budget is estimated at $4.3M.

Maintenance Access Upgrades

In this project, nine (9) new junction boxes are proposed to provide the city with better access to the existing tunnels for inspections and maintenance work. These junction boxes range in size from 8'x8' to 20'x20', and are proposed within city rights-of-way, where they were positioned initially to minimize potential utility conflicts. In some cases, associated traffic impacts might require the junction boxes to be offset into sidewalk areas, side streets or on-street parking spaces to allow to the city to best maintain traffic during construction. The primary benefit of this project is to provide the city safer and easier access into their existing stormwater system. The project budget is estimated at $4.2M.

7.4 Technical Studies and Programmatic Approaches

Watershed Master Plans

Watershed Master Plans (WMPs) have been developed for the Lick Run, Tinker Creek & Tributaries (Carvin Creek, Glade Creek, and Lick Run-Norfolk Southern), Trout Run, and Peters Creek watersheds. The City plans on seeking funding to help complete WMPs for the remaining watersheds that will include Roanoke River, Back Creek, Ore Branch, Murray Run, Mudlick Creek, Murdock Creek, Barnhardt Creek, and Mason Creek watersheds. WMPs should ensure watershed boundaries are consistent (e.g., Lick Run, Lick Run – Norfolk Southern) in future analyses.

The City would conduct the GIS mapping and asset inventory necessary for determining:

- Where the critical environmental assets are and the linkages to stormwater infrastructure.
- Determine where bottle necks currently exist in drain systems or where they may exist in the future.

A complete set of WMPs would enable the City to take a more comprehensive look at environmental assets at the watershed scale and identify opportunities for mitigation and protection, particularly in areas with high social vulnerability. As more WMPs are developed, the findings and recommendations should be incorporated into this Resilience Plan.

The City's process of prioritizing flood resilience projects could incorporate the SVI or other similar metrics, as projects in this area would likely yield a larger improvement in flood recovery capability per dollar of investment than the same project in a less vulnerable area. **This principle is consistent with the City's definition of Equity – that different groups have different needs and should be provided services determined by their needs**[19].

Evaluation of Floodplain, Riparian Buffer and Other Land Preservation Practices

This project would evaluate floodplains, riparian buffers and other land preservation practices throughout the City to determine their potential for preserving or improving natural and beneficial effects of floodplains and buffers. The resulting baseline would help the City prioritize enhancement and restoration projects, aimed at improving the ability of floodplains to spread out and slow down floodwaters during heavy precipitation and storm events, thus reducing downstream erosion. This is one of the least expensive and most effective ways to increase flood resiliency. The data would also be used to focus floodplain improvements in areas with repetitive flood loss and socially vulnerable areas.

This effort could also assess the potential property and economic, social, and environmental impacts of the expanding the River and Creek Corridor (RCC) Overlay District in the City's Zoning ordinance. The RCC requires preservation of riparian buffers along the Roanoke River and certain portions of some tributaries. The study would evaluate the number and extent of impacts to existing properties, including the extent of the drainage network that would be affected. The study would evaluate the costs and benefits of extending protections of the RCC and could explore policy changes or incentives to offset economic effects.

The City could also seek funding to evaluate the economic, social, and environmental impacts and potential hydrologic effects of applying other land conservation policies. The City would identify various models implemented in other localities and consider the impacts of applying them to the City of Roanoke.

Evaluate Predicted Precipitation and Design Practices and Standards

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[19] See City Plan 2040 | Themes: Interwoven Equity - https://planroanoke.org/interwoven-equity/

The City understands the upward trend in the severity of precipitation events and the associated impacts that such storms will likely have in exacerbating flooding problems. The NOAA MARISA (Miro et al., 2021) updated IDF Curve Data Tool provides the City with an opportunity to evaluate the impacts of using this new tool on stormwater management and design. The City would use future funding to evaluate the cost of implementation on existing infrastructure verses maintenance upgrades and assess potential impacts to downstream channel stability. This work would also assess how to use and/or supplement or monitoring networks to support decision making. The study could also include a review of the City's infrastructure to assess bottlenecks and flood potential under increased rainfall to further assist in decision making with infrastructure and development. The study could provide an economic evaluation of short-term cost of improvements compared to long-term costs associated with increased rainfall and flooding.

Evaluate Land Management and Green Infrastructure Practices

Evaluate the costs and benefits of strategies that can be used to minimize impervious surface while encouraging resilient, compact urban development in the City. The evaluation would look at a range of practices that can used to reduce runoff and that can be incorporated into carious City standards and programs. . These could range from increasing tree canopy to various BMPs based on natural processes or harvesting of rainwater for collection and reuse. The study would look at example programs in other jurisdictions and how they were implemented.

This effort would consider two factors in how the existing housing stock or commercial properties could be further protected from flood risk

1. Assess how future development of residential land can incorporate flood resilience into development plans.
2. Balance land use and development policy between acquisition of highly flood prone property for conservation while encouraging development in other areas to provide needed housing.

Review Stormwater Utility Fee Credit Program

The City recognizes the importance of native meadow and forested tracts to flood resilience. Research has quantified the decreased level of absorption and filtering associated with turfgrass relative to native meadow or forested conditions. The City may consider adoption of a stormwater utility credit for land conversion in order to maximize the potential benefits to flooding and stormwater system performance. The City would seek funding to evaluate the utility fee structure impacts and hydrologic effects of such measures

Evaluate Land Preservation Protections

The City's current credit manual was developed in 2014 and 2015 leading up to the creation of the Stormwater Utility. There have been no substantive changes since that time. As flood resilience strategies are developed, it is appropriate to review the types of work that should be eligible for fee credits – making sure the CIty incentiveis/rewards the most valuable activities. These credits should focus on runoff reduction and preservation of critical spaces (floodplains and riparian areas). In particular credits for the protection/restoration of riparian buffers or conversion of paved surfaces and manicured lawns to natural cover (land cover conversion).

7.5 Additional Considerations

Robust Measurement of Social Vulnerability

Realizing the variability in social vulnerability findings, greater equity may be achieved by using a more robust social vulnerability model to determine priority in the scoring matrix. The Resilience Plan presents a model combining data from three different models (Social Vulnerability Index, EPA EJSCREEN, FEMA National Risk

Index) to determine the overall level of social vulnerability, whereas the DCR's Adopt VA Social Vulnerability Index used to ascertain a score in the ranking matrix relies on a modified version of one model (Social Vulnerability Index). Though the DCR model is valid, incorporating all available data sets into a single model strengthens findings and minimizes those weaknesses inherent to a single dataset. Therefore, when determining the level of social vulnerability and corresponding weight in the future, the City recommends a shift toward using the model applied in **Section 3** of this Resilience Plan.

Enhance Project Selection Tools

To create equal evaluation and ranking for resilience projects, the Resilience Plan relies on established criteria and suggested weighting for the project selection matrix. Future efforts may find that additional local constraints or criteria would be beneficial to include in the project selection process. As the City continues to advance resilience efforts, staff would periodically consider the need for Resilience Plan updates and modifications to the project selection matrix to more effectively evaluate and rank projects in a way that prioritizes broader resilience, going beyond flooding and drainage to incorporate other social, economic, and environmental factors.

Increase Inter-departmental Coordination

For nearly a decade the City of Roanoke has had a designated funding stream for stormwater-related projects. Though funding allocations are now more predictable, the need for coordination between City staff remains critical. Often storm drainage improvement projects create opportunities for improvement in other facets of City management. For example, neighborhood drainage improvements made to reduce localized flooding may also allow for road resurfacing. The opposite is also true. Road improvements may create opportunities for enhanced stormwater management (e.g. the addition of street trees, roadside water quality treatment areas, etc.). Quarterly meetings between department management where upcoming project schedules and scope are discussed could help avoid misaligned implementation (i.e. damage to recently installed infrastructure by work from another department) and promote mutually beneficial projects.

Consider Programs to Incentivize Improvements to Increase Flood Resilience

City Plan 2040 promotes the idea of green convenience, making it easy for residents and businesses to take actions that improve our environment. The City's Repetitive Loss Area Analysis contemplates creating a program to assist residents with making improvements to make their homes or businesses more resilient. As public infrastructure projects will not quickly address flood resilience for the entire community, flood resilience efforts should work to furnish flood prone small and mid-sized local businesses with resources to reduce risk and improve recovery, particularly in areas of high social vulnerability.

The City could assess options for assisting homeowners and businesses in evaluating and supporting projects that improve flood resilience and reduce flood risk in the community. Ideally, such a program would leverage state or federal funding to support resilience efforts of residents and business owners and work to furnish flood prone small and mid-sized local businesses with resources necessary to sustain operations during and after flood events. This strategy is especially important for businesses that lie in areas of high social vulnerability.

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APPENDIX A – DCR CROSSWALK

This crosswalk is developed to assist with review of this flood resilience plan for completeness with the City's grant application. The plan elements included in the below table are based on the grant application submitted in the 2021 Community Flood Preparedness Fund grant round.

Plan Element	Plan Location	Notes
Acknowledge climate change and its consequences, and base decision making on the best available science	Section 2.3 Climate Change Chapter 5 Principles of Flood Resilience	The plan focuses on 5 key principles, one of which is climate change.
Identify and address socioeconomic inequities and work to enhance equity through adaptation and protection efforts	Chapter 3 People, Land, Economy, Equity Chapter 5 Principles of Flood Resilience	The plan focuses on 5 key principles, one of which is equity.
Utilize community and regional scale planning to maximum extent possible, seeking region-specific approaches tailored to the needs of individual communities	Chapter 4 Community Engagement Chapter 6 Efforts to Date	The plan focuses on 5 key principles, one of which is community scale benefits. The plan builds on City-wide and watershed specific planning efforts and included a robust public outreach campaign.
Understand the fiscal realities and focus on the most cost-effective solutions for the protection and adaptation of our communities, businesses, and critical infrastructure. The solutions will to the extent possible, prioritize effective natural solutions.	Section 6.5 Funding Chapter 7 Recommended Projects for Flood Resilience	The plan focuses on 5 key principles, one of which is economy and land use. Cost-effectiveness of projects is a major component in project evaluation in the plan. Nature-based solutions/green infrastructure is also major component in project evaluation in the plan.
Recognize the importance of protecting and enhancing nature-based solutions in all regions, natural	Chapters 5 Principles of Flood Resilience	The plan focuses on 5 key principles, one of which is nature-based approach.

coastal barriers and fish and wildlife habitat by prioritizing nature-based solutions.	Section 6.4, Projects Chapter 7 Recommended Projects for Flood Resilience	Nature-based solutions/green infrastructure is a major component in project evaluation in the plan.
The plan is project-based with projects focused on flood control and resilience.	Chapters 5 Principles of Flood Resilience Section 6.4, Projects Chapter 7 Recommended Projects for Flood Resilience	The plan focuses on flood resilience throughout and has 5 key resilience principles.
The plan will incorporate nature-based infrastructure to the maximum extent possible.	Chapters 5 Principles of Flood Resilience Section 6.4, Projects Chapter 7 Recommended Projects for Flood Resilience	The plan focuses on 5 key principles, one of which is nature-based approach. Nature-based solutions/green infrastructure is a major component in project evaluation in the plan.

APPENDIX B – FLOODPLAIN REVIEW

Floodplain Review (Residential and Commercial) SOP attached in the following pages.

1. Purpose

Describe the overall process for reviewing permits that are located on parcels that are at least partially within the Special Flood Hazard Area or Floodplain.

2. Scope

The scope of this procedure is based on the development, partial development or redevelopment of a parcel for commercial or residential purposes.

The development is subject to the requirements of Section 36.2-333, Floodplain Overlay District (F). This review will take place concurrently with other relevant reviews for the development (zoning, building, E&S, etc.)

This procedure applies to the Permit Center, Zoning Administration, Zoning Review, Building Review, and Planning and Building Inspections function in the department.

3. Permit Types/Subtypes

This procedure applies to the following permit types and the associated subtypes.

- Residential New (RNEW)
- Residential Addition (RADD)
- Residential Repair/Remodel (RMRP)
- Residential Deck Porch (RDKP)
- Residential Accessory Structure (RACC)
- Commercial New (CNEW)
- Commercial Addition (CADD)
- Commercial Repair/Remodel (CMRP)
- Commercial Deck/Porch (CDKP)
- Commercial accessory Structure (CACC)
- Subdivision (SU)
- Comprehensive Plan (CP)

This procedure will not apply to any trade permits that are in-kind replacements of existing system unless the upgrade is determined to be a substantial improvement or part of a substantial improvement to the building. However, all ***NEW*** trade permits must meet the NFIP requirements which mean elevating those systems 2 feet above the BFE.

4. Prerequisites

- A signed and sealed elevation certificate has been provided with the permit application.
- A site plan, with floodplain/floodway boundaries shown on the site plan, has been submitted with the application.
- Any flood-proofing certifications have been signed and sealed certifying that dry or wet flood-proofing that is proposed meets Building Code Standards for the floodplain.

5. Initialized from:

Building and Zoning permits are typically initialized from an address. However, some permits may be appropriate to initialize from a building. This is particularly important for floodplain review. If multiple buildings under one address are located within a floodplain and are on the same parcel, it is important to make clear which one of the building/s the permit is for.

6. Responsibilities

- Permit Technicians – Permit initialization, assignment of reviews, document management (ensures that elevation certificate has been provided upon initialization).
- Zoning Floodplain Reviewer/Administrator –Review project sites to ensure compliance with Section 36.2 -333 Floodplain Overlay District (F). Checks to verify accuracy of the Elevation Certificate. In some instances, checks to see if the permit constitutes a substantial improvement to a building. Determines whether an as-built survey or a post-construction elevation certificate is on file before issuance of a CO.
- Building Floodplain Reviewer/Inspector – Review of building plans for flood proofing/elevation data accuracy. Determines that the Flood proofing Certificate is accurate and that the flood proofing was installed correctly.

7. Procedure

The floodplain review process must **ALWAYS** begin with a zoning determination of the use of the new structure, addition, or any other type of development associated with the permit application. This informs reviewers as to changes of use and also allows reviewers to determine if new proposed uses are allowed within certain areas of the floodplain overlay. Certain uses are non-starters for permitting approval in developments or re-developments within the Floodway. Changes of uses within the floodway may require a Special Exception to change from one non-conforming use to another.

After use has been deemed to be compliant, see attached flow chart for the rest of the review process. This procedure is an assembly procedure, based on other defined, detailed procedures for specific tasks.

8. References

- Zoning Ordinance, Chapter 36.2 of the Code of the City of Roanoke (1979), as amended.
- Section 36.2 -333 Floodplain Overlay District (F)
- Stormwater Management Ordinance, Chapter 11.6 of the Code of the City of Roanoke (1979), as amended.
- Uniform Statewide Building Code.

9. Definitions

Substantial Improvement – Any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds fifty (50) percent of the market value of the structure before the start of construction of the improvement. The term does not, however, include either:

1. Any project for improvement of a structure to correct existing violations of state or local health, sanitary, or safety code specifications which have been identified by the local code enforcement official and which are the minimum necessary to assure safe living conditions, or

2. Any alteration of a historic structure, provided that the alteration will not preclude the structure's continued designation as a historic structure.

3. Historic structures undergoing repair or rehabilitation that would constitute a substantial improvement as defined above, must comply with all section requirements that do not preclude the structure's continued designation as a historic structure. Documentation that a specific section requirement will cause removal of the structure from the National Register of Historic Places or the State Inventory of Historic places must be obtained from the Secretary of the Interior or the State Historic Preservation Officer. Any exemption from section requirements will be the minimum necessary to preserve the historic character and design of the structure

Base Flood Elevation - The water surface elevations of the base flood, that is, the flood level that has a one (1) percent or greater chance of occurrence in any given year. The water surface elevation of the base flood in relation to the datum specified on the community's flood insurance rate map.

Add more based on current projects – encroachment, etc

10. Time Limits

- Intake, initialization and scanning of documents – Completed at counter, within next business day for electronic submissions.
- Initial Zoning/Site Reviews – Complete and provide comments within 10 days of initialization.
- Initial Building Plan Review – Complete and provide comments within 10 days of initialization (5 days for residential permits).

11. Revisions

Date	Description of Revision

Procedure Flow Chart:

Zoning Floodplain Review – Commercial

Procedure #: FP-001

Start
Customer submits Building and Zoning permit application

Permit Initialization
Permit Technician
- Identify project scope, permit type/subtype
- Check/link prerequisites
- Assign reviews
- Use/number of units
- Assess fees
- Scan and/or upload documents
- Note document location

Required Submittals
- Applicable permit application form
- Site plan with floodplain/floodway indicated on the site plan
- Building plan (with sealed drawing confirming dry/wet flood-proofing if proposed – only allowed on non-residential structures)
- Signed and sealed elevation certificate with date
- Total valuation of the proposed project

Zoning Use Determination
Zoning Floodplain Reviewer
- Identify zoning use of the property
- Identify if development is occurring in regulatory floodway
- Identify any change of use
- Determine if use is permitted in the floodway
- If new development in floodway, any use not permitted will result in permit denial.
- If change of use in floodway, applicant will need to submit application to BZA, prior to permit review

C

Plan Revision/Resubmission
Applicant
Plans revised to address comments

Resubmission Processing
Permit Technician
- Check for scope change
- Add reviews
- scan and/or upload
- If hard copy, add resubmission to file

Zoning Floodplain Review

Building Floodplain Review

A

B

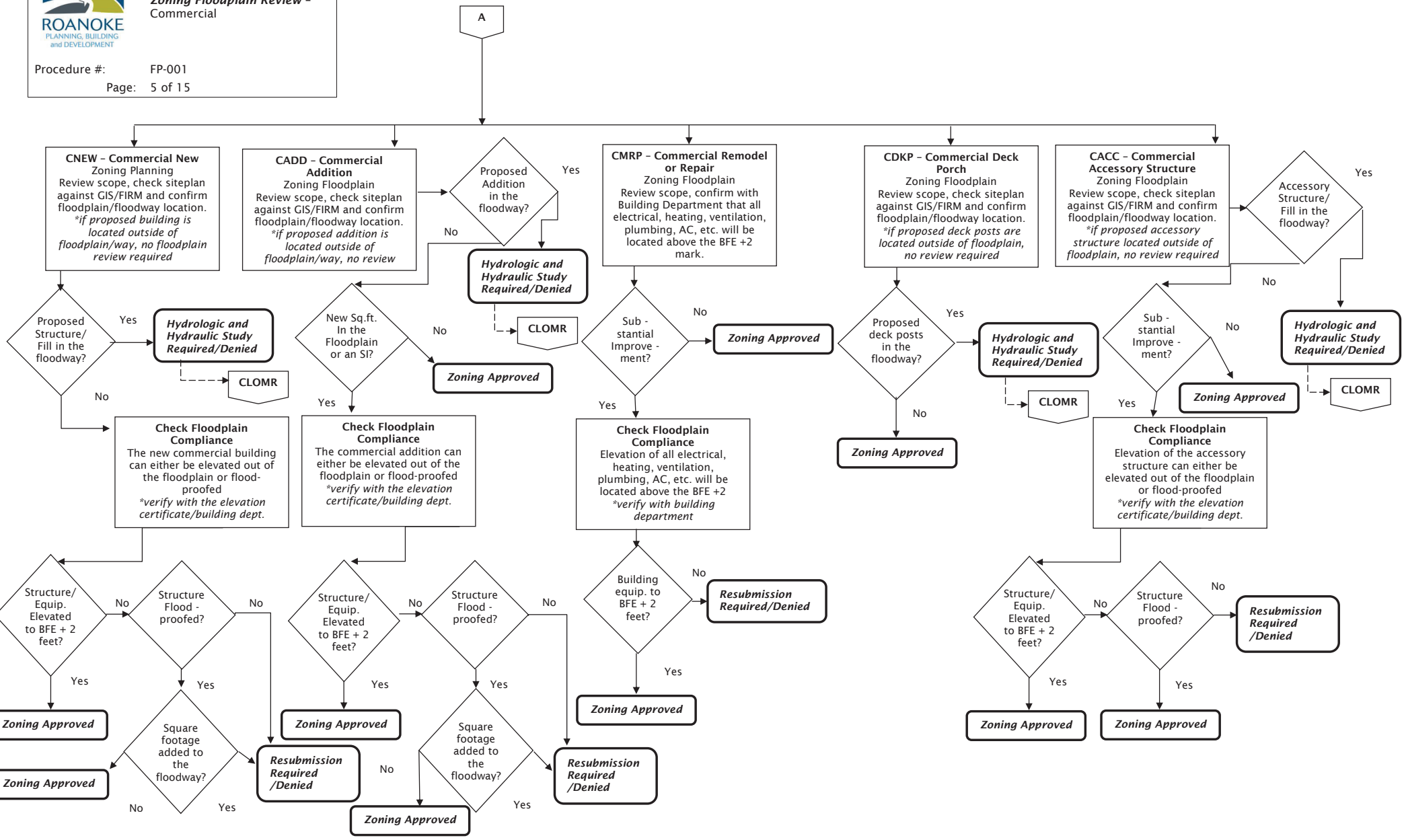
Procedure Flow Chart:

Zoning Floodplain Review – Commercial

ROANOKE PLANNING, BUILDING and DEVELOPMENT

Procedure #: FP-001

Page: 5 of 15

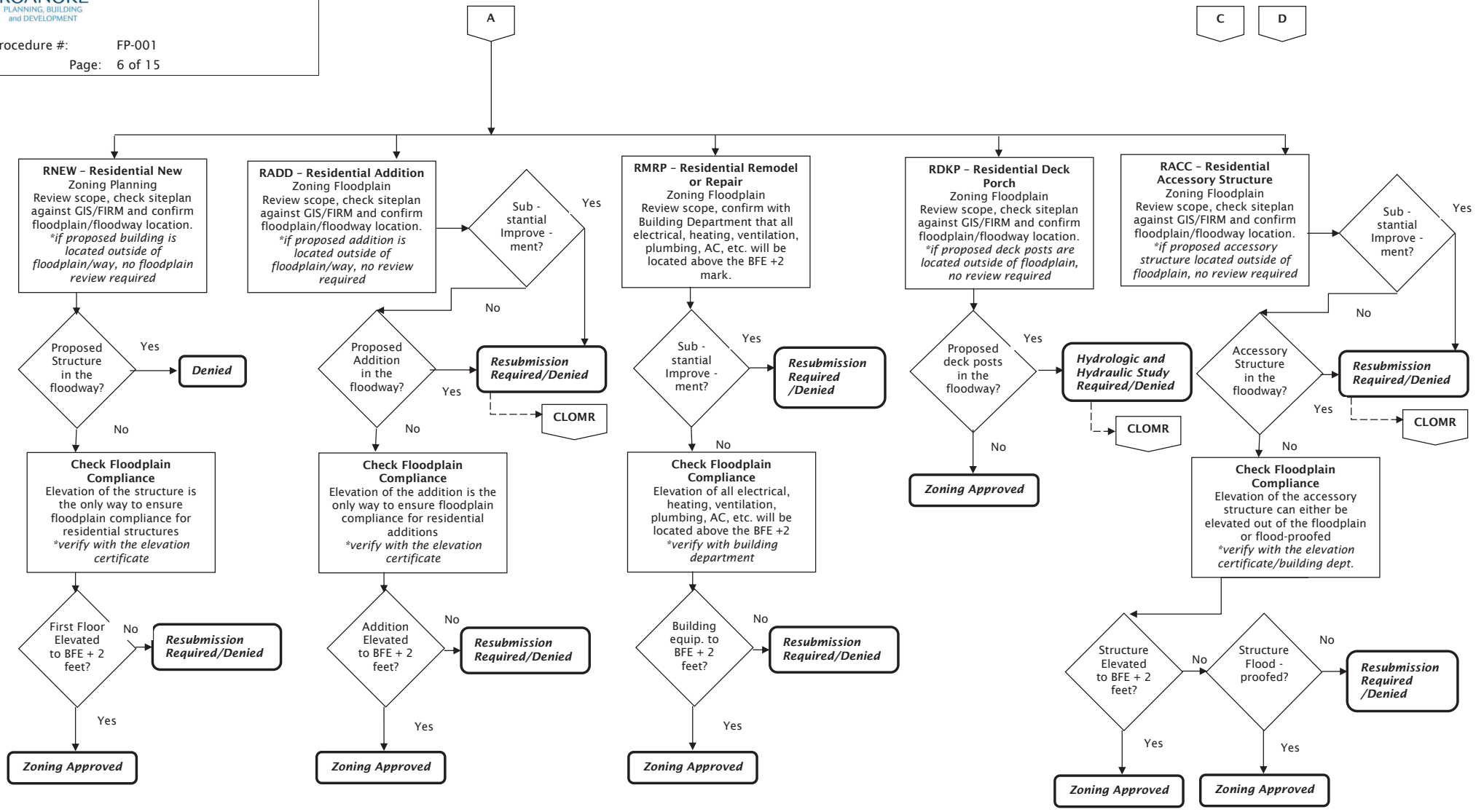


ROANOKE
PLANNING, BUILDING and DEVELOPMENT

Procedure Flow Chart:

Zoning Floodplain Review – Subdivisions and Comp Plans

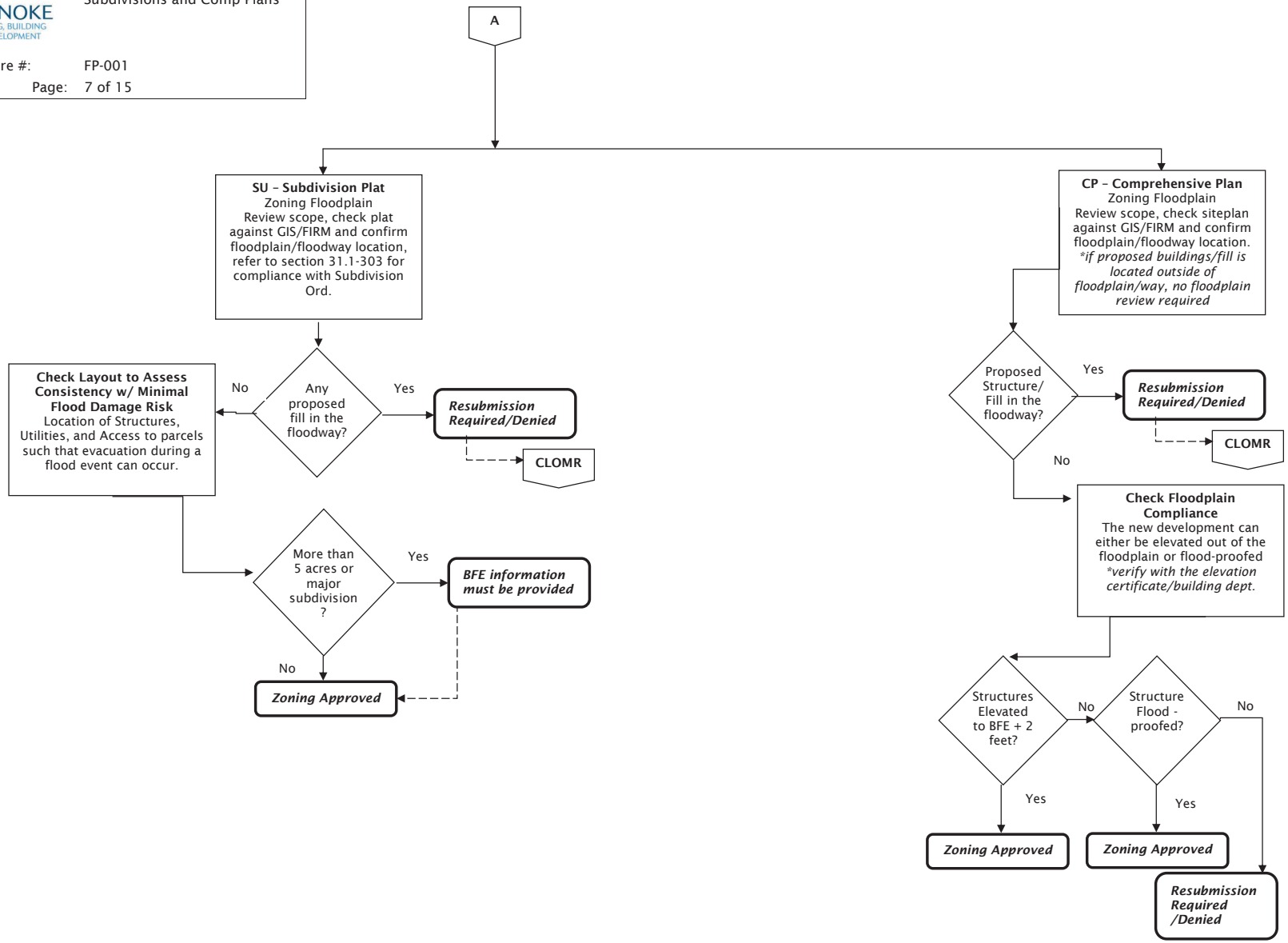
Procedure #: FP-001



Procedure Flow Chart:

Zoning Floodplain Review – Subdivisions and Comp Plans

Procedure #: FP-001



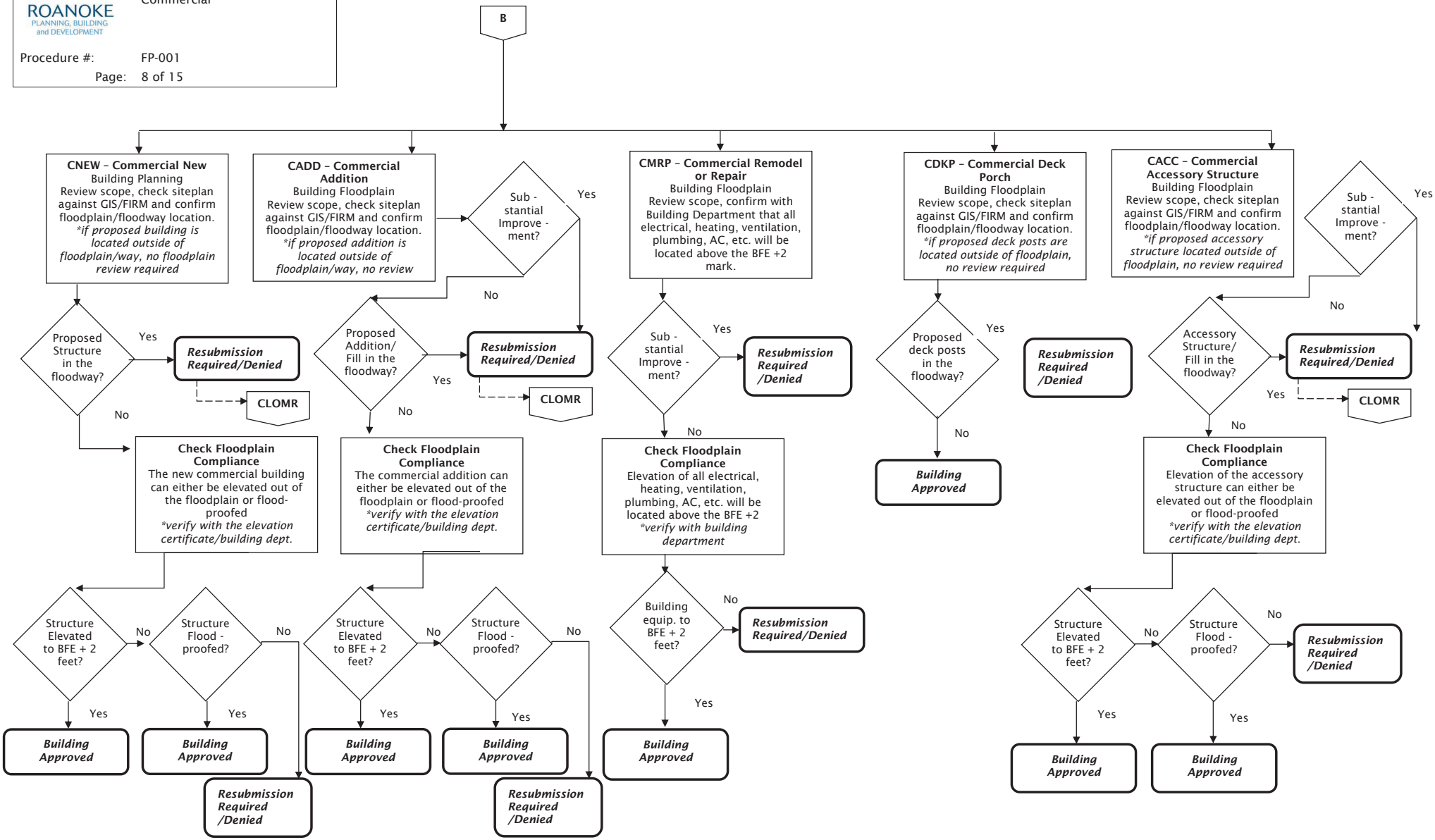
ROANOKE
PLANNING, BUILDING and DEVELOPMENT

Procedure Flow Chart:

Building Floodplain Review – Commercial

Procedure #: FP-001

Page: 8 of 15



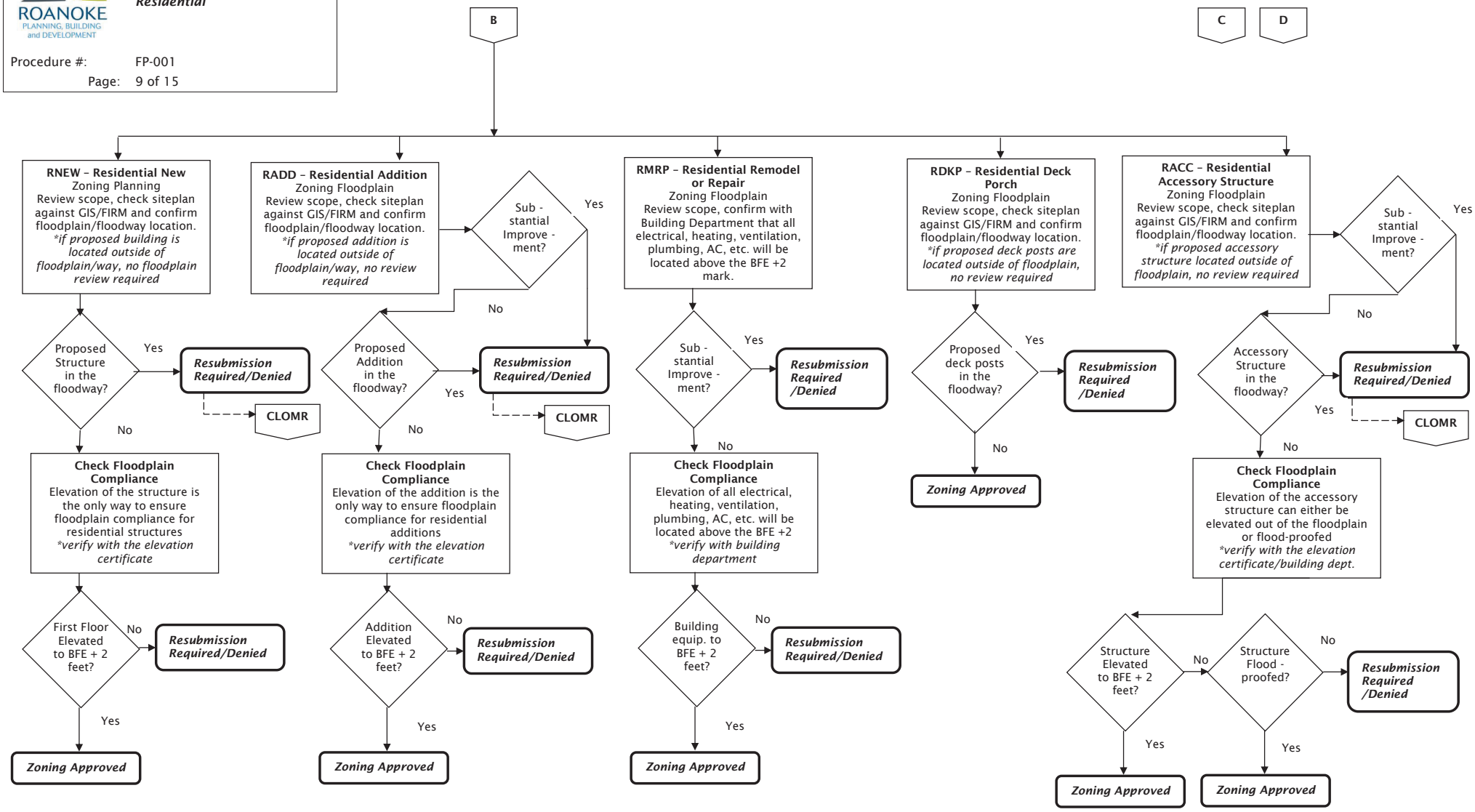
ROANOKE
PLANNING, BUILDING and DEVELOPMENT

Procedure Flow Chart:

Building Floodplain Review Residential

Procedure #: FP-001

Page: 9 of 15



CLOMR

44 CFR 65.12:

"When a community proposes to permit encroachments upon an adopted regulatory floodway which will cause base flood elevation increases in excess of…(0.00 ft in a floodway) and/or [0.1 ft in a floodplain]…the community shall apply to the Administrator for conditional approval of such actions prior to permitting the encroachments to occur…"

44 CFR 60.3(d)(3):

"In the regulatory floodway, communities must prohibit encroachments, including fill, new construction, substantial improvements, and other development within the adopted regulatory floodway unless it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in flood levels within the community during the occurrence of the base flood discharge."

<u>Requirements:</u>

1. Applicant must submit a MT-2 Form from FEMA
    a. Describes data requirements for request
    b. Helps applicant organize submittal
    c. Allows for community involvement early on in the revision process

2. Include "No-Rise" Certification
    a. Floodplain Manager will require that the applicant's engineer certify that there will be no rise in flood heights due to any development within the floodplain.
    b. The Community is required to review and approve the encroachment review ("no-rise" certification), however may request technical assistance and review from the FEMA Regional Office or state NFIP Coordinator. If this alternative is chosen, the Community must review the technical submittal package and verify that all supporting data are included in the package before sending it to FEMA.

       Minor projects: Some projects are too small to warrant an engineering study and the certification. Many of these can be determined with logic: a sign post or telephone pole will not block flood flows. A driveway, road or parking lot at grade (without any filling) won't cause a problem, either.

       Building additions, accessory buildings, and similar small projects can be located in the conveyance shadow. This is the area upstream and downstream of an existing building or other obstruction to flood flows. Flood water is already flowing around the larger obstruction, so the addition of a new structure will not change existing flood flow. Upstream is measured at an angle of 1-to-1, downstream is measured at an angle of 4-to-1.
    c. To support a "No-Rise / No-Impact" certification for proposed developments encroaching onto the regulatory floodway, a community will require that the following procedures be followed:
        i. Currently Effective Model Furnish a written request for the step-backwater hydraulic model for the specified stream and community, identifying the limits of the requested

data. A fee will be assessed for providing the data. Send data requests to: Federal Emergency Management Agency http://www.fema.gov.fhm/st_order.shtm or to: MOD RMC Region 4 Faxed to (678) 459-1030 to the attention of: "Back-up Technical Data Request"

ii. Duplicate Effective Model Upon receipt of the step-backwater hydraulic model, the engineer should run the effective hydraulic model to duplicate the data in the effective FIS.

iii. Existing Conditions Model Revise the duplicate effective model to reflect site-specific existing conditions by adding new cross-sections (two or more) in the area of the proposed development, without the proposed development in place. Regulatory floodway limits should be manually set at the new cross-section locations by measuring from the effective FIRM or FBFM. The cumulative reach lengths of the waterway should remain unchanged. The results of these analyses will indicate the base flood elevations and the regulatory floodway elevations for the effective hydraulic model revised to incorporate existing conditions at the proposed project site.

iv. Proposed Conditions Model Modify the existing conditions models to reflect the proposed development using the new cross-sections, while retaining the currently adopted regulatory floodway widths. The overbank roughness parameters should remain the same unless a valid explanation of how the proposed development will impact the roughness parameters is included with the supporting data. The results of this floodway hydraulic model will indicate the regulatory floodway elevations for proposed conditions at the project site. These results must indicate NO impact on the base flood elevations, regulatory floodway elevations, or regulatory floodway widths shown in the duplicate Effective Model or in the Existing Conditions Model (items ii and iii above, respectively). The "no-impact" analysis along with supporting data and the original engineering certification must be reviewed by the appropriate community official prior to issuing a development permit. The original effective FIS model, the duplicate effective FIS model, the Existing Conditions Model, and the Proposed Conditions Model should be reviewed for any changes in the base flood elevations, regulatory floodway elevations and floodway widths. The "No-Rise / No-Impact" supporting data should include, but may not be limited to:

1. Copy of the currently effective FIS hydraulic models (legible hard copy and a disc (if available))
2. Duplicate effective FIS hydraulic models (hard copy and a disc).
3. Existing conditions hydraulic models (hard copy and a disc).
4. Proposed conditions hydraulics models (hard copy and a disc)
5. Annotated effective FIRM or FBFM and topographic map, showing regulatory floodplain and floodway boundaries, the additional cross-sections, and the site location along with the proposed topographic modifications.
6. Documentation clearly stating analysis procedures. All modifications made to the duplicate effective hydraulic models to correctly represent existing conditions, as well as those made to the existing conditions models to represent proposed conditions should be well documented and submitted with all supporting data.
7. Annotated effective Floodway Data Table (from the FIS report).
8. Statement defining source of additional cross-sections, topographic data, and other supporting information.
9. Cross-section plots of the additional cross sections for existing and proposed conditions hydraulic models.

10. Certified planimetric (boundary survey) information indicating the location of structures on the property.
11. Hard copy of all output files.
12. Clear explanation of how roughness parameters were obtained (if different from those used in the effective hydraulic models).
13. Engineering certification (sample attached).

v. The engineering "No-Rise / No-Impact" certification and supporting technical data must stipulate NO impact or NO changes to the base flood elevations, regulatory floodway elevations, or regulatory floodway widths at the new cross-sections and at all existing cross-sections anywhere in the model. Therefore, the revised computer model should be run for a sufficient distance upstream and downstream of the development site to insure proper "No-Rise / No-Impact" certifications.

Substantial Improvement – Any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds fifty (50) percent of the market value of the structure before the start of construction of the improvement. The term does not, however, include either:

1. Any project for improvement of a structure to correct existing violations of state or local health, sanitary, or safety code specifications which have been identified by the local code enforcement official and which are the minimum necessary to assure safe living conditions, or

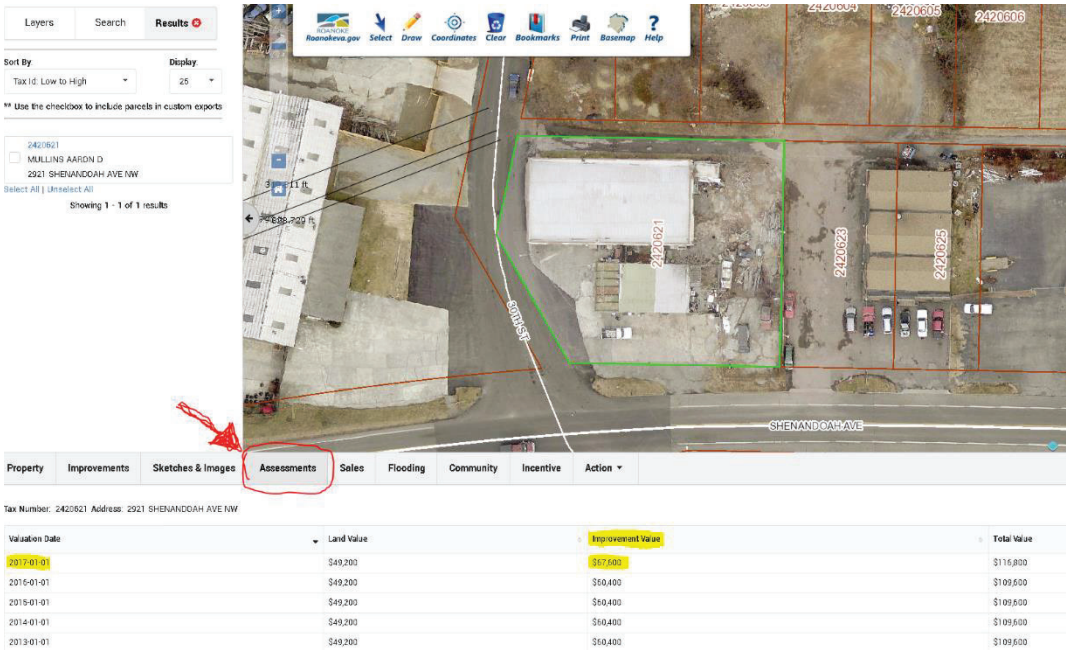
2. Any alteration of a historic structure provided that the alteration will not preclude the structure's continued designation as a historic structure.

3. Historic structures undergoing repair or rehabilitation that would constitute a substantial improvement as defined above, must comply with all section requirements that do not preclude the structure's continued designation as a historic structure. Documentation that a specific section requirement will cause removal of the structure from the National Register of Historic Places or the State Inventory of Historic places must be obtained from the Secretary of the Interior or the State Historic Preservation Officer. Any exemption from section requirements will be the minimum necessary to preserve the historic character and design of the structure

Process for determining Substantial Improvement/ Substantial Damage

1. If any of the three (3) items listed on the previous page match the description of the project, the project is not subject to the substantial improvements review process.

2. Determine the "Improvement Value" on the property (assessed value of the building). This can be done through the GIS website. An example of how to determine the improvement value can be seen below. If there is a discrepancy between the applicant's valuation of the building and the valuation as prescribed by the Tax Assessor's office, the applicant will be informed that an appraisal made by a licensed appraiser according to appraisal laws and regulations could be an option for them to raise this assessed valuation of the building, thereby allowing for potentially more improvements to be made before reaching the "substantial improvement/damage" threshold. It is important to note that the appraisal should only be accepted if the study was done prior to any improvement/damage.



2. Open Trak-It and search under the parcel for all building permits, trade permits, or other permits that pertain to improvements to the specified building within the past 5 years. Tally the sum of all of the building costs related to those permits. If there are more than 5 permits that were completed during this time, create an excel spreadsheet that tabulates the cumulative cost and save it under attachments at the address level. Additional information about what should and should not be included in the costs associated with an improvement/damage project can be found in the FEMA Floodplain Management Handbook.

3. Divide the sum total cost of all permits over the past 5 years found in Step 2, in addition to the current project's cost of improvement/damage, by the assessed value of the structure in Step 1. If this value is more than .50, then the applicant will need to improve

the structure to FEMA floodplain compliance. For residential structures, this means elevating the bottom of the first floor to the Base Flood Elevation, plus two feet. For Commercial buildings, the structure shall either be elevated or flood-proofed to the Base Flood Elevation, plus two feet.

4. Whenever our Department initiates a substantial improvement request, the applicant will be made aware that the improvement will be considered a substantial improvement. If the applicant moves forward, a note will be created on the parcel that indicates that a substantial improvement is being sought. The floodplain manager will also be made aware so that they can report to FEMA about the resulting substantial improvements and a log of the review process will be saved in TrakIt, the City permitting software database.

APPENDIX C – EDUCATION AND OUTREACH

Breakdown of Education and Outreach

Regional Working Groups and Committees

The City works with statewide agencies, other localities/municipalities, and stakeholders in the form of Committees to stay informed on regional water resource management topics, issues and goals, which include flooding and stormwater improvement initiatives. Once organized, these initiatives can then be passed onto residents to inform, and sometimes take action with preventative or enhanced water-related measures.

Roanoke River Blueway Committee

Formed in 2013 to promote planning, tourism, and outreach affairs in relation to the Roanoke River, and now a formal Committee with voting members under the Roanoke Valley Area Regional Commission. The group combines the City of Roanoke, Roanoke County, surrounding cities and counties, the National Park Services and others. The committee helps to organize events that promote awareness, stewardship, and education about the Roanoke River.

Stormwater Advisory Committee (RCSWAC)

The group combines the City of Roanoke, Roanoke County, surrounding counties, agencies, and continues to grow. This committee discusses current needs for floodplain management and infrastructure projects related to stormwater in conjunction with state and federally mandated stormwater requirements (City of Roanoke, 2018).

Regional Pre-Disaster Mitigation Planning Committee

The City of Roanoke, the County of Roanoke and several other localities participate in this committee to keep their residents informed and prepared for natural disasters through hazard mitigation planning such as the 2019 Regional Hazard Mitigation Plan which provides critically important information about flooding (Roanoke Valley-Alleghany Regional Commission, 2019).

Citizen Advisory Committees

Citizen advisory committees are utilized as needed for Citywide planning projects. Committees are comprised of a diversity of professionals and city residents and are established to review and provide feedback on the City's planning goals. As an example, this was utilized in City downtown planning of 2013-2017.

Public Education Events

The City also participates in, as well as sponsors, educational events to both educate and engage the community in local water quality and flooding issues. Often this occurs in partnership with local organizations or non-profits, such as the Clean Valley Council. These events span a wide range of formats to reach diverse community interests.

Clean Valley Days - Roanoke Clean Valley Council (CVC) organizes "Clean Valley Days" twice each year where local roads and water ways are cleaned up by volunteers.

Green Academy - Every year, the City joins forces with the Western Virginia Water Authority and Clean Valley Council to hosts a 5-week Green Academy with specific sessions that address water quality, conservation, stormwater management and BMPs.

Environmental Summits - Environmental Summits have been organized to educate the public on environmental issues and engage the community with planning of environmental outreach efforts. As a result of the 2018 summit, "Roanoke Clean and Green" was formed. This group of volunteers help to spread the word on "green initiatives" and best practices within the community.

Roanoke Prepareathon - Event hosted by the City during National Preparedness Month, in partnership with Emergency Management and Fire-EMS, to highlight local topics on floodplain management and flood mitigation for the community.

Stormdrain Stenciling - CVC helps lead a storm drain stencil marking program where volunteers are trained to do hands-on stenciling work on drainage inlets. Accompanied with this training is education not only about storm sewer inlets, but about water quality as a whole: local streams and rivers, and watersheds.

Citizen Science - Partnering with CVC, Stormwater sponsors a citizen science program to monitor water quality and benthic macroinvertebrates. Residents learn about local water quality at the stream, river and watershed level.

Stormwater Workshops - Partnering with CVC, Stormwater sponsors workshops on water quality and stormwater management and offers rain barrel workshops during certain times throughout the year

Public Art Projects - Partnering with the Roanoke Regional Arts commission, Stormwater sponsors public art projects to engage the public creatively to learn about and help creatively communicate water quality and other stormwater issues. Examples include inlet art, murals, photography, and jingle competitions.

Public Educational Outreach (Mail Delivery, Virtual and Other)

A regular part of City functioning is informing and educating residents with pertinent information. This is done in a variety of formats as necessary according to the information and relevant audience, including taking accessibility and inclusivity into consideration. Interpretation and translations services and resources are available to City residents and visitors regardless of the language they speak. It is the policy of the City of Roanoke to ensure that limited English proficiency individuals have meaningful access to all services, programs, and activities.

Notifications

- Repetitive Loss Area - Repetitive Loss Area Analysis has been introduced to the City public in a letter mailed out last year to residents that are located within Repetitive Loss Areas. Additionally, this letter describes the NFIP, CRS program, and provides resources such as flood preparation steps, online flood plan maps, and the suggestion for permanent protection measures against floods. This letter also leads recipients to a Repetitive Loss survey that can be taken to evaluate possible Repetitive Loss properties. This survey helps the City to further identify Repetitive Loss Areas, which can then result in specifically tailored mitigation projects and/or more grant funding provided by FEMA for various flooding solutions.
- Special Flood Hazard Area – Annual mailer to approximately 360 real estate agents, lenders and insurance agents. Post card titled "Are you aware of the flood hazards?", which provides resources for agents and lenders to share with property owners that possess properties within Special Flood Hazard Areas.

Publications

- Flooding in Roanoke – Annual brochure mailed to all residents and businesses located within the Special Flood Hazard area and/or a Repetitive Loss Area. The brochure promotes flood insurance, provides flood protection information, tips for flood preparedness including actions to take to reduce

flood damage to a home or business, flood map information services, and information about the natural drainage system and the importance of protecting natural floodplain functions.

- State of Our Waters – Mailed to all Stormwater fee payers, about 32,300 addresses, and available in public at City libraries and the City Municipal Building. Information includes local and national data on water pollution and climate change; new projects that relate to water quality such as stream restoration and infrastructure projects; floodplain preparedness information, and ways that the local community can help.
- Flood Preparedness and Recovery Guide – Brochure containing Disaster Response Resource Information, and important messaging such as "Turn Around, Don't Drown". The brochure provides a list of important resource phone numbers for emergencies and non-emergencies, as well as links to resources about flood response, residential flooding, special needs, and recovery after a flood.

Virtual Tools

- Social Media - City's social media platforms include Facebook, Instagram, X (formerly Twitter) and Nextdoor. Through these platforms, information about specific floodplain and resilience issues including flood hazards; insuring property against flooding incidents; how to protect people and property from flooding hazards; responsible flood resistant development; and the importance of protecting natural floodplain functions is shared with the public.
- Website – The City maintains a public facing website with information on flood zones and insurance, flood safety, preventing flood damage, flood warnings, flood management, emergency preparedness, City events, and staff directories.
- SHARKS App - The City has funded a public information web-based application known as Stream Hydrology and Rainfall Knowledge System (SHARKS). Sharks relies on a system of rain gauges, USGS data, and automated computations incorporated into a website that allows you to determine past rainfall data and/or can determine areas that are experiencing a flood event in real time. This information is available to the public and can advise locals on what roads to avoid during storm events. This rainfall data can also be instrumental in further research to show hotspots of flood-prone areas.

APPENDIX D – PROPERTY ACQUISITION

Property Acquisition SOP

The City of Roanoke, must at times acquire certain real property rights from private owners to achieve annual and long-term program objectives of varying master plans and capital projects. These rights include the acquisition of vacant properties, and the acquisition and demolition of structures. This outlines the procedure for City staff to engage private property owners in voluntary sales of their property, ensure full transparency in the acquisition process, leverage resources for fair and equitable treatment of property owners and their tenants, and adhere to land preservation requirements of all properties acquired.

1. Letters of Interest and Voluntary Participation

Once a property has been identified as high priority to achieve overall objectives of a project or program, the Department Manager or Project Manager shall coordinate with their Economic Development Department representative to initiate contact with the property owner. This "Letter of Interest" should give an overview of the need for the property, the future use of the site, and listed source of funding. This LOI will not include a certified offer, City projects must gain City Council approval to obtain all property rights from private owners. The goal of the LOI is to gage interest from the owner(s), that would warrant submission to Council. This also provides a personal approach to owner engagement on each project.

For projects funded by the Virginia Department of Emergency Management, FEMA, or other state agencies that are federal backed, a Voluntary Participation Agreement must be signed by each property owner for grant application submittal. This agreement demonstrates interest of the property owners, serves as support for readiness to proceed on the project, waives the rights of relocation for owners, protects the rights of the tenant, and reinforces the voluntary nature of each acquisition. The Voluntary Participation Agreement for FEMA's FMA, PDM, and HMGP grants is attached as Exhibit A.

2. Appraisals, Offers and Negotiations, and Sales Agreement

If a property owner responds positively to the Letter of Interest, a submittal to City Council for approval of acquisition is required. Pending the project schedule, owner expectations, and time of Council approval; the project manager may also concurrently work with the Economic Development Department to hire a third-party appraiser to ensure fair and objective value estimation of the property. The third-party appraiser coordinates a visit to the property, and provides a detailed report to the City and property owner at no cost to the owner.

The appraised value reflects the current fair market value for the property, and is the basis for the offer letter. As this is a voluntary agreement, the property owners have the right to negotiate a different purchase price, and it is the City's right to accept, decline, or renegotiate this counter-offer. It should be noted, the City is required to purchase each property at either the tax assessed or appraised value, whichever is higher. If the acquisition is funded through a grant, the appraised value is the amount in which can be reimbursed. If a property owner exercises their right to negotiate for a higher purchase price, the City must determine if paying 100% of the difference between appraised value and final offer meets cost/benefit.

Once a final price is agreed, City attorney's office will prepare closing documents and sales agreement.

3. Uniform Relocation Act

If there are active renters at the property, the Federal Uniform Relocation Act may apply. Form II-3 URA Relocation Assistance for Tenants Fact Sheet is included as Exhibit B to assist in determining when a tenant may be eligible. 49 CFR 24.402 (part of the federal regulations governing the Uniform Relocation Act), requires the City to provide relocation funds for the tenant and ensure their new dwelling is decent, safe, and sanitary in addition to being comparable to their current rental.

Working closely with the tenants in their relocation, assisting in identifying a new dwelling that meets all federal grant requirements, and ensuring the new dwelling is decent, safe, and sanitary aligns with the City's goals of equitable treatment of both property owner and tenant. All of the tenant's rights are outlined in the Federal Uniform Relocation Act.

4. Land Preservation and Deed Restrictions

In the sales agreement for each acquisition, an exhibit is included that furthermore restricts the deed from sale, development; maintaining the parcel as open space. An example of the deed restrictive language is included as Exhibit C, with an excerpt as follows:

"Federal program requirements consistent with 44 C.F.R. Part 80, the Grant Agreement, and the State-local Agreement, the following conditions and restrictions shall apply in perpetuity to the Property described in the attached deed and acquired by the Grantee pursuant to FEMA program requirements concerning the acquisition of property for open space:

a. Compatible uses. The Property shall be dedicated and maintained in perpetuity as open space for the conservation of natural floodplain functions. Such uses may include: parks for outdoor recreational activites; wetlands management; nature 1 PG)29b:; ~18 22 reserves; cultivation; grazing; camping (except where adequte warning time is not available to allow evacuation); unimproved, unpaved parking lots; buffer zones; and other uses consistent with FEMA guidance for open space acquisition, Hazard Mitigation Assistance, Requirements for Property Acquisition and Relocation for Open Space.

b. Structures. No new structures or improvements shall be erected on the Property other than:

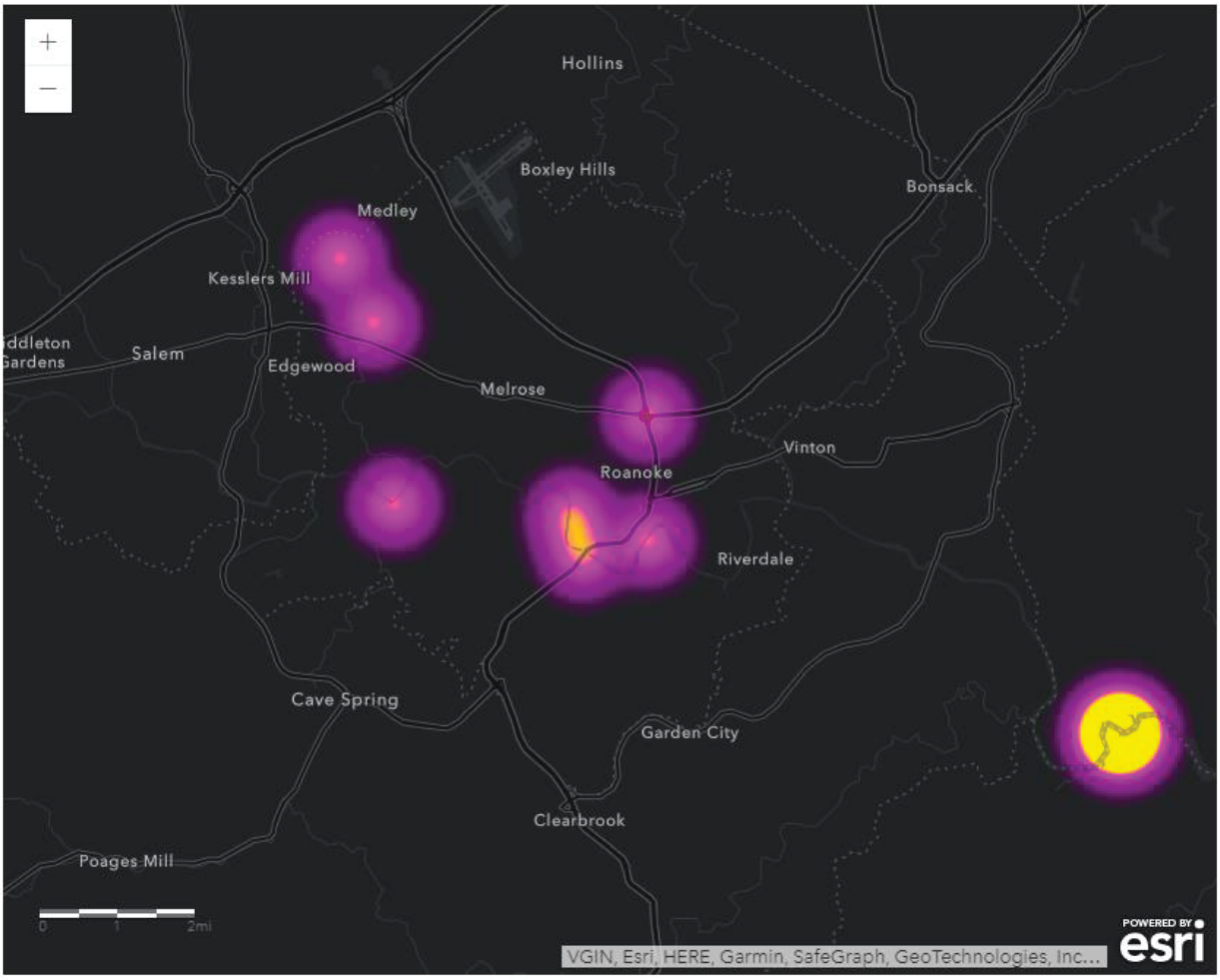
i. A public facility that is open on all sides and functionally related to a designated open space or recreational use;

ii. A public rest room; or

iii. A structure that is compatible with open space and conserves the natural function of the floodplain, including the uses described in Paragraph 1.a., above, and approved by the FEMA Administrator in writing before construction of the structure begins."

APPENDIX E – COMMUNITY SURVEY

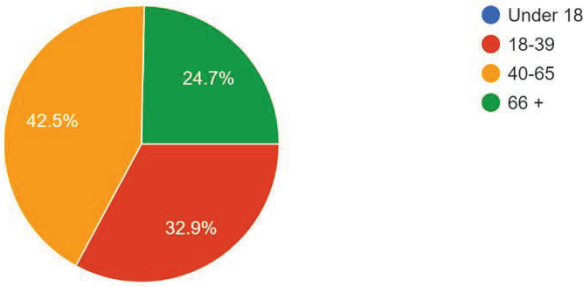
This Appendix contains Figures that portray the results of the community survey and map that were open from January 2023 through March 2023 for public input and resulted in 160 responses.



Resilience Plan Survey Responses

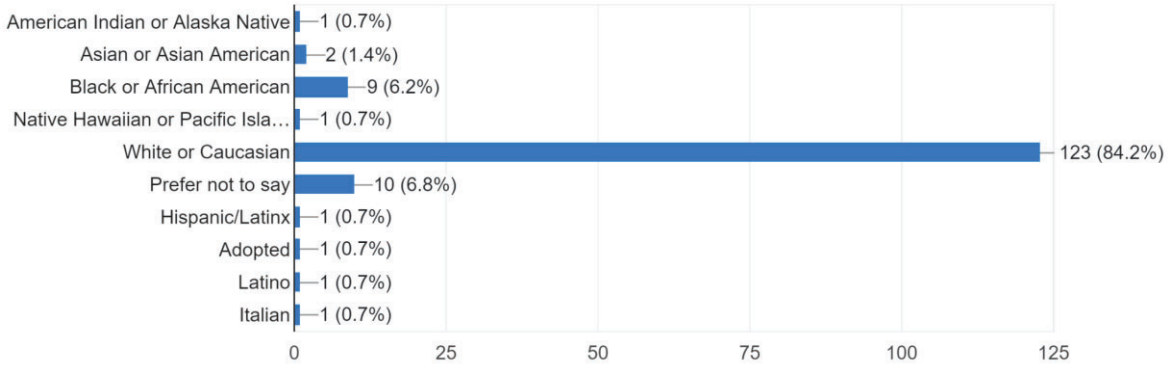
Please identify your age bracket.

146 responses



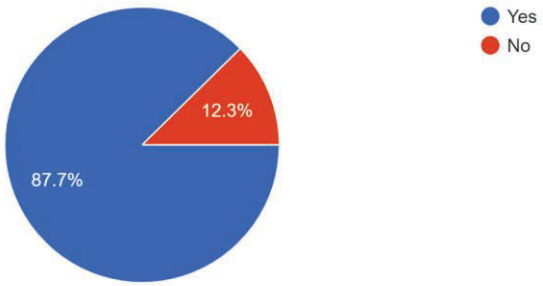
Please identify your race (select all that apply).

146 responses



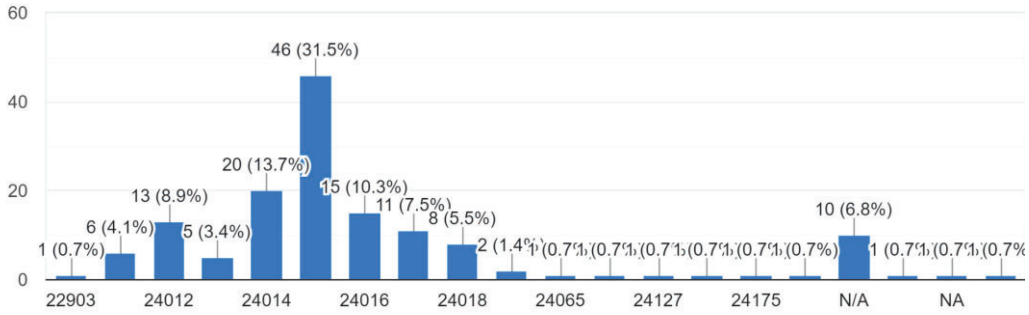
Do you live in the City of Roanoke?

146 responses



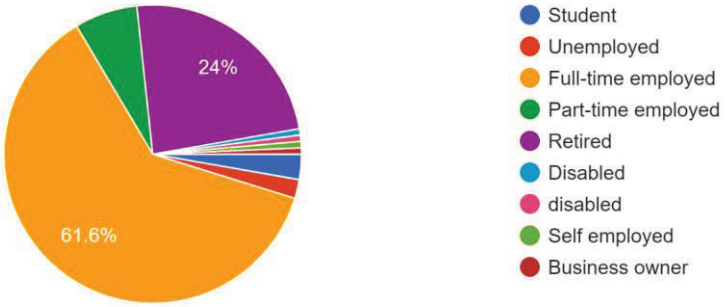
If you live in the City please provide your zip code. If this does not apply, please type "N/A".

146 responses



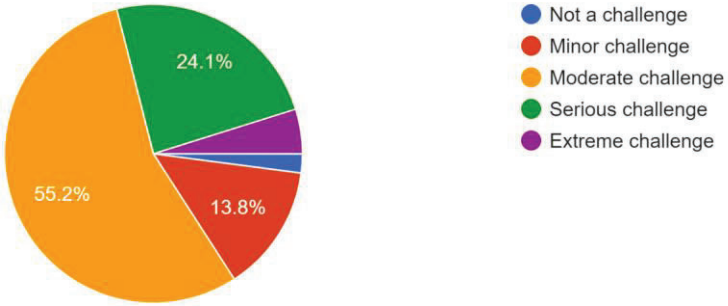
Please identify your occupational status.

146 responses



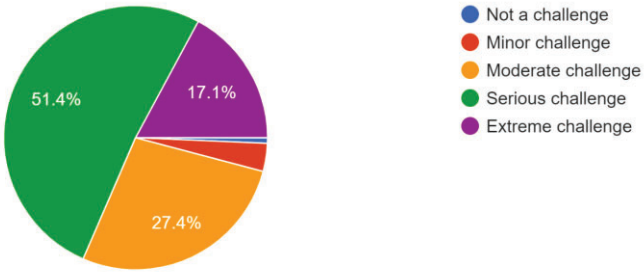
How much of a challenge do you feel flooding poses to your community currently?

145 responses



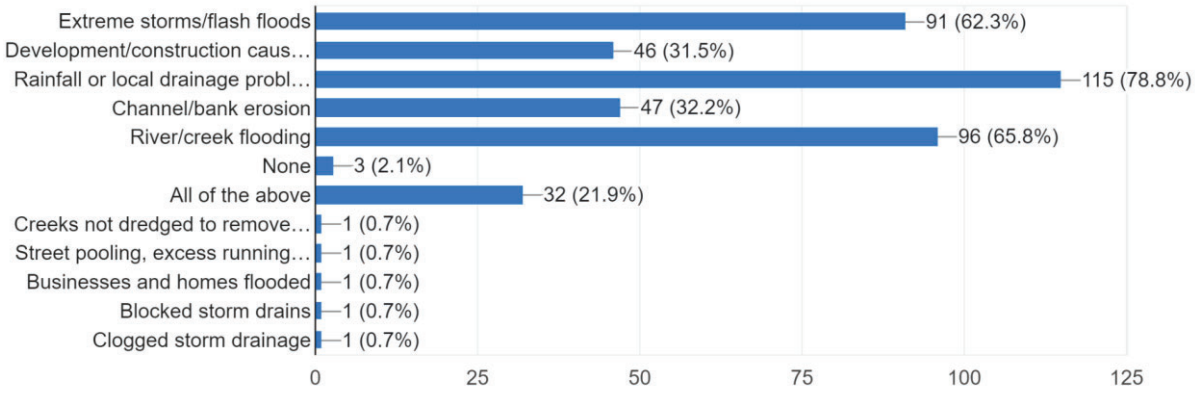
How much of a challenge do you feel flooding poses to your community in the next 20-40 years, given climate change?

146 responses



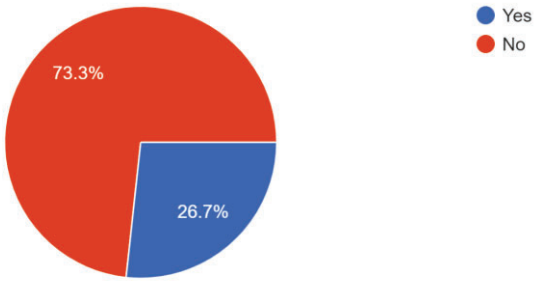
What type of flooding hazards have you witnessed in your community? Select all that apply.

146 responses



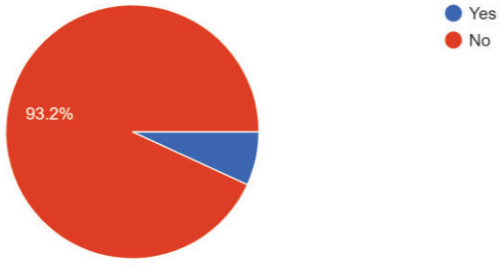
Has your home ever flooded?

146 responses



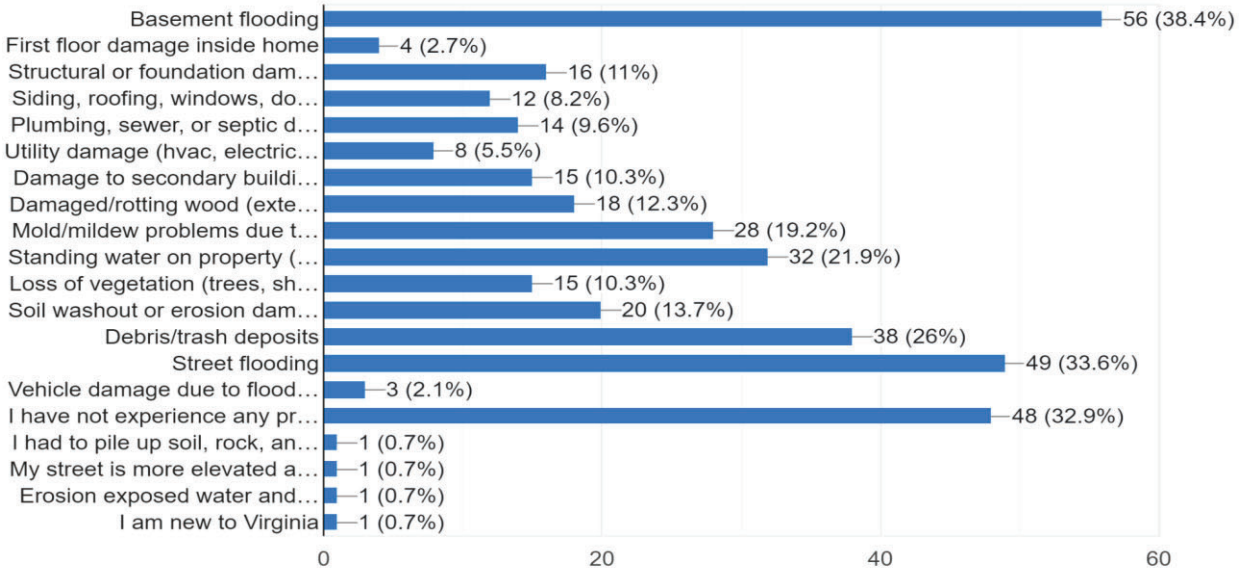
Has your business ever flooded?

146 responses



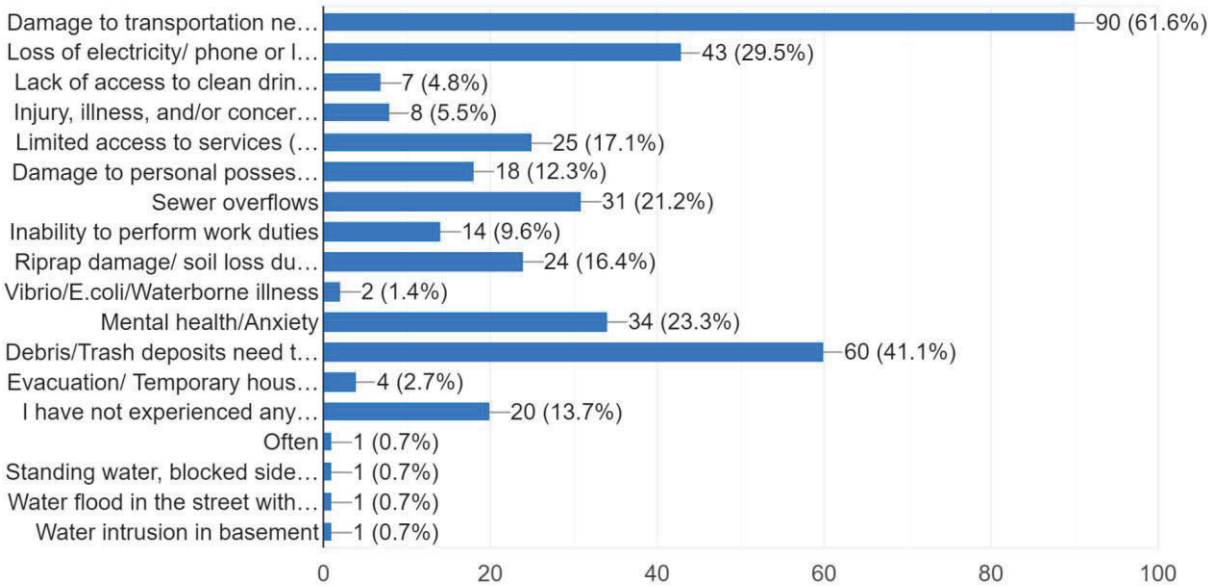
What type of property damage have you experienced resulting from a flood event? (select all that apply)

146 responses



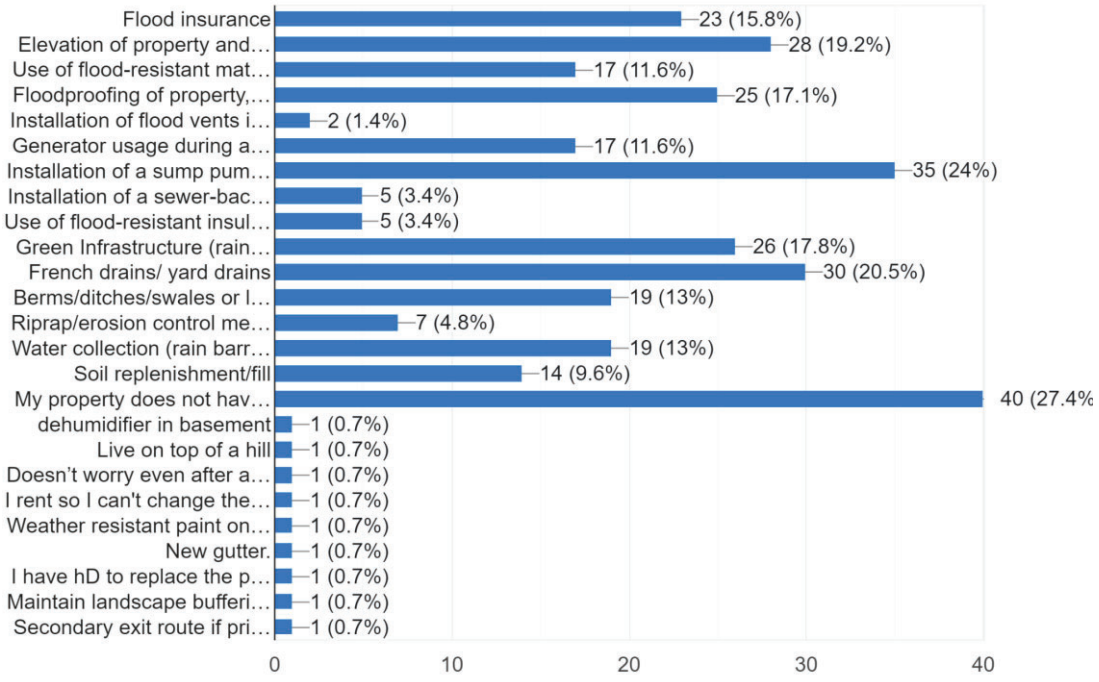
What type of negative impacts have you experienced resulting from a flood event? (select all that apply)

146 responses



Do you currently have any prevention or mitigation measures in place on your property(ies)? (select all that apply)

146 responses

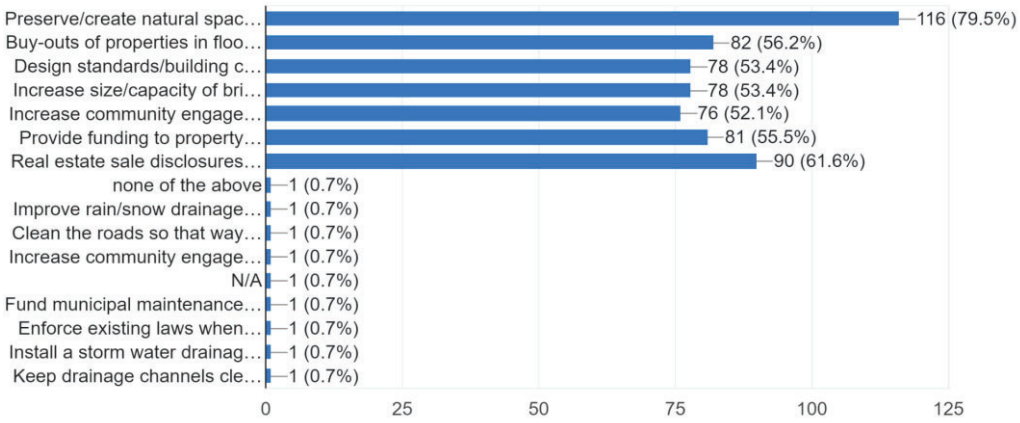


Have you ever considered moving to another location (inside or outside the City of Roanoke) to avoid future flood losses, impacts, or damage?

146 responses

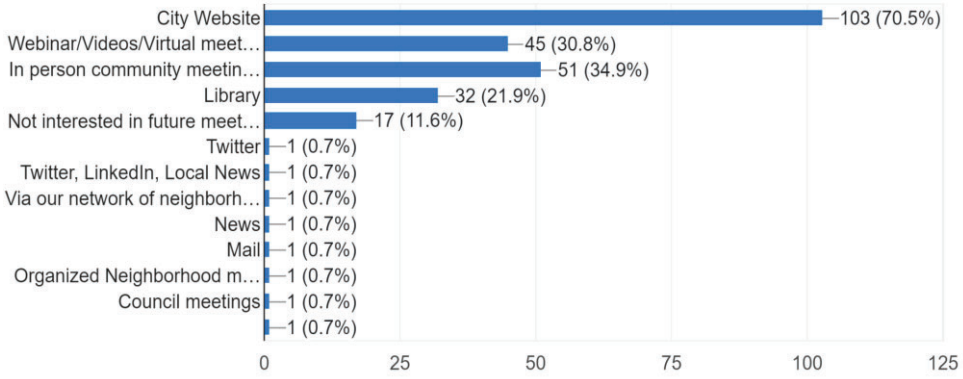
Do you believe any of the project types listed below would provide benefits to your community? (select all that apply)

146 responses



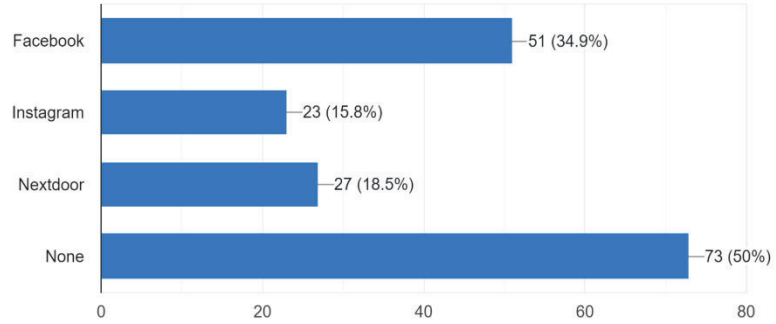
Other communication options for follow up (select all that apply)

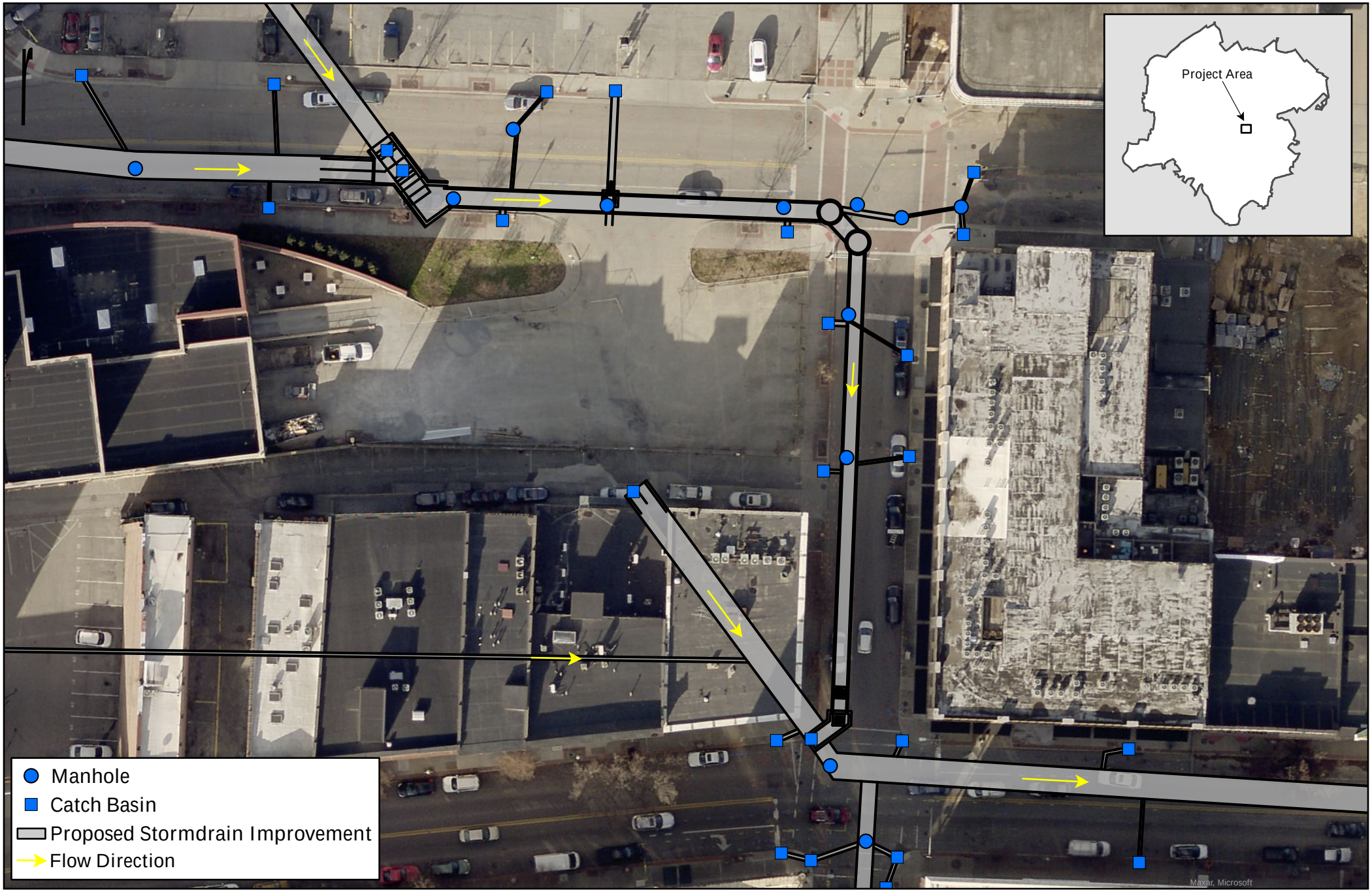
146 responses



Social Media, select which social media platform you prefer for updates or select none.

146 responses

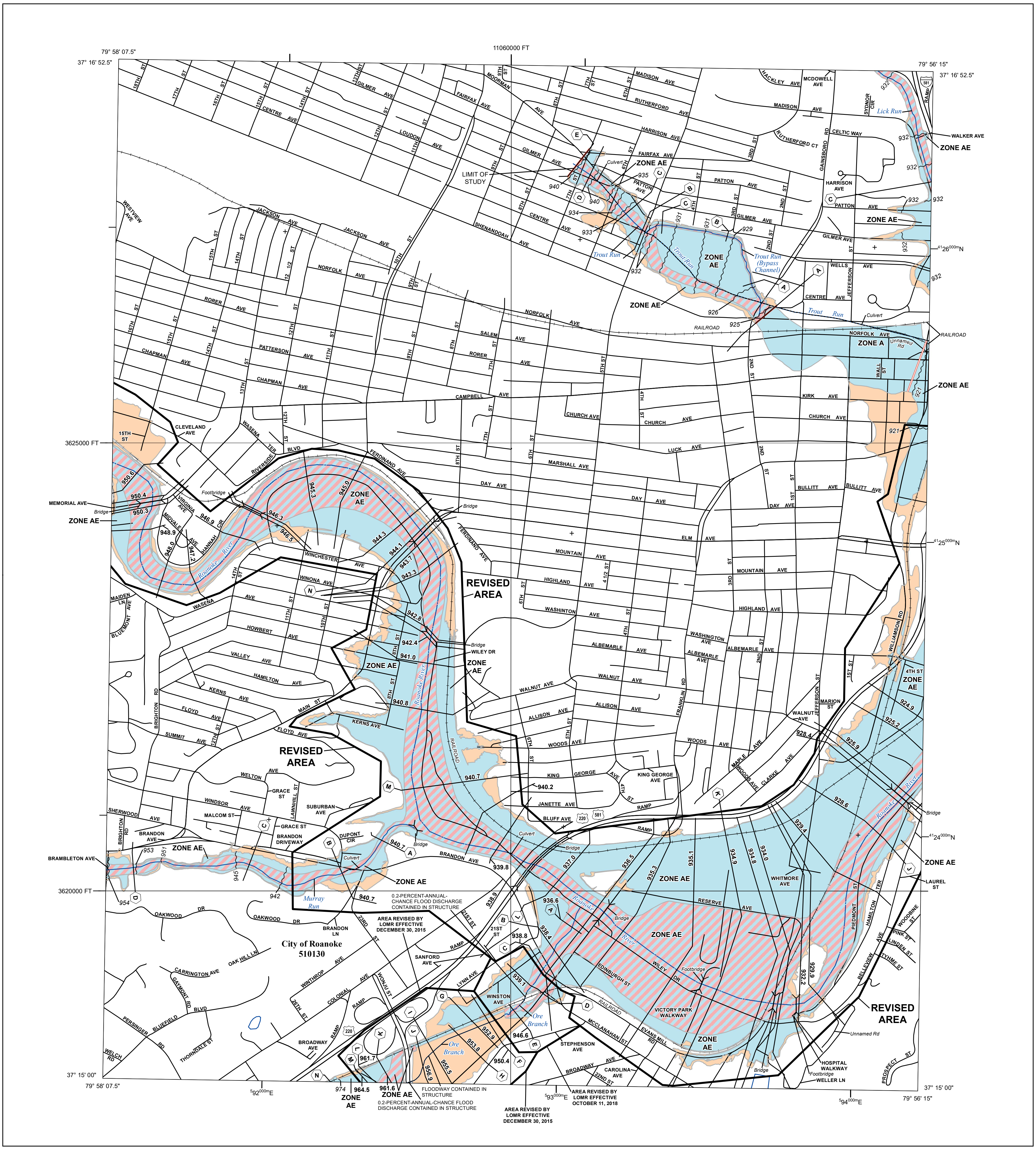




ROANOKE
STORMWATER

1st & Salem Drainage Improvement Project
Proposed Project Map
November, 2023

0 25 50 100 Feet



FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR ZONE DESCRIPTIONS AND INDEX MAP

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT HTTP://MSC.FEMA.GOV

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A, V, A99*
	With BFE or Depth *Zone AE, AO, AH, VE, AR*
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee See Notes. *Zone X*
OTHER AREAS	NO SCREEN Areas Determined to be Outside the 0.2% Annual Chance Floodplain *Zone X*
	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Levee, Dike, or Floodwall
OTHER FEATURES	E 18.2 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation (BFE)
	8 Coastal Transect
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
	513 Base Flood Elevation Line (BFE)
	Limit of Study
	Jurisdiction Boundary

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Mapping and Insurance eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this FIRM was provided in digital format by Roanoke County.

Road features shown on this FIRM have been updated using the 2022 TIGER/Line Shapefiles from the U.S. Census Bureau.

SCALE

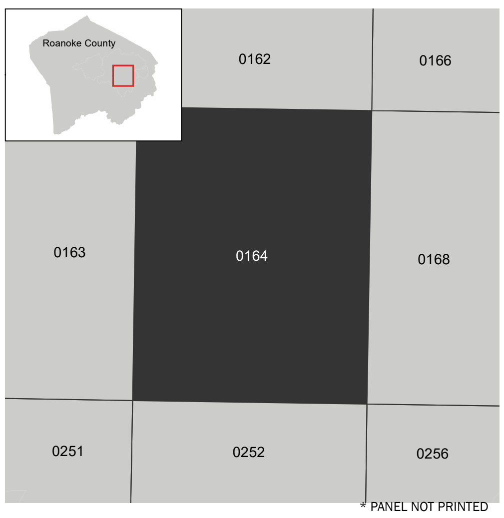
Map Projection:
NAD 1983 StatePlane Virginia South FIPS 4502 Feet;
Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet 1:6,000

0 500 1,000 2,000 Feet

0 125 250 500 Meters

PANEL LOCATOR



* PANEL NOT PRINTED

FEMA National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

ROANOKE COUNTY, VIRGINIA
and Incorporated Areas

PANEL 164 OF 310

FEMA

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
ROANOKE, CITY OF	510130	0164	G

REVISED TO REFLECT LOMR EFFECTIVE: December 22, 2023

VERSION NUMBER
2.1.3.0

MAP NUMBER
51161C0164G

MAP REVISED
SEPTEMBER 28, 2007

WebGrants Portal -> Scope of Work Document Crosswalk

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8	Critical Facilities/Infrastructure	4.1.g.iii.
9	Financial and Staff Resources	4.1.d, 4.2.a
10	Goals and Objectives	3.2
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14	Criteria	4.8, Table 4

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6	A link to or a copy of the current hazard mitigation plan	Appendix C.6
7	A link to or a copy of the current comprehensive plan	Appendix C.7
8	Social vulnerability index score(s) for the project area	Section 4.2.b
9	Authorization to request funding from the Fund from governing body or chief executive of the local government	Appendix C.13
10	Signed pledge agreement from each contributing organization	Appendix A
11	Maintenance Plan	Section 4.7
12	Benefit Cost Analysis	Section 4.1.e.
13	Other Relevant Attachments	Appendix D-G

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IN THE COUNCIL OF THE CITY OF ROANOKE, VIRGINIA

The 16th day of October 2023.

No. 42806-101623.

A RESOLUTION authorizing the City Manager or his designee to submit an application to the Department of Conservation and Recreation ("DCR") for grant funding under the Community Flood Preparedness Fund; and authorizing the City Manager or his designee to take such further actions and execute such further documents as may be necessary in connection with this application and grant funding.

BE IT RESOLVED by the Council of the City of Roanoke as follows:

1. City Council hereby authorizes the City Manager or his designee to submit an application to the DCR for Community Flood Preparedness Fund grant funding, such funding to be used to help communities reduce the impacts of flooding, for the 1st Street and Salem Drainage Improvements Project and the Ore Branch Restoration Project, all as more particularly described in the City Council Agenda Report dated October 16, 2023, with such application being approved as to form by the City Attorney.

2. The City Manager or his designee is further authorized to take any such further actions and execute such further documents, approved as to form by the City Attorney, as may be necessary to submit the above application to the DCR and to furnish such additional information as may be required for such application.

ATTEST:

Cecelia F. McCoy

City Clerk.

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Tab 6 - Scope of Work Supporting Information - Projects

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4	Ability to Provide Share of Cost	4.1.d.
5	Benefit-Cost Analysis	4.1.e
6	Repetitive Loss and or Severe Repetitive Loss Properties	4.1.g.i.
7	Residential and/or Commercial Structures	3.1, 4.1.e, 4.1.g.ii.
8	Critical Facilities/Infrastructure	4.1.g.iii.
9	Financial and Staff Resources	4.1.d, 4.2.a
10	Goals and Objectives	3.2
11	Approach Milestones and Deliverables	3.3
12	Relationship to Other Projects	4.6
13	Maintenance Plan	4.7
14	Criteria	4.8, Table 4

Tab 10 - Supporting Documentation

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4	A link to or a copy of the current floodplain ordinance	Appendix C.4
5	Maintenance and management plan for project	Section 4.7
6	A link to or a copy of the current hazard mitigation plan	Appendix C.6
7	A link to or a copy of the current comprehensive plan	Appendix C.7
8	Social vulnerability index score(s) for the project area	Section 4.2.b
9	Authorization to request funding from the Fund from governing body or chief executive of the local government	Appendix C.13
10	Signed pledge agreement from each contributing organization	Appendix A
11	Maintenance Plan	Section 4.7
12	Benefit Cost Analysis	Section 4.1.e.
13	Other Relevant Attachments	Appendix D-G

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DCR CFPF Grant Application
1st and Salem Drainage Improvement
Total Cost: $2.556M
Proposed DCR 90% / City 10%
Due Nov 12, 2023

Applicants must have prior approval from the Department t
supporting documents by mail in lieu of the WebGrants port

Appendix A: Application Form for Grant
All Categories

Virginia Department of Conservation and Recreation
Virginia Community Flood Preparedness Fund Grant Program

Name of Local Government: City of Roanoke, Virginia

Category Being Applied for (check one):

☐ **Capacity Building/Planning**

☑ **Project**

☐ **Study**

NFIP/DCR Community Identification Number (CID) 510130

Name of Authorized Official and Title: Robert S. Cowell, Jr.; City Manager

Signature of Authorized Official: _____

Mailing Address (1): 215 Church Ave SW

Mailing Address (2): _____

City: Roanoke **State:** VA **Zip:** 24011

Telephone Number: (540) 853-2333 **Cell Phone Number:** (____) _____

Email Address: bob.cowell@roanokeva.gov

Contact and Title (If different from authorized official): Marcus F. Aguilar; Civil Engineer II

Mailing Address (1): 1802 Courtland Rd. NE

Mailing Address (2): _____

City: Roanoke **State:** VA **Zip:** 24012

Telephone Number: (____) _____ **Cell Phone Number: (** 540 **)** 580-7209

Email Address: marcus.aguilar@roanokeva.gov

Is the proposal in this application intended to benefit a low-income geographic area as defined in the Part 1 Definitions? Yes __X__ No ____

Categories (select applicable activities that will be included in the project and used for scoring criterion):

Capacity Building and Planning Grants

☐ Floodplain Staff Capacity.

☐ Resilience Plan Development

- ☐ Revisions to existing resilience plans and modifications to existing comprehensive and hazard mitigation plans.
- ☐ Resource assessments, planning, strategies, and development.
  - Policy management and/or development.
  - Stakeholder engagement and strategies.

☐ Other: _____

Study Grants (Check All that Apply)

☐ Studies to aid in updating floodplain ordinances to maintain compliance with the NFIP, or to incorporate higher standards that may reduce the risk of flood damage. This must include establishing processes for implementing the ordinance, including but not limited to, permitting, record retention, violations, and variances. This may include revising a floodplain ordinance when the community is getting new Flood Insurance Rate Maps (FIRMs), updating a floodplain ordinance to include floodplain setbacks, freeboard, or other

higher standards, RiskMAP public noticing requirements, or correcting issues identified in a Corrective Action Plan.

- ☐ Revising other land use ordinances to incorporate flood protection and mitigation goals, standards, and practices.
- ☐ Conducting hydrologic and hydraulic (H&H) studies of floodplains. *Changes to the base flood, as demonstrated by the H&H must be submitted to FEMA within 6 months of the data becoming available.*
- ☐ Studies and Data Collection of Statewide and Regional Significance.
- ☐ Revisions to existing resilience plans and modifications to existing comprehensive and hazard.
- ☐ Other relevant flood prevention and protection project or study.

Project Grants and Loans (Check All that Apply – Hybrid Solutions will include items from both the "Nature-Based" and "Other" categories)

Nature-based solutions

- ☐ Acquisition of property (or interests therein) and/or structures for purposes of allowing floodwater inundation, strategic retreat of existing land uses from areas vulnerable to flooding; the conservation or enhancement of natural flood resilience resources; or acquisition of structures, provided the acquired property will be protected in perpetuity from further development, and where the flood mitigation benefits will be achieved as a part of the same project as the property acquisition.
- ☐ Wetland restoration.
- ☐ Floodplain restoration.
- ☐ Construction of swales and settling ponds.
- ☐ Living shorelines and vegetated buffers.
- ☐ Permanent conservation of undeveloped lands identified as having flood resilience value by *ConserveVirginia* Floodplain and Flooding Resilience layer or a similar data driven analytic tool, or the acquisition of developed land for future conservation.
- ☐ Dam removal.
- ☐ Stream bank restoration or stabilization.
- ☐ Restoration of floodplains to natural and beneficial function.

Other Projects

- ☐ Structural floodwalls, levees, berms, flood gates, structural conveyances.
- ☑ Storm water system upgrades.
- ☐ Medium and large-scale Low Impact Development (LID) in urban areas.

- ☐ Developing flood warning and response systems, which may include gauge installation, to notify residents of potential emergency flooding events.
- ☐ Dam restoration.
- ☐ Beneficial reuse of dredge materials for flood mitigation purposes
- ☐ Removal or relocation of structures from flood-prone areas where the land will not be returned to open space.
- ☐ Acquisition of property (or interests therein) and/or structures for purposes of allowing floodwater inundation, strategic retreat of existing land uses from areas vulnerable to flooding; the conservation or enhancement of natural flood resilience resources; or acquisition of structures, provided the acquired property will be protected in perpetuity from further development, and where the flood mitigation benefits will **not be** achieved as a part of the same project as the property acquisition.
- ☐ Other project identified in a DCR-approved Resilience Plan.

Location of Project or Activity (Include Maps): Roanoke City, Virginia (see attached map)

NFIP Community Identification Number (CID#) : 51030

Is Project Located in an NFIP Participating Community? ☑ Yes ☐ No

Is Project Located in a Special Flood Hazard Area? ☑ Yes ☐ No

Flood Zone(s) (If Applicable): Zone A

Flood Insurance Rate Map Number(s) (If Applicable): 51161C0164G

Total Cost of Project: $2,556,214.00

Total Amount Requested $2,300,592.60

Amount Requested as Grant $2,300,592.60

Amount Requested as Project Loan (not including short-term loans for up-front costs) $0

Amount Requested as Short-Term loan for Up-Front Costs (not to exceed 20% of amount requested as Grant) $0

For projects, planning, capacity building, and studies in low-income geographic areas: Are you requesting that match be waived? □ Yes ☑ No

Additional Information for Loan Requests

Requested Loan Security: _____

(General Obligation, Lease, Revenue, Special Fund Revenue, and/or Moral obligation from other government entity)

Desired loan term: _____

Since the date of your latest financial statements, did the applicant issue any new debt? _____
(If yes, provide details)

Is there any pending or potential litigation by or against the applicant? _____

Attach five years of current audited financial statements (FY18-22) or refer to website if posted
(Not necessary for existing VRA borrowers)

Not Applicable

Attach FY2024 adopted budget or refer to website

Attach current Capital Improvement Plan

Attach adopted Financial Policies

Attach a list of the ten largest employers in the Applicant's jurisdiction.

Attach a list of the ten largest taxpayers in the Applicant's jurisdiction

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CITY OF ROANOKE, VIRGINIA
DOWNTOWN FLOOD RESILIENCE – 1ST AND SALEM DRAINAGE IMPROVEMENTS

CID510130_RoanokeCity_CFPF-2

Grant Application Submitted to:

Virginia Department of Conservation and Recreation

Community Flood Preparedness Fund

November 12, 2023

TABLE OF CONTENTS

1. INTRODUCTION

In this grant proposal, the City of Roanoke, Virginia requests funding from the Department of Conservation and Recreation's (DCR's) Community Flood Preparedness Fund (CFPF) in support of the 1st and Salem Drainage Improvements project – the first of several projects designed to improve flood resilience in Downtown Roanoke. We anticipate that this proposed project would reduce flood depths in the area by approximately six inches during the 25-year flood by replacing severely undersized storm drain pipes and by re-aligning the pipes for improved hydraulic efficiency. This re-alignment would also move the primary flow path of this drainage out from underneath an existing private building and into the public right-of-way, avoiding future structural issues to the building. Finally, these improvements would provide safe maintenance access for debris and sediment removal to assure that the proposed storm drain continues to provide flood mitigation benefits for the duration of its life-cycle. As this project is the "vanguard" project in a series of proposed green and gray infrastructure solutions to Downtown flooding, the project is submitted as a hybrid solution. As such the City is requesting 90% DCR CFPF funding for the full delivery project cost of $2,556,214.00. This project will be managed by the City's Stormwater Division, and we anticipate that the project will be a significant contribution to our goal of transforming the Roanoke River and its tributaries into community assets, focal points, and sources of pride for those that live, work, learn and play in its watershed.

This proposal is organized using the same hierarchy as DCR's Round 4 CFPF grant manual for ease of review. The content in this document mirrors that in the WebGrants Portal, but allows for more robust narrative, tables, figures and appendices.

2. ORGANIZATIONAL INFORMATION

See Appendix A – Application Form

3. SCOPE OF WORK NARRATIVE

The narrative provided in this section provides the information requested in Part IV.B. Scope of Work Narrative in the Round 4 CFPF Manual.

3.1 NEEDS AND PROBLEMS

Downtown Roanoke is a historical, cultural and economic hub in southwest Virginia, and its long-term sustainability and resiliency is vital to the viability of the City and broader Roanoke Valley. Unfortunately, the downtown area is subject to recurring flash flooding due to three overlapping factors. First, Downtown sits atop a historical salt marsh bottomland at the confluence of two perennial streams - Trout Run and Lick Run - which are now conveyed under City streets in drainage tunnels dating back to the 1880's. Second, the tunnels in which these historical streams are conveyed were not designed or built to modern engineering standards for capacity, materials, or maintenance, and are therefore not adequate to convey runoff to even a very low level of service. Finally, the 2.25 mi^2 Trout Run watershed draining through Downtown has experienced significant land development, resulting in poor infiltration capacity due to compacted urban soils and a 66% impervious land cover condition. As such, surface flooding in Downtown begins at the 5-10 yr. recurrence interval rainfall, and structure impacts begin at approximately the 25 yr. recurrence interval (see Table 2 and corresponding photos in Appendix D).

The FEMA regulatory special flood hazard area (SFHA) in Downtown is designated as a Zone A approximate (Appendix C.2), and encompasses a total of 73 buildings. However, more recent hydraulic modeling suggests that the 1% (100 yr.) flood would actually impact approximately 179 structures and that the smaller, more frequent floods (i.e. 25 yr.) result in a larger proportion of the long-term risk than the larger but very rare floods (i.e. 100 yr.). These smaller but chronic urban flooding issues and their on-the-ground impacts are known as "nuisance flooding" which is now acknowledged as a major factor in the field of urban flood risk management[1]. In Downtown Roanoke, nuisance flooding typically manifests during brief, intense, highly localized rainfall that falls over the Trout Run watershed causing surcharge of the storm drain system and surface flooding and resulting in road closures, vehicle damages, loss of business assets, business closures, etc. These direct impacts are especially important to the City's Market Square area because of the large number of small, locally owned businesses operating in this area that may not be able to float the downtime due to business closure and could have potentially catastrophic asset losses and/or cleanup costs. Moreover, this chronic flooding diminishes confidence in business investment in Downtown – another economic risk in an already vulnerable locality and region. We note that while the flood waters from Trout Run directly affect in the hundreds of buildings, the more difficult to quantify social and economic impacts of Downtown flooding propagate outward to the Roanoke Region and beyond because of the importance of Downtown Roanoke to the region.

3.2 GOALS AND OBJECTIVES

The City's long range strategic objectives for Trout Run (i.e. the Downtown drainage), the Roanoke River and the remainder of the City's waterways is to reduce flood risk and improve water quality. Progress towards these goals began in Trout Run in 2016 with an extensive watershed mapping, hydrology and hydraulics study that culminated in a 2021 Preliminary Engineering Report (PER, Appendix F)[2] which considered fifty different implementation options, and finally proposed a series of 10-15 green and gray infrastructure projects that would improve the long-range flood resilience of Downtown Roanoke. In general, the projects proposed in this PER were categorized as:

1. *Conveyance* – In the core of Downtown, improve the hydraulic capacity of the existing storm drain system to evacuate the rainfall that lands on the immediate Downtown core as efficiently as possible.
2. *Storage* – In the area immediately upstream of Downtown, detain stormwater runoff using green infrastructure until the peak flood has been evacuated from the immediate core of Downtown as per Strategy 1, Conveyance. Maximize infiltration of upstream runoff and release the remainder at a controlled rate.
3. *Maintenance* – As the existing storm drain system does not have safe or adequate maintenance access, construct access vaults at key points to allow for periodic inspection and debris and sediment removal.

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[1] National Academies of Sciences Engineering and Medicine, *Framing the Challenge of Urban Flooding in the United States*. Washington, D.C.: The National Academies Press, 2019.

[2] A. Morton Thomas and Associates Inc. (2021). *Preliminary Engineering Report for Flood Mitigation in the City of Roanoke's Central Business District (CBD)*. City of Roanoke Department of Public Works.

In this proposal, we request funding to support the construction of the first of a multi-phase, long-range program that incorporates a mixture of green and gray infrastructure to achieve the three implementation objectives outlined in the PER. This proposed "vanguard project" – referred to as the **1st and Salem Drainage Improvements** – will significantly improve flood conveyance at the known epicenter of flooding in Downtown, reduce flood depths in the area by approximately 6" during the 25-year flood and will provide safe maintenance access to the storm drain tunnel system in this area. The project will also move the primary flow path of Trout Run out from underneath an existing private structure and into the public right-of-way avoiding future structural issues to the private building resulting from a nearly 150 year old tunnel. We anticipate that the direct benefits of flood depth reduction afforded by this project would be realized by the owners and tenants of the 35 structures (primarily commercial) immediately adjacent to the project, the reduced risk of vehicle flooding for the 132 surface parking spaces in the flooded area, and by the improved vehicular level of service for the following roadways in the project area: Salem Ave. (2,700 vehicles per day, VPD), 1st St. (740 VPD) and Campbell Ave. (5,800 VPD).

With respect to water quality benefits, the improved clearing of sediment and debris that this project will allow is consistent with the City's efforts towards fine sediment removal as required by the Roanoke River total maximum daily load (TMDL). In addition, this area has had issues with relatively high pathogen indicator concentration – while the exact genesis of this issue is not known, it is anticipated that re-aligning the storm drain away from the sanitary sewer could help alleviate this issue.

The scope of the 1st and Salem Drainage Improvements project includes upsizing existing 15 – 36" diameter storm drain pipes to 4' H x 6' W tunnels, using an alignment that is more hydraulically efficient and that directs flow away from existing structures (see schematic in Appendix C.1 and engineering plans in Appendix E). The proposed work will also include improvements to the aging water mains within the project footprint in order to provide additional benefits to the community with a single project.

3.3 WORK PLAN

In order to execute the proposed project in a timely fashion, a proposed plan of work is provided in Table 1 (next page); this table assumes a grant award of January 2024 with a three year period of performance ending in January 2027. Note that right-of-way acquisition is not included in the work plan, as the proposed work will all take place on an existing City-owned property and the project therefore will not require any acquisition of right-of-way.

Table 1 – Proposed project work plan for 1st and Salem Drainage Improvements. MOT = Maintenance of Traffic; AMT = A. Morton Thomas, the City's design consultant.

Task	Description	Resp. Party	Begin Date	End Date	% Complete	Deliverables
01 - Public Engagement	Share MOT with community, Downtown stakeholders	City	2/6/2018	10/27/2024	85%	Presentations, News Reports, Outreach Notes
02 - Engineering Design	Develop engineering plans, specs, estimate	AMT	12/9/2021	3/1/2024	90%	Final Design Plans and Specifications
03 - Permitting	Prepare, submit, acquire necessary local permits	AMT/City	8/1/2022	3/1/2024	50%	Approved Permit Documentation
04 - Contractor Procurement	Invitation to Bid, Contract Negotiation, Execution	City	3/1/2024	3/31/2024	0%	Executed Construction Contract
05 - Construction	Mobilize, Build, Complete, Document project	City/ Contractor/ AMT	4/30/2024	10/27/2024	0%	Weekly Reports and Photographs
06 - Post-Construction	Admin Closeout	City	10/27/2024	4/25/2025	0%	As-Built Drawings, Final Photographs; Final Acceptance Letter; O&M Reports

Public engagement for this project began in 2018 with a presentation of the broader flood risk mitigation implementation plan to Downtown Roanoke Incorporated, an organization representing the numerous businesses in Downtown Roanoke. Since then, City staff have had numerous conversations with owners of properties adjacent to the proposed work, though no formal meeting has been held as the City cannot provide a construction timeline until funding is secured. The second task described in Table 1 – "02– Engineering and Design" began in December 2021 with the engagement of A. Morton Thomas (AMT) for topographic survey and design services. These plans have gone through several rounds of revisions and are attached to this application as Appendix E. Permitting for this project is limited to local utility and excavation permitting, which has already been initiated and will be completed once final design drawings are complete. With respect to long-term maintenance of the project, the City's Stormwater Division will be responsible for inspecting and maintaining the structure as part of the Division's regular operations; this will include clearing of debris and any accumulated sediment. Maintenance would be performed by the Division's existing operations staff which includes ~30 personnel and a fleet that includes two vactor trucks, two pipe inspection trucks plus a broad range of heavy equipment and maintenance capabilities. As the proposed work uses concrete pipes, it is anticipated that that the lifespan of this project is at least 50 years though conceivably much longer.

3.4 EVALUATION

The selection of this project as the first of several Downtown Flood Resilience projects was the result of five years of mapping, monitoring and hydrology/hydraulic modeling of the Trout Run watershed and its neighboring Lick Run watershed. A full description of the selection of this project in terms of benefit:cost is provided in Section 4.1, but a brief summary is provided here. In general, the Downtown Flooding Preliminary Engineering Report (PER, Appendix G) found that the 1st and Salem Drainage Improvements project provided a strong measure of flood depth reduction, given the relatively low cost of the project as compared to the remaining projects proposed in the PER (see PER page 10, Appendix G). Moreover, this project is unique because it does not require any right-of-way (ROW) acquisition – an extremely important aspect of this project given the highly developed nature of the Downtown area. All future Downtown flooding projects will require at least some ROW acquisition, and in some cases acquisition will comprise a majority of total project cost. This is because the PER estimates that at least 200 acre-ft. of detention storage will be needed (in addition to the proposed conveyance projects) to fully mitigate the 25-yr. storm.

As part of the extensive study and PER process, it was determined that rainfall that exceeded approximately the 5-10 yr. return period based on the City's rain gage network would result in surcharge of the tunnel system and some street flooding, while the 25-yr. return period rainfall would result in structure flooding and vehicle damages. The success of this project and the following series of Downtown flood risk reduction projects will be measured by continuing to document the relationship between rainfall return period and surface flooding. In particular, the evaluation of this project will focus on flooding of the 35 private properties (total area = 4.93 acres) near the intersection of 1st and Salem as well as the continued function of the roadways themselves during threshold-exceeding rainfall events[3]. The City also plans to install a water depth sensor in the new storm drain to compare the hydraulic function of the new tunnel with the existing conditions measured in a 2018 - 2019 study[4]. As this project and subsequent projects are constructed, it is anticipated that surface flooding under the 25-yr. rainfall would diminish to a point that no material impacts would occur, though this would likely require a full build-out of the projects proposed in the Downtown Flooding PER and funding in the $100M range.

In terms of the efficiency in project delivery, the City will submit progress reports as per DCR grant requirements that provide a narrative of work-to-date, estimates of percent complete and documentation of issues that may lead to project delay. The objective of this project tracking and reporting is to evaluate the efficiency of the project delivery in terms of time, conformance to plan, cost, and management of unforeseeable issues.

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[3] The total area of anticipated flood mitigation for this project is 4.93 acres including the 35 private properties near the intersection of 1st and Salem. The largest intersecting census block is 2006, which has a total land area of 0.52 acres. Therefore this project will provide benefits at a scale greater than 100% of a census block.

[4] Aguilar, M. F., Dymond, R. L., & Cooper, D. R. (2019). History, Mapping, and Hydraulic Monitoring of a Buried Stream under a Central Business District. *Journal of Water Resources Planning and Management*, 1–10. https://doi.org/10.1061/(ASCE)WR.1943-5452.0001131

4. SUPPORTING DOCUMENTS FOR PROJECT APPLICATIONS

4.1 PROJECT INFORMATION

The following subsections provide information requested on PDF p.28/50 of the CFPF Round 4 Grant Manual and mirrors the "Scope of Work Supporting Information – Projects" tab in the WebGrants portal.

a. Population – Provide population data for the local government in which the project is taking place, including identification of any low-income geographic area and the estimated number of residents that will be impacted by this project.

The population of Roanoke City was 97,847 as of the 2022 ACS. The median household income of Roanoke City is $48,476 while the median household income of Virginia is $80,615 (both from 2020 U.S. Census); the City's median income is 60.1% of the statewide median, designating the City as a "Low-income geographic area" as per the DCR definition.

This project will take place on the border of Census Block Groups 517700011001 and 517700011002, both of which are designated as "Moderate" social vulnerability. These Block groups would directly benefit from the project, and it is no other impacts to the area are anticipated as the entirety of the project is located within City right-of-way.

b. Historic flooding data and hydrologic studies projecting flood frequency – Provide information on the flood risk of the project area, including whether the project is in a mapped floodplain, what flood zone it is in, and when it was last mapped. If the property or area around it has been flooded before, share information on the dates of past flood events and the amount of damage sustained.

As previously described, the project area is currently mapped as a Zone A – Approximate 1% floodplain, though more rigorous recent modeling studies have provided more detailed information on flooding extent and depth in this area. This effort includes the development of a PCSWMM-2D hydrology/hydraulic model that simulates flow through the tunnels and overland surface flooding as part of the Downtown Flooding PER (see Appendix G and Brendel et al., 2021[5]). This model was calibrated to nine sensors installed in the tunnel system, two nearby rain gages, and was also benchmarked against actual flooding events. This modeling effort indicates that surface flooding in Downtown can be caused by as small as the 5-10 yr. return period rainfall. This was corroborated by estimating the return periods of rainfall events that actually caused surface flooding in Downtown, as shown in Table 2 – photographs of each of these flood events are provided in Appendix D. Note that this type of record-keeping is the function of the City Stormwater Division, which was created in 2014 and as such the City does not have this type of record of flood events prior to 2014.

[5] Brendel, C. E., Dymond, R. L., & Aguilar, M. F. (2021). Modeling Storm Sewer Networks and Urban Flooding in Roanoke, Virginia, with SWMM and GSSHA. *Journal of Hydrologic Engineering*, *26*(1), 1–13. https://doi.org/10.1061/(asce)he.1943-5584.0002021

Table 2 – Flood events in Downtown Roanoke since 2016 and the corresponding rainfall return period that caused the flood.

Date	Start Time	Dura -tion (min)	Depth (in)	Rain Gage	Estimated Return Period (yrs.)	Notes
6/15/2016	18:28	31	1.82	KROA	25 - 50	
7/12/2016	15:12	56	0.21	KROA	N/A	Gage may have missed storm
8/15/2016	14:03	35	0.96	KROA	2	
6/15/2017	18:28	22	1.07	KROA	5 - 10	
4/3/2018	1:05	60	0.10	Garden City Elem USGS	N/A	Gages missed storm
10/11/2018	11:05	180	2.81	Fire Station #5	10 - 25	
8/19/2021	19:40	60	2.24	Lick Run	25	

The observed impacts during these events included business closure for post-flood clean up, loss of business assets, vehicle damages and loss of roadway use. However, it is important to note that records of monetary damages due to these storms was not available as most of the buildings in Downtown are tenant occupied and the tenants do not carry flood insurance.

c. No adverse impact – Studies, data, reports must demonstrate proposed project minimizes flood vulnerabilities and does not create flooding or increased flooding (adverse impact) to other properties.

Due to the complex hydrodynamic nature of Downtown flooding, it is not possible to definitively quantify no adverse impact at all points in the system. However, because this project replaces a section of storm drain that is significantly undersized and allows runoff to flow into a section of storm drain that has a significantly higher flow capacity, no adverse impact is anticipated from this project.

d. The ability of the local government to provide its share of the cost – This must include an estimate of the total project cost, a description of the source of the funds being used, evidence of the local government's ability to pay for the project in full or quarterly prior to reimbursement, and a signed pledge agreement from each contributing organization.

The total proposed project cost as outlined in Section 5 with supporting documentation in Appendix B is $2,556,214.00; as the proposed project is the first of a portfolio of both green and gray solutions to Downtown Flooding outlined in the Downtown PER, we propose this project as a "hybrid" solution which would result in a match for this project would be 90% DCR/10% City. This would require a commitment of $255,621.40 by the City, though a portion of this has already been encumbered for the pre-award design and permitting work by AMT. As such, the total additional commitment needed from the City would be $246,000.00 which has already been appropriated out of the City's FY2024 general obligation bond issuance (see Appendix B.4).

e. Benefit-cost analysis must be submitted with project applications over $2,000,000. In lieu of using the FEMA benefit-cost analysis tool, applicants may submit a narrative to describe in detail the cost benefits and value. The narrative must explicitly indicate the risk reduction benefits of a flood mitigation project and compares those benefits to its cost-effectiveness. (https://www.fema.gov/grants/tools/benefit-cost-analysis)

This proposed project provides multi-faceted flood risk mitigation benefits that could not be reasonably estimated using FEMA's benefit-cost analysis (BCA) spreadsheet. This is because the proposed project will reduce flood depths at 35 adjacent parcels comprised of 4.93 acres of businesses and surface parking and will improve transportation level of service through the area. By comparison the BCA tool is built to estimate benefits that are more straightforward in nature (e.g. demolition of a single floodprone structure). As such, a narrative is provided here that relies on the same principles of the BCA tool that describes the extent of benefits provided by the project, and compares these benefits to the cost.

First, it is important to understand that this project is designed to reduce flood depths by approximately six inches during the 25 yr. rainfall event – which has a 4% annual exceedance probability in any given year. This means that benefits from the project would be realized at a relatively high frequency as this project would also reduce flood depths for smaller more frequent events (e.g. 5 yr., 10 yr.) that can also sometimes cause flooding in this area. The high frequency that benefits would be realized is exemplified by the fact that this area has flooded seven times in the past seven years (Table 2), or on average once per year (though obviously the events were not evenly distributed). The benefits realized by this project can be divided into five general categories: (1) property damages avoided to the 23 adjacent buildings; (2) vehicle damages avoided to the 132 parking spaces in the project impact area; (3) improved transportation level of service through the area (4) water quality and (5) indirect social, economic and cultural impacts.

Property Damages Avoided – Within the project impact area, the 35 adjacent parcels contain 23 commercial buildings with a 2023 structure value of $27.5M. However, all of these buildings are 3-4 stories tall, and any flood impacts/benefits would only affect the first floor. As such, we estimate that the total first floor value of all 23 buildings is $6.875M (one-fourth of the total value). Structure depth-damage relationships from FEMA's HAZUS-MH Software[6] suggest that for commercial office buildings, the first incremental foot of flooding incurs damages equivalent to 26% of a building's value. However, as the proposed project is only estimated to reduce flooding by approximately 0.5 ft. for the 25-yr. storm, we assume that the marginal structure damage reduction for this particular event is 13% of each building's first floor value or $894K. Similarly, for commercial structures, FEMA estimates that on average the contents of these structures can be valued at 12% of the building value[7], resulting in an additional $825K in estimated contents value for first floor of the 23 buildings. Contents depth-damage relationships

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[6] Scawthorn, C., Flores, P., Blais, N., Seligson, H., Tate, E., Chang, S., Mifflin, E., Thomas, W., Murphy, J., Jones, C., and Lawrence, M. (2006). HAZUS-MH Flood Loss Estimation Methodology. II. Damage and Loss Assessment. *Natural Hazards Review*, *7*(2), 72–81. doi:10.1061/(asce)1527-6988(2006)7:2(72).

[7] FEMA. (2019). *FEMA Benefit Cost Analysis (BCA) Toolkit Help Content*. Washington, D.C.: Federal Emergency Management Agency.

from HAZUS-MH suggest that for large commercial offices, the first incremental foot of flooding incurs damages equivalent to 16% of total contents value. Again, as this project only reduces flooding by 0.5 ft. for the 25-yr. storm, we assume that the marginal contents damage reduction is 8% of the total first floor contents value or $66K. This means that the total first floor structure and contents damage reduction provided by the project for all 23 structures is estimated as $960K for the 25-yr. storm.

The total property damages avoided can then be estimated as the present value of the annual probability of the 25-yr. storm (4%) multiplied by the total damage reduction provided for this storm ($960K) over the project's lifecycle, which we assume to be 50 years. Using a conservative estimate of the annual appreciation in real estate and contents valuation of 2% renders a **property damages avoided benefit of $3.4M over the project's 50-yr lifecycle.** We note that this analysis only focuses on the 25-yr. storm and does not add the benefits that would be realized during smaller more frequent storms or larger less frequent storms – this would increase the benefits significantly.

Vehicle Damages Avoided – As the conservative estimate of building and contents damages avoided already outweighs the cost to deliver this project, we do not attempt to monetize vehicle damages avoided. However, it should be noted that there are an estimated 132 public and private parking spaces in the area of flood impacts for this project, and based on a 2012 Downtown Parking Study[8] it is estimated that at any given time, 112 of these 132 spaces are occupied. In addition, based on the average annual daily traffic (AADT) of Salem Ave. in this area of 2,700 vehicles per day, it is estimated that over the duration of a typical flood event in this area – approximately 0.5 hrs., that 56 vehicles would be traveling in the impact area. This means that on average, there may be a total of 168 vehicles parked or driving through the flood impact area at any time that flood conditions may occur. While this is likely a reasonable estimate of the number of vehicles in the area, staff experience suggests that vehicle impacts rarely exceed 5-10 vehicles damaged and there is insufficient data on the level of damage incurred to these vehicles. As such, no attempt to monetize vehicle damage is attempted, though it is important to understand that reduction in vehicle damages would be an additional benefit provided by this project.

Transportation Level of Service - As the conservative estimate of building and contents damages avoided already outweighs the cost to deliver this project, we do not attempt to monetize benefits related to a reduction in lost time due to flood impacts. However, AADT estimates from VDOT are provided here for reference, as reduced flooding of the travelled way would improve uptime and reduce local business impacts.

[8] RVARC. (2012). *Downtown Roanoke Parking Study*. Roanoke Valley-Alleghany Regional Commission. http://rvarc.org/wp-content/uploads/2014/10/Parking-Study-Final-Report-Phase-I.pdf

Table 3 – Average Annual Daily Traffic (AADT) estimates for roadways in the flood impact area in units of vehicles per day

Roadway Section	Average Annual Daily Traffic (vehicles per day)
Salem Ave. b/w Jefferson and 2nd	2,700
1st St. b/w Campbell and Salem	740
Campbell Ave. b/w Jefferson and 3rd St.	5,800

Water Quality – This project would allow for periodic clearing of sediment, debris and trash from the storm drain system, consistent with the City's sediment total maximum daily load (TMDL). In addition, the re-alignment of the storm drain will move the primary flow of the system away from an existing 15" vitrified clay sewer line built pre-1900. It is likely that the re-alignment of the storm drain proposed in this project will help mitigate some of the known pathogen issues in this tunnel.

Indirect Social, Cultural and Economic Impacts – Flood reduction in this area would also result in impact reduction associated with diminished property values/associated loss of tax base, diminished usage of downtown businesses, psychological impacts, etc. Inclusion of these non-structural damages may significantly increase the estimated existing risk and also the marginal benefit of the proposed project, though no estimate was attempted as part of this study because of the complex nature and high level of uncertainty in these economic calculations.

Summary – Using the principles embedded in FEMA's BCA worksheet, we estimate that benefits from property damages avoided provided by this project are at least $3.4M, which would result in a favorable **benefit to cost ratio of 1.31.** However we note that additional benefits related to vehicle damages avoided, roadway uptime, and socioeconomic/cultural issues would further improve this ratio but could not be reasonably monetized for this proposal.

f. The administration of local floodplain management regulations – The Department will determine if the community is in good standing with the NFIP. If applicable, provide the Department with a link to the current floodplain ordinance, or attach a PDF or Word document of the ordinance.

The City's Floodplain Ordinance is located at City Code Sec. 36.2-333 – Floodplain Overlay District (F), and a direct hyperlink to the ordinance is below:
https://library.municode.com/va/roanoke/codes/code_of_ordinances?nodeId=CORO1979_CH36.2ZO_ART3RESPZODI_DIV5OVDI_S36.2-333FLOVDIF

g. Other Necessary Information to Establish Project Priority:

i. Repetitive Loss and/or Severe Repetitive Loss Properties - Do not provide the addresses for these properties but include an exact number of repetitive loss and/or severe repetitive loss structures within the project area. Work with the local floodplain administrator or emergency manager to find this information. If they do not have a list of repetitive loss/severe repetitive loss structures, the Department can assist them in accessing these lists for NFIP insured structures. Please note, that

repetitive loss and/or severe repetitive loss often occurs outside of the SFHA and to properties not captured in NFIP reporting. All flooding involving these properties should be tracked and addressed by the community.
No repetitive loss (RL) or severe repetitive loss (SRL) properties are within or adjacent to the project site.

ii. **Residential and/or Commercial Structures - Describe the residential and commercial structures impacted by this project, including how they contribute to the community such as historic, economic, or social value. Provide an exact number of residential structures and commercial structures in the project area. (250 Words)**
Proposed project will provide benefits to a number of structures as defined in Section 3.1, but will not otherwise impact any existing structures (i.e. no right-of-way acquisition or modifications to existing structures are proposed).

iii. **Critical Facilities/Infrastructure - If there are critical facilities/infrastructure within the project area, describe each facility. (250 Words)**
No critical facilities/infrastructure within project area

4.2 NEED FOR ASSISTANCE

Identify and describe any relevant issues or problems that will be addressed by the project.

a. **Explain the local government's financial and staff resources. Identify relevant staff members (floodplain administrators, planners, emergency managers, building officials, engineers) employed with the local government. Identify relevant software the local government has access to. Explain the local government's capabilities. (250 Words)**
The City of Roanoke Stormwater Division has a backlog of approximately $150M in neighborhood drainage projects, $90M in downtown flooding projects and $150M in water quality projects. By comparison, the City's annual bond issuance for Stormwater projects is typically $3M supplemented with $0.5M in cash revenue. As such, it is imperative that the City leverage external funding in order to achieve the long range goals of flood risk mitigation and improved water quality. To work towards these goals, the City has a Stormwater technical staff comprised of a Division Manager, three senior engineers, one water quality administrator, three junior engineers, one project inspector, two GIS/Asset Management staff and two environmental specialists. The Stormwater Division also has nearly thirty front-line operations employees that build and maintain stormwater assets, and the Division collaborates heavily with the City's Planning Building and Development Department, City Engineer's office, and Emergency Managers.

This particular project will be managed by a senior stormwater engineer (P.E.), with the support of a junior engineer (E.I.T.), project inspector, and consultant construction engineer (P.E.). The design and permitting team at AMT includes a senior engineer (P.E., CFM), an engineering principle (P.E., CFM) and a Designer. Hydraulic and hydrologic modeling for this effort was performed in PCSWMM-2D and all design work was performed in AutoCAD Civil 3D.

b. **The Department will prioritize low-income geographic areas for funding.**

i. **The Department will consider the project area's social vulnerability index score when reviewing grant applications. The Social Vulnerability Index layer, available through Virginia Flood Risk Information System (VFRIS), will be used for this review.**
The social vulnerability indices (SVIs) for the census block groups 517700011002 and 517700011001 in which this project is located are both designated as "moderate" in the VFRIS (2020).

ii. **This index is based on census block data; the index score for the census block that contains the project area should be used. If the project area falls within multiple census blocks, please provide the scores for all census blocks. The average score for the project area will be used for scoring the application.**
The reviewer should note that the GIS layers provided in the VFRIS are at the census block group level, not the block level

4.3 ALTERNATIVES

If the project proposed does not employ a nature-based or hybrid solution and the total project cost is greater than $2 million, describe at least one alternative that could reasonably address the issue identified. Please also consider the No Action Option as a third alternative as part of the analysis. Explain these alternatives and the reason the proposed project was selected.

As previously described, the scale and age of the Downtown Flooding issue cannot be resolved with a single project, and will require the construction of several projects over an approximately 50 year timeframe. As such, the City has a list of 10-15 projects from the 2021 Downtown Flooding PER (Appendix G) that incorporate a combination of green and gray infrastructure to reduce Downtown flood risk. While the proposed project does not employ a nature-based solution, it is the first step in a hybrid (i.e. green and gray infrastructure) approach to the problem. It is important to note that in the Downtown Flooding PER, fifty different options were initially considered by the consultant, which were subsequently narrowed down to a shorter list of fifteen projects using a combination of modeling, GIS analysis, professional judgment, economic considerations, etc.

The selection of the 1st and Salem Drainage Improvements project as the first of the proposed projects was because of the relatively small capital outlay needed to deliver the project and because no additional right-of-way was needed for the project. By comparison, the remaining projects proposed in the PER are significantly more costly, more complex in terms of ROW and engineering, and will take further planning to assure successful delivery. The 1st and Salem project therefore represents the "vanguard" project for the Downtown Flood Resilience program while planning and funding for the remaining projects is completed. In particular, the City has an existing grant application under review in FEMA's 2022 Building Resilient Infrastructure and Communities (BRIC) program to support the development of construction documents for green infrastructure upstream of Downtown[9]; it is anticipated that the construction phase of these projects would be submitted to a future round of BRIC or to DCR's CFPF program, depending on the final scope of these projects.

[9] Search "Roanoke" at FEMA's BRIC webpage here: https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities/after-apply/fy22-status

Finally, the No Action option was explored as part of a staff analysis in 2021 that found that the existing flood risk to Downtown Roanoke is approximately $116M (2021 USD) over a 50-year planning horizon.

4.4 Goals and Objectives

Identify and describe the goals and objectives of the project. Include a description of the expected results of the completed project and explain the expected benefits of the project. This may include financial benefits, increased awareness, decreased risk, etc. (250 Words)

See Section 3.2.

4.5 Approach, Milestones and Deliverables

Outline a plan of action laying out the scope and detail of how the proposed work will be accomplished with a timeline identifying expected completion dates. Determine milestones for the project that will be used to track progress. Explain what deliverables can be expected at each milestone, and what the final project deliverables will be. Identify other potential project partners (250 Words)

See Section 3.3.

4.6 Relationship to Other Projects

Where applicable, briefly describe the relationship between this project and other past, current, or future resilience projects. If the applicant has received or applied for any other grants or loans through the CFPF, please identify those projects, and, if applicable, describe any problems that arose with meeting the obligations of the grant and how the obligations of this project will be met. (250 Words)

As previously described, this project represents the first of several Downtown flood resilience projects to be constructed over the next fifty years as per the Downtown Flooding PER (Appendix G). In addition to this grant proposal, the City also has an application under review in FEMA's 2022 Building Resilient Infrastructure and Communities (BRIC) program to support the development of construction documents for green infrastructure upstream of Downtown. It is anticipated that the construction phase of these projects would be submitted to a future round of BRIC or to DCR's CFPF program, depending on the final scope of these projects. In order to understand the importance of the 1st and Salem Drainage Improvements project, it is imperative that the project be evaluated in the context of the larger scale improvements that the City plans to make with respect to Downtown Flooding.

4.7 Maintenance Plan

For ongoing projects or projects that will require future maintenance, such as infrastructure, flood warning and response systems, signs, websites, or flood risk applications, a maintenance, management, and monitoring plan for the projects must be provided demonstrating how they will be maintained, managed, and monitored after the lifespan of this award for a minimum of ten years or the expected lifespan of the project, whichever is longer. (250 Words)

Maintenance will be the responsibility of the City of Roanoke's Stormwater Division; the Division presently has the maintenance staff (~30 personnel) and equipment to inspect and maintain this project over its lifecycle. This includes:

- Periodic inspection of the structure by pipe camera and/or manned entry if necessary
- Removal of sediment and small debris using a vactor truck
- Removal of any larger debris as needed

4.8 CRITERIA

Describe how the project meets each of the applicable scoring criteria contained in Appendix D and provide the required documentation where necessary. Documentation can be incorporated into the Scope of Work Narrative or included as attachments to the application.

The DCR grant criteria are listed in Table 4 with scores for the proposed project, a description and the pertinent supporting section in the "Reference" column.

Table 4 – DCR CFPF Grant Criteria from Round 4 manual

Criteria	Points Available	Proposed Project	Description	Reference
Eligible Projects	30	15	Hybrid approach	Section 3.2, 4.3
Social Vulnerability Index Score	10	5	VFRIS "Moderate"	Section 4.2
Community scale of benefits	30	30	Total mitigation area = 4.93 acres; Largest impacted block 2006 = 0.52 ac	Section 3.4
Expected lifespan of project	10	10	Over 20 years	Section 3.3
Remedy for NFIP probation/suspension	5	0	No	
Proposed project part of a low-income geographic area	10	10	City of Roanoke designated as low income	Section 4.1a
Proposed project implements a Chesapeake Bay TMDL	5	5	Improved sediment/debris clearing capability; pathogen mitigation benefit	Section 3.2, 4.1e
TOTAL	*100*	*75*		

5. BUDGET NARRATIVE

In this section, we provide a project budget summary (Table 5) and narrative for all costs related to the proposed work. An Engineer's Construction Cost estimate is provided in Appendix B along with executed Task Order contracts for design services which have been completed pre-award. The City requests reimbursement for these pre-award design services, as the deliverables from these contracts constitute the necessary construction documents for the proposed work. The total costs proposed reflect the total cost to bring this project to completion including engineering fees (pre-award and startup line) and contractor fees (construction line). The City requests that this project be funded as a hybrid approach (90% fund/10% City), as the proposed work represents the first of numerous Downtown flood resilience projects, and per DCR recommendations in Appendix F. Evidence of the City's ability to fund the local match is provided in Appendix B.4. Authorization to request funding is provided in Appendix C.13. The City does not plan to use staff salaries as match but would note the significant staff effort required to accomplish this project as described in Section 4.2.a. Furthermore, we note that the City is committed to funding long-term maintenance of this structure, which is not shown as part of the Local Share, but is a major commitment over the project's life-cycle.

Table 5 – Project budget summary table

Applicant Name:	City of Roanoke, VA
Project Name:	1st and Salem Drainage Improvements
Period of Performance	
Start Date:	1/2/2024
End Date:	1/1/2027
Submission Date:	11/12/2023
Project Type:	Hybrid
DCR Match	90%

Description	**Federal Share**	**State Share**	**Local Share**	***Total***
Personnel				*$0.00*
Fringe				*$0.00*
Travel				*$0.00*
Equipment				*$0.00*
Supplies				*$0.00*
Construction		$2,214,000.00	$246,000.00	*$2,460,000.00*
Contracts				*$0.00*
Maintenance Costs				*$0.00*
Pre-Award and Startup		$86,592.60	$9,621.40	*$96,214.00*
Other Direct Costs				*$0.00*
Total	*$0.00*	*$2,300,592.60*	*$255,621.40*	*$2,556,214.00*

Estimated Total Project Cost:	$2,556,214.00
Amount Request from the Fund:	$2,300,592.60
Local Match:	$255,621.40

APPENDIX A - PROJECT APPLICATION FORM

Applicants must have prior approval from the Department to submit applications, forms, and supporting documents by mail in lieu of the WebGrants portal.

Appendix A: Application Form for Grant and Loan Requests for All Categories

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Virginia Department of Conservation and Recreation
Virginia Community Flood Preparedness Fund Grant Program

Name of Local Government: City of Roanoke, Virginia

Category Being Applied for (check one):

☐ **Capacity Building/Planning**

☑ **Project**

☐ **Study**

NFIP/DCR Community Identification Number (CID) 510130

Name of Authorized Official and Title: Robert S. Cowell, Jr.; City Manager

Signature of Authorized Official: _____

Mailing Address (1): 215 Church Ave SW

Mailing Address (2): _____

City: Roanoke **State:** VA **Zip:** 24011

Telephone Number: (540) 853-2333 **Cell Phone Number:** (____) _____

Email Address: bob.cowell@roanokeva.gov

Contact and Title (If different from authorized official): Marcus F. Aguilar; Civil Engineer II

Mailing Address (1): 1802 Courtland Rd. NE

Mailing Address (2): _____

City: Roanoke **State:** VA **Zip:** 24012

Telephone Number: (____) _____ **Cell Phone Number:** (540) 580-7209

Email Address: marcus.aguilar@roanokeva.gov

Is the proposal in this application intended to benefit a low-income geographic area as defined in the Part 1 Definitions? Yes X No ____

Categories (select applicable activities that will be included in the project and used for scoring criterion):

Capacity Building and Planning Grants

☐ Floodplain Staff Capacity.

☐ Resilience Plan Development

- ☐ Revisions to existing resilience plans and modifications to existing comprehensive and hazard mitigation plans.
- ☐ Resource assessments, planning, strategies, and development.
  - o Policy management and/or development.
  - o Stakeholder engagement and strategies.

☐ Other: _____

Study Grants (Check All that Apply)

☐ Studies to aid in updating floodplain ordinances to maintain compliance with the NFIP, or to incorporate higher standards that may reduce the risk of flood damage. This must include establishing processes for implementing the ordinance, including but not limited to, permitting, record retention, violations, and variances. This may include revising a floodplain ordinance when the community is getting new Flood Insurance Rate Maps (FIRMs), updating a floodplain ordinance to include floodplain setbacks, freeboard, or other

higher standards, RiskMAP public noticing requirements, or correcting issues identified in a Corrective Action Plan.

- ☐ Revising other land use ordinances to incorporate flood protection and mitigation goals, standards, and practices.
- ☐ Conducting hydrologic and hydraulic (H&H) studies of floodplains. *Changes to the base flood, as demonstrated by the H&H must be submitted to FEMA within 6 months of the data becoming available.*
- ☐ Studies and Data Collection of Statewide and Regional Significance.
- ☐ Revisions to existing resilience plans and modifications to existing comprehensive and hazard.
- ☐ Other relevant flood prevention and protection project or study.

Project Grants and Loans (Check All that Apply – Hybrid Solutions will include items from both the "Nature-Based" and "Other" categories)

Nature-based solutions

- ☐ Acquisition of property (or interests therein) and/or structures for purposes of allowing floodwater inundation, strategic retreat of existing land uses from areas vulnerable to flooding; the conservation or enhancement of natural flood resilience resources; or acquisition of structures, provided the acquired property will be protected in perpetuity from further development, and where the flood mitigation benefits will be achieved as a part of the same project as the property acquisition.
- ☐ Wetland restoration.
- ☐ Floodplain restoration.
- ☐ Construction of swales and settling ponds.
- ☐ Living shorelines and vegetated buffers.
- ☐ Permanent conservation of undeveloped lands identified as having flood resilience value by *ConserveVirginia* Floodplain and Flooding Resilience layer or a similar data driven analytic tool, or the acquisition of developed land for future conservation.
- ☐ Dam removal.
- ☐ Stream bank restoration or stabilization.
- ☐ Restoration of floodplains to natural and beneficial function.

Other Projects

- ☐ Structural floodwalls, levees, berms, flood gates, structural conveyances.
- ☑ Storm water system upgrades.
- ☐ Medium and large-scale Low Impact Development (LID) in urban areas.

- ☐ Developing flood warning and response systems, which may include gauge installation, to notify residents of potential emergency flooding events.
- ☐ Dam restoration.
- ☐ Beneficial reuse of dredge materials for flood mitigation purposes
- ☐ Removal or relocation of structures from flood-prone areas where the land will not be returned to open space.
- ☐ Acquisition of property (or interests therein) and/or structures for purposes of allowing floodwater inundation, strategic retreat of existing land uses from areas vulnerable to flooding; the conservation or enhancement of natural flood resilience resources; or acquisition of structures, provided the acquired property will be protected in perpetuity from further development, and where the flood mitigation benefits will **not be** achieved as a part of the same project as the property acquisition.
- ☐ Other project identified in a DCR-approved Resilience Plan.

Location of Project or Activity (Include Maps): Roanoke City, Virginia (see attached map)

NFIP Community Identification Number (CID#) : 51030

Is Project Located in an NFIP Participating Community? ☑ Yes ☐ No

Is Project Located in a Special Flood Hazard Area? ☑ Yes ☐ No

Flood Zone(s) (If Applicable): Zone A

Flood Insurance Rate Map Number(s) (If Applicable): 51161C0164G

Total Cost of Project: $2,556,214.00

Total Amount Requested $2,300,592.60

Amount Requested as Grant $2,300,592.60

Amount Requested as Project Loan (not including short-term loans for up-front costs) $0

Amount Requested as Short-Term loan for Up-Front Costs (not to exceed 20% of amount requested as Grant) $0

For projects, planning, capacity building, and studies in low-income geographic areas: Are you requesting that match be waived? ☐ Yes ☑ No

Additional Information for Loan Requests

Requested Loan Security: _____

(General Obligation, Lease, Revenue, Special Fund Revenue, and/or Moral obligation from other government entity)

Desired loan term: _____

Since the date of your latest financial statements, did the applicant issue any new debt? _____
(If yes, provide details)

Is there any pending or potential litigation by or against the applicant? _____

Attach five years of current audited financial statements (FY18-22) or refer to website if posted
(Not necessary for existing VRA borrowers)

Not Applicable

Attach FY2024 adopted budget or refer to website

Attach current Capital Improvement Plan

Attach adopted Financial Policies

Attach a list of the ten largest employers in the Applicant's jurisdiction.

Attach a list of the ten largest taxpayers in the Applicant's jurisdiction

APPENDIX B - DETAILED BUDGET NARRATIVE SUPPLEMENTAL INFORMATION

This Appendix contains four attachments supplementing the budget narrative provided in Section 5 of this Grant Proposal. The three attachments include:

1. Engineer's cost estimate showing individual items, unit costs, and total costs.
2. An executed Task Order for design and permitting services for the 1st and Salem Drainage Improvements
3. An executed Task Order for additional water line design that was necessary as part of this project
4. A summary table from the City's Accounting System (AC554), showing the funding balance in the project capital account. The reviewer will note that the "Current Budgeted Amt" total exceeds the City's match needed for this project, as the City had anticipated the lesser DCR match that was available in previous rounds of this program. The excess City funds would be transferred from this account to provide the City match for the proposed Ore Branch Stream and Landscape Restoration project or another flood resilience project.

City of Roanoke
Stormdrain Capital Improvement Projects

Project Name	Project ID	Date	Engr
Salem Av. and 1st St. 'L-Tunnel'	1143	10/6/2023	JVJudy

Item	Quantity	Unit	Unit Price	Item Total
Mobilization / Demobilization	Lump Sum			$190,000.00
Construction Stakeout & Survey	Lump Sum			$15,000.00
Maintenance of Traffic and Work Area Protection	Lump Sum			$40,000.00
Erosion & Sediment Control	Lump Sum			$5,000.00
Demolition	Lump Sum			$25,000.00
Excavation - Disposal of Excess	Lump Sum			$60,000.00
Trench Rock Removal	200	CY	$200.00	$40,000.00
Sheet Piling	400	LF	$360.00	$144,000.00
6" D.I. Water Main	240	LF	$200.00	$48,000.00
12" D.I. Water Main	345	LF	$225.00	$77,625.00
6" D.I. Miscleanous Fittings	6	EA	$500.00	$3,000.00
12" D.I. Miscleanous Fittings	8	EA	$1,000.00	$8,000.00
6" Gate Valve	2	EA	$5,000.00	$10,000.00
Concrete Pier	2	EA	$1,000.00	$2,000.00
Fire Hydrant Assembly	1	EA	$10,000.00	$10,000.00
6" Water Main Connection	6	EA	$2,000.00	$12,000.00
10" Water Main Connection	1	EA	$2,500.00	$2,500.00
New Water Meter - 3/4"	1	EA	$5,000.00	$5,000.00
Saw-Cut and Asphalt Base Restoration	330	SY	$100.00	$33,000.00
Junction Box - Campbell and 1st	1	LS	$150,000.00	$150,000.00
Junction Box - Salem Av.	1	LS	$125,000.00	$125,000.00
6' x 4' Concrete Box Culvert	325	LF	$2,500.00	$812,500.00
6' x 4' Concrete Box Culvert -45 Bends	2	EA	$25,000.00	$50,000.00
4' Dia. Concrete Access Manhole Riser	3	EA	$5,000.00	$15,000.00
Existing Inlet Modification - Pipe Extension	7	EA	$4,000.00	$28,000.00
Existing Inlet Modification - New Pipe Connection	2	EA	$7,500.00	$15,000.00
Saw-Cut and Asphalt Base Restoration	525	SY	$100.00	$52,500.00
VDOT Std. CG-2 Concrete Curb	50	LF	$100.00	$5,000.00
VDOT Std. CG-6 Concrete Curb and Gutter	50	LF	$125.00	$6,250.00
Concrete Pavement/Walk - 7" Depth	20	SY	$600.00	$12,000.00
Brick Soldier Course	120	LF	$80.00	$9,600.00
Tree Replacement	5	EA	$1,000.00	$5,000.00
Pavement Milling	2200	SY	$10.00	$22,000.00
Pavement Overlay	2200	SY	$30.00	$66,000.00
4" Wide Pavement Striping - Yellow	900	LF	$2.50	$2,250.00
4" Wide Pavement Striping - White	100	LF	$2.50	$250.00
8" Wide Crosswalk Striping - White	60	LF	$5.00	$300.00
2' Wide Stop Bars	60	LF	$20.00	$1,200.00
Directional Arrows	1	EA	$350.00	$350.00
Loop Detectors / Pedestrian Signal Repair or Replace	1	LS		$15,000.00
Record / As-built Drawings - Stormwater	Lump Sum			$7,500.00
Record / As-built Drawings - WVWA	Lump Sum			$7,500.00
			Sub-Total	$2,138,325.00
			15% Contingency	$321,000.00
			ESTIMATED TOTAL	$2,460,000.00

Contract Task Order

Vendor / Contract Number: A. Morton Thomas and Associates Inc.
Purchase Order #: CT211209000292
Date: 12/09/2021

The terms and conditions of the above referenced Contract apply to this Contract Task Order and are incorporated by reference. The parties acknowledge and agree that the Contract, the RFP issued by the City, the Consultant's Proposal submitted in response to the RFP, and this Contract Task Order, constitutes the entire agreement between the parties with respect to the provision of On-Call Architecture, Engineering and Construction Support Services.

SCHEDULE 1: GENERAL DESCRIPTION AND SCOPE OF SERVICES

In the attached Consultant's proposal is a Description of the Project(s) and Work for which the Consultant has been engaged.

SCOPE OF SERVICES:

The Consultant covenants and agrees to provide all necessary On-Call Architecture, Engineering and Construction Support Services required to professionally accomplish the work and services, as set forth within this Contract Task Order. This Contract Task Order identifies the specific Phase(s) of service for which the Consultant is being engaged, along with the Consultant's compensation and time for performance. The Scope of Work is included in the attached Consultant's proposal.

SCHEDULE 2: PROJECT SCHEDULE AND DELIVERABLES

The attached proposed schedule details how the Consultant plans to achieve completion of performance within the time specified within this Contract Task Order. Review and acceptance of the Project Schedule by the Owner shall not relieve the Consultant of any of its responsibility to timely complete performance in accordance with the agreed Contract Task Order. The Project Schedule shall incorporate sufficient time for preparation and review of documents and submittals. The schedule is included in the attached Consultant's proposal.

SCHEDULE 3: CONSULTANT'S PERSONNEL AND SUBCONSULTANTS CHART

In performing the Services, the Consultant shall utilize its own staff and such other persons or firms as are identified within the attached Consultant's proposal. The Consultant may not substitute any other staff, individual(s) or firms without the advance written consent of the Owner. Under no circumstances shall the Owner be required to consent to or accept any substitution(s) if to do so would require an increase in any

amount(s) required to be paid to the Consultant for this Project, or a decrease in the Services described under this Contract Task Order.

SCHEDULE 4: CONSULTANT'S SCHEDULE OF SERVICES AND FEES

The Consultant shall choose to be compensated on either a Fixed Sum or Percentage Basis, or on a Time Basis, as detailed below.

1 - Fixed Sum Basis or Fixed Percentage Basis

In the attached Consultant's proposal is a Fixed Sum or Fixed Percentage for the services that the Consultant shall supply in its performance of the Project(s) under this Contract Task Order.

Consultant's Cost of Services as a Fixed Sum: $

2 - Time Basis

In the attached Consultant's proposal is a list of all billable services that the Consultant may supply in its performance of individual Project(s) under this Contract Task Order, and the hourly rates at which those services will be billed for the duration of this Contract Task Order. The Consultant shall set forth its hourly rates for standard services that would be necessary to perform the range of services listed in Schedule 1.

Not to Exceed Amount: $79,326.00

Unless otherwise indicated within the Project Schedule, this Contract Task Order serves as a Notice to Proceed for the Project(s) and Work described within this Contract Task Order.

DocuSigned by:
Pamela Simpkins
85925E4EF8FD48E...

Pamela Simpkins, CPPB, VCO
Purchasing Manager

12/9/2021
Date

December 6, 2021

Joseph Judy, P.E., Acting CIP Manager
City of Roanoke, Stormwater Utility
Public Works Service Center
1802 Courtland Road, NE
Roanoke, Virginia 24012
Via Email: joseph.judy@roanokeva.gov

RE: Term Contract for Group V – Stormwater Management
Salem Avenue and 1st Street – L-Shaped Tunnel Design Task
AMT File P18-1108

Mr. Judy:

A. Morton Thomas and Associates, Inc. (AMT) is pleased to provide this task order proposal pursuant to our Term Contract Agreement for Professional Services in Group V, Stormwater Management with the City of Roanoke, that is dated March 7, 2019, and all terms are incorporated herein by reference.

SCOPE OF WORK

This scope of work includes the surveying, engineering design and construction support for installing a new storm drain system at the intersection of Salem Avenue and 1st Street. The design will be in general agreement with recommendations in the Downtown Flood Mitigation Study, dated November 2020.

The focus of this project is to provide flood relief for the Central Business District with the installation of a new drainage diversion pipe system that begins at the intersection of the existing storm drain system along Salem Avenue, just west of 1st Street, and then continues along Salem Avenue and 1st Street to the Campbell Tunnel at the intersection of 1st Street and Campbell Avenue. Improved maintenance access will be established into the storm drainage system as part of this engineering design for the 25-year design storm event using PC-SWMM modeling of the downtown area for pipe sizing. This project is budgeted at $1.4M using local stormwater utility funds for the design and construction work planned in 2022.

Task 01 - Topographic Survey

Given their recent surveying along Salem Avenue just east of 1st Street, AMT will hire Balzer Associates to conduct a topographic survey and base mapping for this project. The survey will include:

1. Coordinate survey schedule and survey workplan with AMT and city staff.
2. Call in a Miss Utility Ticket to then pickup the paint marks from.
3. Establish horizontal and vertical control points as required for the fieldwork.

4. Perform topographic surveying along the new storm drain route on Salem Avenue and 1st Street based on the attached survey limits map. Measure and obtain pipe inverts and pipe sizes of existing storm drains and sanitary sewers.
5. Research and plot property and street rights-of-way on the topographic survey based on available property records, right of way records, and plats.
6. Prepare an AutoCAD base map at 1" = 20' scale with a Civil-3D digital topographic model (DTM) or similar modeling of existing topography.

All construction work and staging are currently anticipated within the public rights of way, so no temporary or permanent drainage easements or plats are included for this project.

Task 02 - Preliminary Engineering Design (60%)

Preliminary engineering design will move directly to the intermediate level of detail for this project and will include the following:

1. Kickoff meeting to review changes to the prior concept plan that were discussed during the scoping meeting. This includes: (1) Moving the incoming junction box to sit over the 42"x72" east-west arch pipe; (2) moving the 45-degree bends or junction boxes at Salem/1st Street into the street to avoid sidewalk hardscapes, (3) moving the storm drain along 1st Street into the street itself, and (4) Building the outlet pipe over the 64"x120" arch pipe in Campbell Avenue.
2. Hydrology and Hydraulics (H&H) Modeling for the existing and proposed conditions will be updated in the downtown PC-SWMM modeling to determine any relative differences in proposed flood reduction benefits for the intermediate design. We will look at the benefits of increasing the pipe size relative to the concept plan and costs involved in upsizing to then work with the City to make a determination on the desired pipe size to be "maximized" per our scoping meeting.
3. Drainage calculations will additionally include rational equation hydrology and inlet throat sizing for spread in the gutter pan, per HEC-12 methods. GIS contours will be used to supplement field surveying for overall general layouts and drainage area mapping needs.
4. Plan and profile of proposed storm drain systems, with trench details and a preliminary determination for the limits of disturbance. No stormwater management calculations for water quantity and quality compliance should be required since this is a linear project.
5. Plan notes for other design related concerns, including identifying property ownership and easement needs will be included.
6. Construction staging within the public rights of way by closing roads and creating a Traffic Management Plan (TMP) for this project. Detour routes are typically designated.
7. Reviewing all potential utility conflicts and minimizing them through the design, as well as noting test pit requirements for the contractor prior to digging on this project to check crossings for a potential

conflict [Roanoke SWU may choose to conduct design test holes with AMT through a contingency budget, instead].

8. Prepare a construction cost estimate based on the intermediate design for comparison to the $1.4M budget established for this CIP project.

The 60% engineering design will first be presented for an over the shoulder review via a virtual meeting. Based on comments received from the City, AMT will then update and finalize the 60% design for submittal and documentation with the cost estimate and supporting engineering calculations included. If necessary, a pre-application meeting could then be scheduled with the City Planning Department and others for a more formal site plan discussion, or we can move straight into final engineering design at the City's direction at this time.

Task 03 - Final Engineering Design (90%)

A final engineering design plan (90%) will be prepared that addresses the 60% intermediate design comments received from the City, and the results of any design utility test holes that might be acquired under separate cover. The final engineering design will include utility adjustment and protection plan details, as well as newly proposed utility profiles. The final engineering design will also include the erosion and sediment control plans, and related details with quantity takeoffs for updating the cost estimate. The plans and supporting design calculations will be updated and finalized to reflect construction staging areas, utility protection and adjustment measures, and final H/H calculations.

The 90% final engineering design will be presented for an over the shoulder review via a virtual meeting. Based on comments received from the City, AMT will then update and finalize the 90% design plans for submittal and documentation with the updated cost estimate, supporting final H&H engineering calculations, and any site plan application forms and checklists for the permit submittal to follow. Permit fees if required, will be paid by others for this project.

Task 04 – Engineering Design Approval (100%)

A 100% design plan will be prepared by addressing all city comments received after the 90% submission, to obtain city design approvals and to establish final plans for the bidding and construction work. Bid phasing, bid alternatives, and value engineering recommendations will be incorporated into the 100% final design plan and cost estimate at this time, as well as any technical specifications beyond what is shown on the plans.

An additional design coordination meeting related to utility relocations or adjustments, drainage easement plats and requirements, and the anticipated schedule for bidding and construction will be held virtually, at this time.

Task 05 - Bid Phase Services

AMT will assist the City in the public bidding of this construction work by helping to establish bid and contract documents for this project based on the approved design plans and cost estimate. We will then assist city procurement with bid advertisement as necessary, as well as helping to plan and lead the pre-bid meeting, answering bid addenda for design-related construction questions, and then review and make a recommendation of award upon the City's receipt of bids. These services will be provided at the direction of the City project manager and procurement officer working together.

Task 06 - Construction Phase Services

AMT will assist the City during construction by initially supporting notifications for a signed construction contract including: (1) notice of award and (2) notice to proceed. AMT will then additionally provide technical support during construction, related to the engineering design. AMT can attend a pre-construction meeting and make up to three (3) additional site visits, as requested during construction by the City project manager. A substantial completion inspection and punch list input can also be provided during the 4th site visit. As-builts or record drawings are not included except as a possible contingency item for this task order.

ASSUMPTIONS

1. Survey work and site visits will be limited to the public rights of way. No subsurface utility engineering and designation services are included in this task order proposal.
2. No temporary or permanent easements are planned for this project; therefore, no easement acquisition support is included in this task order proposal.
3. No public meetings or Town Council presentations are currently planned for this project. Outreach to adjacent landowners and developers will be the responsibility of the city's project manager, if any.
4. Environmental permitting and landscape architectural design are not included in this task order proposal.
5. Survey as-builts or record drawings are not included in this task order proposal.
6. Permit fees will be paid by others, if any.

SCHEDULE & DELIVERABLES

Services will begin on receipt of a signed agreement and notice to proceed, and should extend for a duration of an estimated five (5) months until the submission of a 90% or greater site plan application to the City of Roanoke for this engineering design. After that, virtual coordination meetings will generally be conducted in monthly intervals throughout the design and approval process.

PROJECT PERSONNEL

1. Don Rissmeyer, PE, CFM will provide services as overall Project Manager.
2. Dave Krisnitski, PE will serve as Lead Design Engineer.
3. James A. Patton, LS will serve as Lead Surveyor (Balzer and Associates)
4. Dan Papa, EIT, CFM will provide services as Lead Hydraulic Engineer for H&H Modeling.

No substitutions or additions will be made to these positions in the task order unless authorized in advance by the City of Roanoke.

FEES

The lump sum fee for the above described services is **$79,326** as detailed with the attached man hour estimate and further summarized below:

Task 01 - Topographic Survey (Balzer and Associates)	$	4,262.00
Task 02 - Preliminary Engineering Design (60%)	$	24,760.00
Task 03 - Final Engineering Design (90%)	$	18,646.00
Task 04 – Engineering Design Approval (100%)	$	14,012.00
Task 05 – Bid Phase Services	$	3,925.00
Task 06 – Construction Phase Services	$	6,510.00
Direct Expense Budget (1%)	$	721.00
Contingency (9%)	$	6,490.00
TOTAL LUMP SUM FEE =	**$**	**79,326.00**

AMT appreciates the opportunity to submit this task order proposal. Upon receipt of a purchase order agreement and/or notice-to-proceed from the City of Roanoke, AMT will begin work. Let us know if you have any questions, or if we can provide any additional information.

Sincerely,

A. MORTON THOMAS and Associates, Inc.

Donald J. Rissmeyer, PE, CFM
Project Manager

Cc: Marcus F. Aguilar, Ph.D., P.E. – City of Roanoke Senior Stormwater Research Engineer

	Task	Project Manager	Senior Engineer	Engineer	CADD / Technician	Surveyor	Inspector	Technical Typist	TOTAL
1	**Topographic Survey**								
	Project Coordination and Set-up with Balzer	4						2	6
	Subcontract the Surveying to Balzer Associates								0
	Subtotal Hours	**4**	**0**	**0**	**0**	**0**	**0**	**2**	
	Hourly Rate	**$158.00**	**$131.00**	**$95.00**	**$84.00**	**$3,500.00**	**$65.00**	**$65.00**	
	Subtotal	**$632.00**	**$0.00**	**$0.00**	**$0.00**	**$3,500.00**	**$0.00**	**$130.00**	**$4,262.00**
2	**Preliminary Engineering Design - 60%**								
	Setup AutoCAD base map for existing conditions	1	2		16				19
	Design Kickoff Meeting	3	3					1	7
	H&H Modeling and HEC-12 Calculations (w/ DA Maps)	2	3	18	2				25
	Storm Drain Plan and Profiles	1	6	12	32				51
	Plan Notes / Property Ownership Considerations	1	3	6	16				26
	Construction Staging / Traffic Management Plan (TMP) with detours	1	3	12	18				34
	Construction Cost Estimate	1	2	6	3				12
	Over the Shoulder Review Meeting / 60% Revisions	3	12	12	43			1	71
	City Pre-Application Meeting	3	3					1	7
	Subtotal Hours	**16**	**37**	**66**	**130**	**0**	**0**	**3**	**252**
	Hourly Rate	**$158.00**	**$131.00**	**$95.00**	**$84.00**	**$131.00**	**$131.00**	**$65.00**	
	Subtotal	**$2,528.00**	**$4,847.00**	**$6,270.00**	**$10,920.00**	**$0.00**	**$0.00**	**$195.00**	**$24,760.00**
3	**Final Engineering Design - 90%**								0
	Incorporate Test Hole Results, if provided by others	1	4		12				17
	Utility Adjustment Plans	1	12	4	18				35
	Erosion and Sediment Control Plans	1	12	4	16				33
	Finalize H&H Calculations and Report	1	3	16	2				22
	90% Cost Estimate	1	2	6	3				12
	Over the Shoulder Review Meeting / 60% Revisions	3	9	6	26			1	45
	City Site Plan Application Package / Checklists and Forms	2	4	3	8			2	19
	Subtotal Hours	**10**	**46**	**39**	**85**	**0**	**0**	**3**	**183**
	Hourly Rate	**$158.00**	**$131.00**	**$95.00**	**$84.00**	**$131.00**	**$131.00**	**$65.00**	
	Subtotal	**$1,580.00**	**$6,026.00**	**$3,705.00**	**$7,140.00**	**$0.00**	**$0.00**	**$195.00**	**$18,646.00**
4	**Engineering Design Approval - 100%**								0
	Address City Comments / Response to Comments	3	12	12	44			1	72
	Technical Specs / Other Supporting Info.	2	8	8	8			1	27
	Final Plans, Specs, and Cost Estimate (PS&E)	1	3	2	8			1	15
	Design Coordination with Pre-Construction Actions / Utility Adjustments	3	3	1	4			1	12
	Design Coordination with City Procurement for Public Bidding	3	3	1	4			1	12
	Subtotal Hours	**12**	**29**	**24**	**68**	**0**	**0**	**5**	**138**
	Hourly Rate	**$158.00**	**$131.00**	**$95.00**	**$84.00**	**$131.00**	**$131.00**	**$65.00**	
	Subtotal	**$1,896.00**	**$3,799.00**	**$2,280.00**	**$5,712.00**	**$0.00**	**$0.00**	**$325.00**	**$14,012.00**

	Task	Project Manager	Senior Engineer	Engineer	CADD / Technician	Surveyor	Inspector	Technical Typist	TOTAL
5	**Bid Phase Services**								0
	Pre-Bid Meeting	3	4	1	2			1	11
	Bid Addenda, if any	3	5	2	6			1	17
	Evaluate Bids, Recommend Award	1	3	1				1	6
	Subtotal Hours	**7**	**12**	**4**	**8**	**0**	**0**	**3**	**34**
	Hourly Rate	**$158.00**	**$131.00**	**$95.00**	**$84.00**	**$131.00**	**$131.00**	**$65.00**	
	Subtotal	**$1,106.00**	**$1,572.00**	**$380.00**	**$672.00**	**$0.00**	**$0.00**	**$195.00**	**$3,925.00**
6	**Construction Phase Services**								0
	Pre-Construction Meeting	2	4	1	2			1	10
	Submittal Reviews	3	9	2	2			1	17
	Monthly Progress Meetings (up to 3)	3	9	3				1	16
	Final Inspection and Punchlist Support	2	4	2	2			1	11
	Subtotal Hours	**10**	**26**	**8**	**6**	**0**	**0**	**4**	**54**
	Hourly Rate	**$158.00**	**$131.00**	**$95.00**	**$84.00**	**$131.00**	**$131.00**	**$65.00**	
	Subtotal	**$1,580.00**	**$3,406.00**	**$760.00**	**$504.00**	**$0.00**	**$0.00**	**$260.00**	**$6,510.00**
	TOTAL HOURS	**59**	**150**	**141**	**297**	**0**	**0**	**20**	**667**
	Hourly Rate	**$158.00**	**$131.00**	**$95.00**	**$84.00**	**$84.00**	**$131.00**	**$65.00**	
	TOTAL	**$7,900.00**	**$16,375.00**	**$12,730.00**	**$24,528.00**	**$3,631.00**	**$131.00**	**$1,105.00**	**$72,115.00**
	Direct Expense Budget	Estimated at 1% for copying, FedEx, and other related costs							**$721.00**
	Contingency Budget	Estimated at 7% of fee							**$6,490.00**
								GRAND TOTAL	**$79,326.00**

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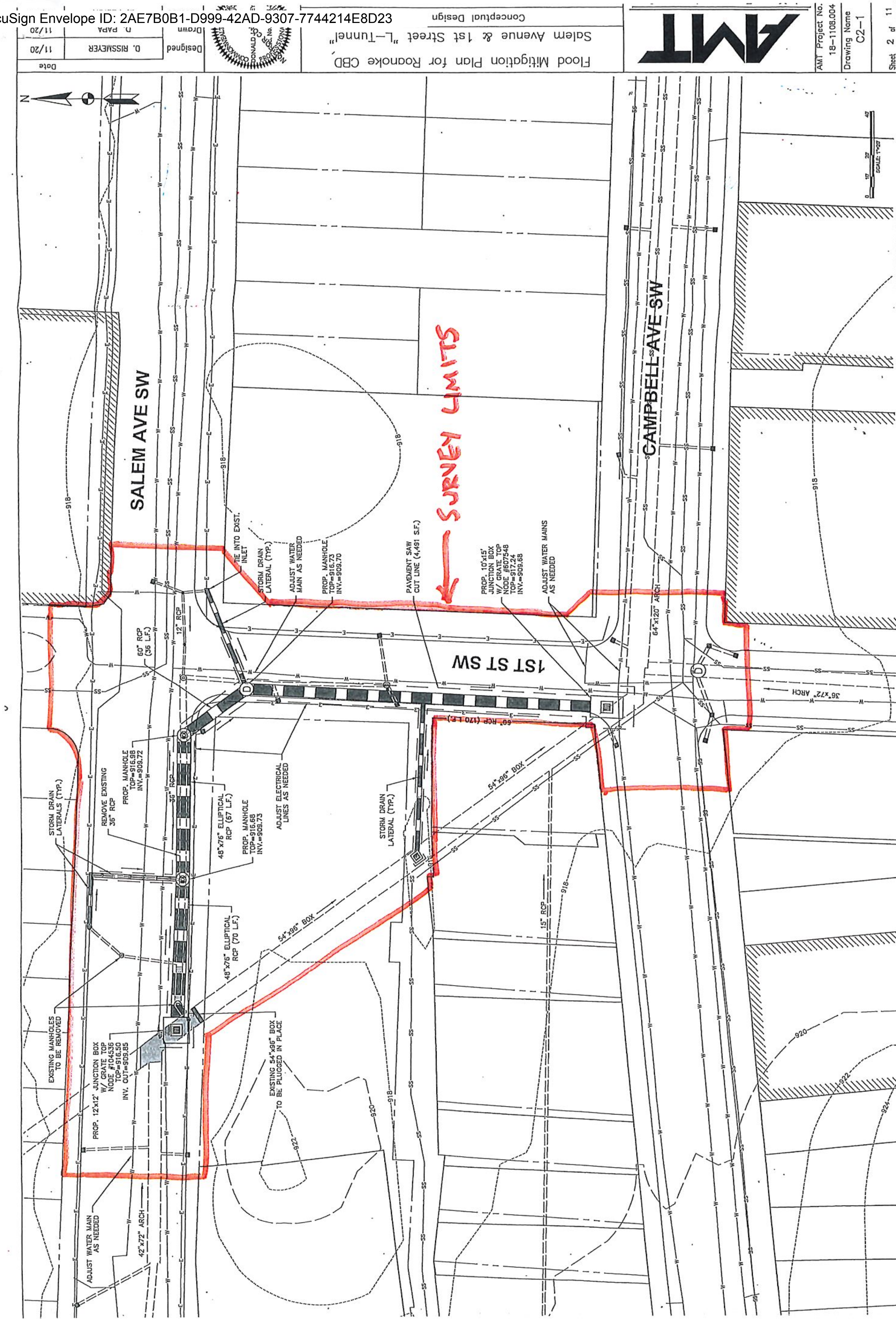

DocuSign

Certificate Of Completion

Envelope Id: 2AE7B0B1D99942AD93077744214E8D23
Status: Completed
Subject: Please DocuSign: IDIQ Request 716_AMT_Stormwater_Engineering_Approval Needed.pdf
Source Envelope:
Document Pages: 10
Signatures: 1
Certificate Pages: 4
Initials: 0
AutoNav: Enabled
EnvelopeId Stamping: Enabled
Time Zone: (UTC-05:00) Eastern Time (US & Canada)

Envelope Originator:
Stanley Wells
215 Church Avenue SW
Room 202
Roanoke, VA 24011
stanley.wells@roanokeva.gov
IP Address: 4.79.207.126

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12/9/2021 9:17:26 AM
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stanley.wells@roanokeva.gov
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Signer Events	Signature	Timestamp
Pamela Simpkins pamela.simpkins@roanokeva.gov Purchasing Manager City of Roanoke Security Level: Email, Account Authentication (Optional)	DocuSigned by: Pamela Simpkins 65325E4EF6FD48E... Signature Adoption: Pre-selected Style Using IP Address: 4.79.207.126	Sent: 12/9/2021 9:18:30 AM Viewed: 12/9/2021 9:55:42 AM Signed: 12/9/2021 9:56:05 AM

Electronic Record and Signature Disclosure:
Accepted: 3/26/2020 4:22:11 PM
ID: a959ad4a-889b-4be0-93d7-275f44213506

In Person Signer Events	Signature	Timestamp

Editor Delivery Events	Status	Timestamp

Agent Delivery Events	Status	Timestamp

Intermediary Delivery Events	Status	Timestamp

Certified Delivery Events	Status	Timestamp

Carbon Copy Events	Status	Timestamp

Witness Events	Signature	Timestamp

Notary Events	Signature	Timestamp

Envelope Summary Events	Status	Timestamps
Envelope Sent	Hashed/Encrypted	12/9/2021 9:18:30 AM
Certified Delivered	Security Checked	12/9/2021 9:55:42 AM
Signing Complete	Security Checked	12/9/2021 9:56:05 AM
Completed	Security Checked	12/9/2021 9:56:05 AM

Payment Events	Status	Timestamps

Electronic Record and Signature Disclosure

Contract Task Order

Vendor / Contract Number: A. Morton Thomas and Associates Inc. / IDIQ5AMT
Purchase Order #: CT230531000811
Date: 05/31/2023

The terms and conditions of the above referenced Contract apply to this Contract Task Order and are incorporated by reference. The parties acknowledge and agree that the Contract, the RFP issued by the City, the Consultant's Proposal submitted in response to the RFP, and this Contract Task Order, constitutes the entire agreement between the parties with respect to the provision of On-Call Architecture, Engineering and Construction Support Services.

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SCOPE OF SERVICES:

The Consultant covenants and agrees to provide all necessary On-Call Architecture, Engineering and Construction Support Services required to professionally accomplish the work and services, as set forth within this Contract Task Order. This Contract Task Order identifies the specific Phase(s) of service for which the Consultant is being engaged, along with the Consultant's compensation and time for performance. The Scope of Work is included in the attached Consultant’s proposal.

SCHEDULE 2: PROJECT SCHEDULE AND DELIVERABLES

The attached proposed schedule details how the Consultant plans to achieve completion of performance within the time specified within this Contract Task Order. Review and acceptance of the Project Schedule by the Owner shall not relieve the Consultant of any of its responsibility to timely complete performance in accordance with the agreed Contract Task Order. The Project Schedule shall incorporate sufficient time for preparation and review of documents and submittals. The schedule is included in the attached Consultant’s proposal.

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amount(s) required to be paid to the Consultant for this Project, or a decrease in the Services described under this Contract Task Order.

SCHEDULE 4: CONSULTANT'S SCHEDULE OF SERVICES AND FEES

The Consultant shall choose to be compensated on either a Fixed Sum or Percentage Basis, or on a Time Basis, as detailed below.

1 - Fixed Sum Basis or Fixed Percentage Basis

In the attached Consultant's proposal is a Fixed Sum or Fixed Percentage for the services that the Consultant shall supply in its performance of the Project(s) under this Contract Task Order.

Consultant's Cost of Services as a Fixed Sum: $

2 - Time Basis

In the attached Consultant's proposal is a list of all billable services that the Consultant may supply in its performance of individual Project(s) under this Contract Task Order, and the hourly rates at which those services will be billed for the duration of this Contract Task Order. The Consultant shall set forth its hourly rates for standard services that would be necessary to perform the range of services listed in Schedule 1.

Not to Exceed Amount: $16,888.00

Unless otherwise indicated within the Project Schedule, this Contract Task Order serves as a Notice to Proceed for the Project(s) and Work described within this Contract Task Order.

DocuSigned by:
Pamela Simpkins
65325E4EE6FD48E...

Pamela Simpkins, CPPB, VCO
Purchasing Manager

6/1/2023
Date

May 10, 2023

Marcus Aguilar, Ph.D., P.E.
City of Roanoke, Senior Stormwater Research Engineer
Public Works Service Center
1802 Courtland Road, NE
Roanoke, Virginia 24012
Via Email: Marcus.Aguilar@Roanokeva.gov

RE: Term Contract for Group V – Stormwater Management
Salem Avenue and 1st Street – WVWA Water Main Relocation Plan
AMT File P18-1108

Mr. Aguilar:

A. Morton Thomas and Associates, Inc. (AMT) is pleased to provide this task order proposal pursuant to our Term Contract Agreement for Professional Services in Group V, Stormwater Management with the City of Roanoke, that is dated March 7, 2019, and all terms are incorporated herein by reference.

SCOPE OF WORK

This scope of work includes the additional design detailing and design coordination with the Western Virginia Water Authority (WVWA) for relocating their water main to accommodate the proposed stormwater infrastructure upgrades for this project. No other changes or additions are planned to the recently submitted engineering design plans for this project.

Task 01 – WVWA Water Main Relocation Design Plans

Given their recent comments from the WVWA on this engineering design plan, the following additional services are planned in coordination with the WVWA for their design approval.

1. Plan layout updates to address WVWA comments, if any.
2. The addition of a water main plan and profile sheet to the plans.
3. Depicting all known existing utility crossings of the proposed water main and any crossings of other proposed utility adjustments including new storm drainage pipes to check for utility conflicts and denote clearance or separation between utilities, based on assumed depths.
4. Denote contractor utility test pits to be required at all known utility crossings.
5. Add supplemental specifications and standards based on WVWA comments, if any.
6. Make a second submittal to address WVWA comments, if required.

ASSUMPTIONS

1. Existing utilities are shown based on previous surveying and Miss Utility tickets. No additional services are currently planned for utility locating work.
2. No additional services are planned for utility test pits for the design at this time. Contractor test pit requirements will be noted on the design plans.

SCHEDULE & DELIVERABLES

Services will begin on receipt of a signed agreement and notice to proceed, and should extend for a duration of an estimated thirty (30) calendar days for the additional time required for the surveying and the WVWA submission of the water main plan and profile, and then another thirty (30) calendar days for the revisions and response to WVWA design comments to be incorporated into the city's bid package.

PROJECT PERSONNEL

1. Don Rissmeyer will provide services as Project Manager.
2. Dave Krisnitski will serve as Senior Engineer
3. Phillip Murrie-Robinson will serve as Engineer
4. Kevin Hylton will serve as CADD/Technician
5. AMT will serve as the Surveyor for the additional surveying work.
6. Ty Cook for Technical Typist for the Project Specifications / Supplemental Provisions

No substitutions will be made to these positions unless authorized in advance by the City of Roanoke.

FEES

The not-to-exceed fee for the above described services is **$16,888 (SIXTEEN THOUSAND AND eIGHT HUNDRED AND EIGHTY-EIGHT DOLLARS)** as detailed with the attached man hour estimate.

AMT appreciates the opportunity to submit this task order proposal. Upon receipt of a purchase order agreement and/or notice-to-proceed from the City of Roanoke, AMT will begin work. Let us know if you have any questions, or if we can provide any additional information in the meantime.

Sincerely,

A. MORTON THOMAS and Associates, Inc.

Don Rissmeyer, PE, CFM
AMT Program Manager

Cc: Dave Krisnitski, PE, CFM – AMT Project Manager

	Task	Project Manager	Senior Engineer	Engineer	CADD / Technician	Technical Typist	TOTAL
1	**Engineering Design Approval - 100%**						0
	Develop Existing Grade Elevations along the Water Main Alignment	1	2		8		11
	Develop the Water Main Profile based on required depth of cover	1	4	2	16		23
	Show Utility Crossings with Assumed Depths	1	2	4	12		19
	Denote Utility Test Pits by the Contractor			1	3		4
	Develop MOT Plans for the Water Main construction	1	2	4	12		19
	Develop E&S Plans for the Water Main construction	1	2	4	8		15
	Update 100% Plans, WVWA Specs, and Cost Estimate (PS&E)	1	2	2	4	2	11
	Address One Round of Additional WVWA Comments, if any	1	8	5	18		32
	Develop Final Plans, WVWA Specs, and Cost Estimate (PS&E)	1	2	2	4	2	11
	Subtotal Hours	**8**	**24**	**24**	**85**	**4**	145
	Hourly Rate	**$158.00**	**$131.00**	**$95.00**	**$84.00**	**$65.00**	
	Subtotal	**$1,264.00**	**$3,144.00**	**$2,280.00**	**$7,140.00**	**$260.00**	**$14,088.00**
						SURVEYING (AMT ENGINEERING) =	**$2,400.00**
						DIRECT REIMBURSABLES =	**$400.00**
						GRAND TOTAL	**$16,888.00**

DocuSign

Certificate Of Completion

Envelope Id: F5BD1EA095BB4CA0BB376B9F38473518
Status: Completed
Subject: Complete with DocuSign: IDIQ Request 1421_AMT_Stormwater_Signature Needed.pdf
Source Envelope:
Document Pages: 5
Signatures: 1
Certificate Pages: 4
Initials: 0
AutoNav: Enabled
EnvelopeId Stamping: Enabled
Time Zone: (UTC-05:00) Eastern Time (US & Canada)

Envelope Originator:
Stanley Wells
215 Church Avenue SW
Room 202
Roanoke, VA 24011
stanley.wells@roanokeva.gov
IP Address: 4.79.207.126

Record Tracking

Status: Original
6/1/2023 12:26:49 PM
Holder: Stanley Wells
stanley.wells@roanokeva.gov
Location: DocuSign

Signer Events	Signature	Timestamp
Pamela Simpkins pamela.simpkins@roanokeva.gov Purchasing Manager City of Roanoke Security Level: Email, Account Authentication (Optional)	DocuSigned by: Pamela Simpkins 65325E4EF6FD48E... Signature Adoption: Pre-selected Style Using IP Address: 4.79.207.126	Sent: 6/1/2023 12:27:26 PM Viewed: 6/1/2023 1:24:34 PM Signed: 6/1/2023 1:24:45 PM

Electronic Record and Signature Disclosure:
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Editor Delivery Events	Status	Timestamp

Agent Delivery Events	Status	Timestamp

Intermediary Delivery Events	Status	Timestamp

Certified Delivery Events	Status	Timestamp

Carbon Copy Events	Status	Timestamp

Witness Events	Signature	Timestamp

Notary Events	Signature	Timestamp

Envelope Summary Events	Status	Timestamps
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Signing Complete	Security Checked	6/1/2023 1:24:45 PM
Completed	Security Checked	6/1/2023 1:24:45 PM

Payment Events	Status	Timestamps

Electronic Record and Signature Disclosure

Fund 03 - STORMWATER UTILITY FUND

Reporting Code 1 CAP - Capitalizable

Department 530 - DIRECTOR OF PUBLIC WORKS

Unit 3079 - DOWNTOWN FLOOD - 1ST AND SALEM - 1 **Unit Manager** I Shaw **Unit End Date:**

Activity 0000 - PROPRIETARY FUNDS

Appropriation DTF - Downtown Flood - 1st and Salem - 1

Obj	Object Description	Current Period Expenditures	Outstanding Pre-Encumbrances	Outstanding Encumbrances	YTD Expenditures	ITD Expenditures	Current Budgeted Amt	Uncommitted Budget Balance	Percent Committed
2010	FEES FOR PROFESSIONAL SERVICES	0.00	0.00	17,440.84	1,688.80	43,390.08	0.00	(60,830.92)	0.00%
9024	EASEMENTS	0.00	0.00	0.00	0.00	1,367.00	0.00	(1,367.00)	0.00%
9050	LAND PURCHASES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00%
9055	A & E FEES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00%
9056	VDOT ADMIN FEES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00%
9060	CONSTRUCTION-STRUCTURES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00%
9065	CONSTRUCTION OTHER	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00%
9600	APPROPRIATED FROM 2021 BONDS FUNDS	0.00	0.00	0.00	0.00	0.00	100,000.00	100,000.00	0.00%
9603	APPROPRIATED FROM 2023 BONDS FUNDS	0.00	0.00	0.00	0.00	0.00	16,888.00	16,888.00	0.00%
9606	APPROPRIATED FROM 2024 BONDS FUNDS	0.00	0.00	0.00	0.00	0.00	1,125,000.00	1,125,000.00	0.00%

Fund 03 - STORMWATER UTILITY FUND

Reporting Code 1 CAP - Capitalizable

Department 530 - DIRECTOR OF PUBLIC WORKS

Unit 3079 - DOWNTOWN FLOOD - 1ST AND SALEM - 1 **Unit Manager** I Shaw **Unit End Date:**

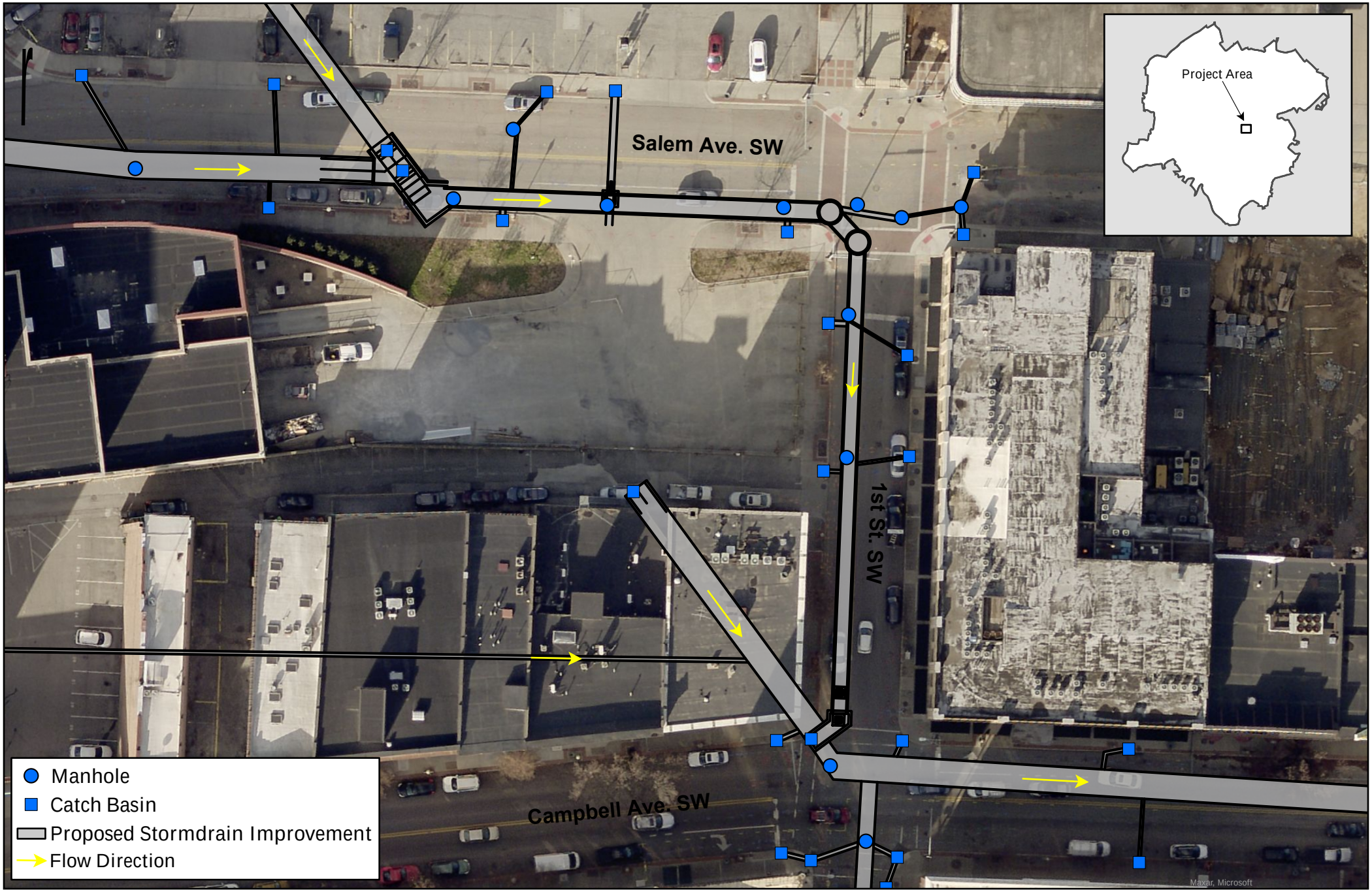
Activity 0000 - PROPRIETARY FUNDS

Obj	Object Description	Current Period Expenditures	Outstanding Pre-Encumbrances	Outstanding Encumbrances	YTD Expenditures	ITD Expenditures	Current Budgeted Amt	Uncommitted Budget Balance	Percent Committed
Total for Appropriation: DTF - Downtown Flood - 1st and Salem - 1		**0.00**	**0.00**	**17,440.84**	**1,688.80**	**44,757.08**	**1,241,888.00**	**1,179,690.08**	5.01%
Total for Unit 3079 - DOWNTOWN FLOOD - 1ST AND SALEM - 1		**0.00**	**0.00**	**17,440.84**	**1,688.80**	**44,757.08**	**1,241,888.00**	**1,179,690.08**	**5.01 %**

APPENDIX C - CHECKLIST FOR ALL CATEGORIES

This Appendix includes the following requested information for items in **bold** below. Other items reference respective sections in this scope of work, or provide hyperlinks as appropriate.

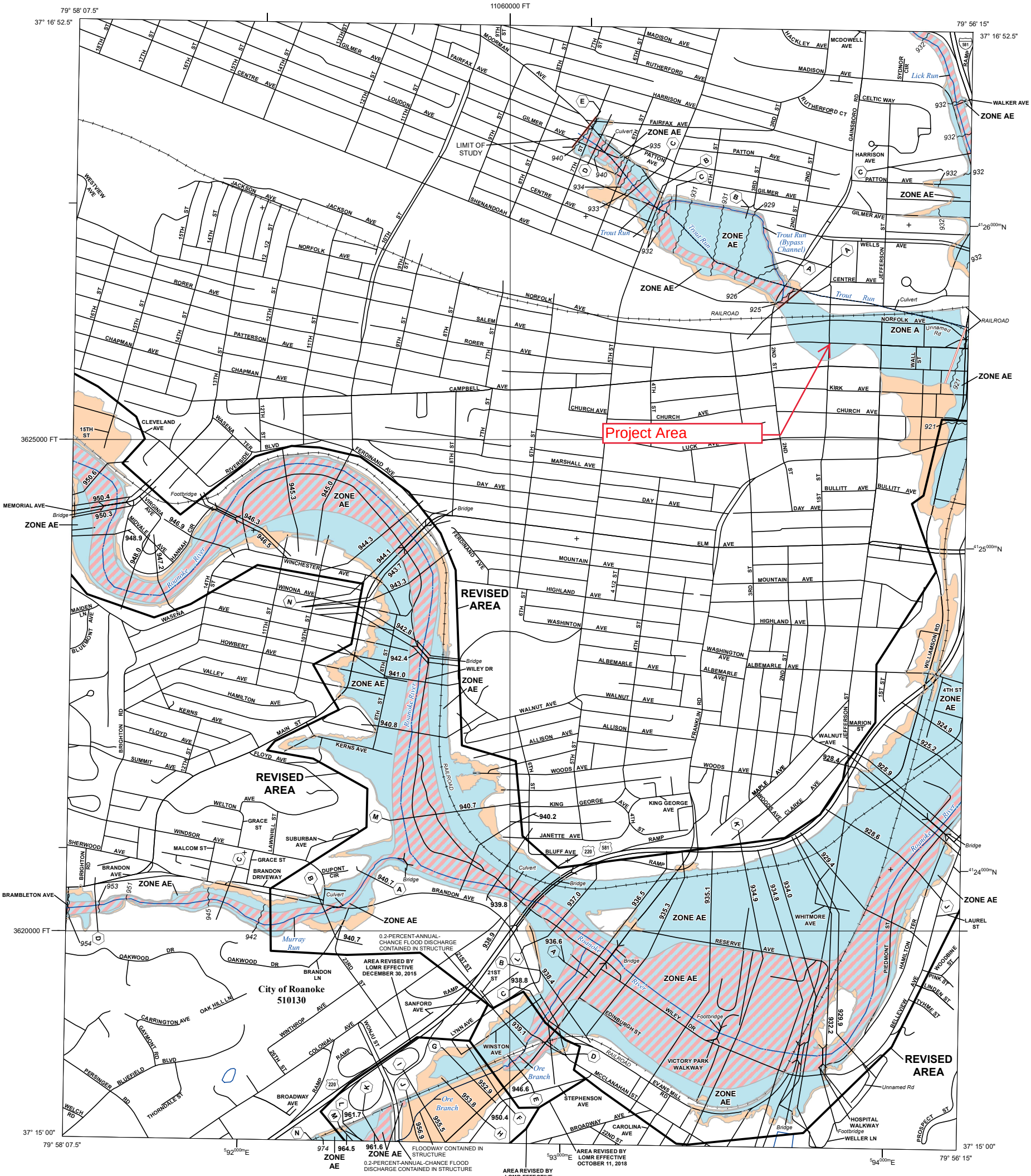
1. **Detailed map of the project area**
2. **FIRMette of the project area**
3. Historic flood damage data and or/images - see Appendix D and Section 4.1.b
4. A link or copy of the current floodplain ordinance – see https://library.municode.com/va/roanoke/codes/code_of_ordinances?nodeId=CORO1979_CH36.2ZO_ART3RESPZODI_DIV5OVDI_S36.2-333FLOVDIF
5. Non-fund-financed maintenance and management plan for project extending a minimum of 10 years from project close – see Section 4.7
6. A link to the current hazard mitigation plan - https://rvarc.org/wp-content/uploads/2019/08/RVAR_Hazard_Mitigation_Plan_2019.pdf
7. A link to the current comprehensive plan - https://planroanoke.org/city-plan-2040/
8. Social Vulnerability Index scores for the project area from VFRIS Layer – "Moderate" - see Section 4.1a
9. If applicant is not a town, city, or county, letters of support from affected localities – N/A
10. Letter of support from impacted stakeholders
11. Budget Narrative – See Section 5 with supplemental documentation in Appendix B
12. Benefit Cost Analysis Narrative – see Section 4.1e
13. **Authorization to request funding from the Fund from governing body or chief executive of the local government**
14. Signed pledge agreement from each contributing organization – see Appendix A
15. Detailed budget narrative for all costs - See Section 5 with supplemental documentation in Appendix B



ROANOKE
STORMWATER

1st & Salem Drainage Improvement Project
Proposed Project Map
November, 2023

0 25 50 100 Feet



FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR ZONE DESCRIPTIONS AND INDEX MAP

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT HTTP://MSC.FEMA.GOV

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A,V, A99*
	With BFE or Depth *Zone AE, AO, AH, VE, AR*
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee See Notes. *Zone X*
OTHER AREAS	NO SCREEN Areas Determined to be Outside the 0.2% Annual Chance Floodplain *Zone X*
	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Levee, Dike, or Floodwall
OTHER FEATURES	Cross Sections with 1% Annual Chance Water Surface Elevation (BFE)
	Coastal Transect
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
	Base Flood Elevation Line (BFE)
	Limit of Study
	Jurisdiction Boundary

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Mapping and Insurance eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this FIRM was provided in digital format by Roanoke County.

Road features shown on this FIRM have been updated using the 2022 TIGER/Line Shapefiles from the U.S. Census Bureau.

SCALE

N

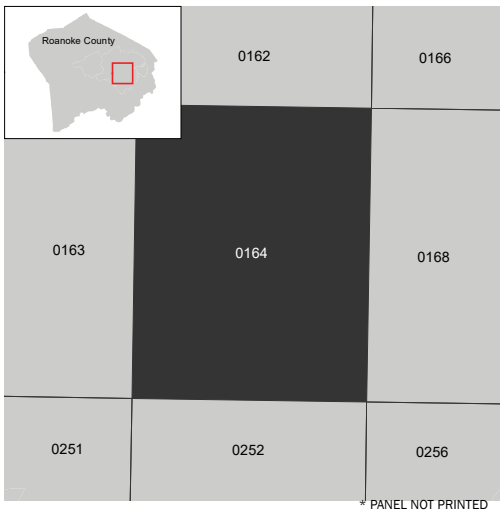
Map Projection:
NAD 1983 StatePlane Virginia South FIPS 4502 Feet;
Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet 1:6,000

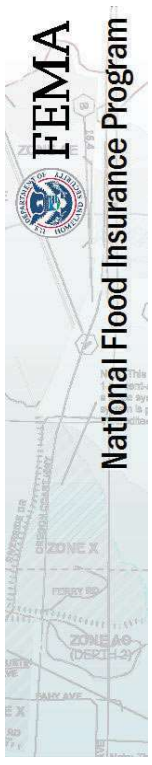
0 500 1,000 2,000 Feet

0 125 250 500 Meters

PANEL LOCATOR



* PANEL NOT PRINTED



NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

ROANOKE COUNTY, VIRGINIA
and Incorporated Areas

PANEL 164 OF 310

FEMA

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
ROANOKE, CITY OF	510130	0164	G

REVISED TO REFLECT LOMR EFFECTIVE: December 22, 2023

VERSION NUMBER
2.1.3.0

MAP NUMBER
51161C0164G

MAP REVISED
SEPTEMBER 28, 2007

IN THE COUNCIL OF THE CITY OF ROANOKE, VIRGINIA

The 16th day of October 2023.

No. 42806-101623.

A RESOLUTION authorizing the City Manager or his designee to submit an application to the Department of Conservation and Recreation ("DCR") for grant funding under the Community Flood Preparedness Fund; and authorizing the City Manager or his designee to take such further actions and execute such further documents as may be necessary in connection with this application and grant funding.

BE IT RESOLVED by the Council of the City of Roanoke as follows:

1. City Council hereby authorizes the City Manager or his designee to submit an application to the DCR for Community Flood Preparedness Fund grant funding, such funding to be used to help communities reduce the impacts of flooding, for the 1st Street and Salem Drainage Improvements Project and the Ore Branch Restoration Project, all as more particularly described in the City Council Agenda Report dated October 16, 2023, with such application being approved as to form by the City Attorney.

2. The City Manager or his designee is further authorized to take any such further actions and execute such further documents, approved as to form by the City Attorney, as may be necessary to submit the above application to the DCR and to furnish such additional information as may be required for such application.

ATTEST:

Cecelia F. McCoy

City Clerk.

APPENDIX D - FLOOD PHOTOGRAPHS IN DOWNTOWN ROANOKE

This section contains a compilation of photographs of Downtown Flooding with the corresponding dates and links to news articles where relevant.

Figure 1 – The Flood of 1985 - 11/4/1985 – Market Square Downtown. Courtesy Tommy Firebaugh

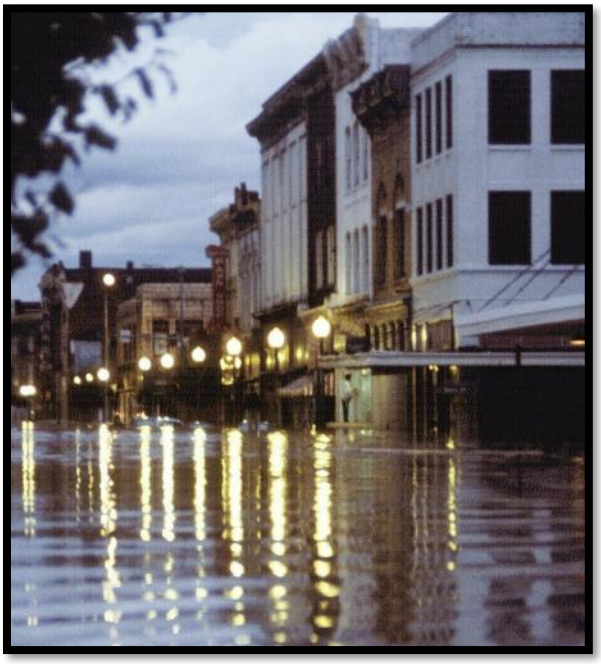


Figure 2 – The Flood of 1985 – 11/4/1985 – Campbell Ave. Downtown. Courtesy Tommy Firebaugh

Figure 3 – June 15, 2016 – Intersection of 1st and Salem Downtown. Courtesy of WDBJ7

Figure 4 – July 12, 2016 – Intersection of 1st and Salem Downtown. City of Roanoke Staff

Figure 5 – August 15, 2016 – Campbell Ave. Downtown – City of Roanoke Staff

Figure 6 – June 15, 2017 – Market Square Downtown. Courtesy WDBJ7

Figure 7 – April 5, 2018 – 1st and Salem Downtown. Courtesy WSLS10

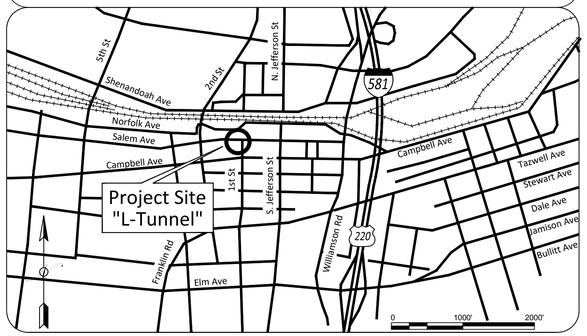
Figure 8 – October 11, 2018 – 1st and Salem Downtown. City of Roanoke Staff

Figure 9 – August 20, 2021 – Salem Ave. near 1st St. Downtown. Courtesy WSLS10.

APPENDIX E - 95% ENGINEERING DESIGN DRAWINGS

STORMWATER C.I.P. – SALEM AVE. & 1ST ST. "L–TUNNEL"

VICINITY MAP



LEGEND

ABBREVIATIONS

AHFH	ARROW HEAD TOP OF FIRE HYDRANT	LT	LEFT
APPROX	APPROXIMATE	MH	MANHOLE
ASPH	ASPHALT	MIN	MINIMUM
BC	BOTTOM OF CURB	MON	MONUMENT
BIT	BITUMINOUS	N–S	NORFOLK SOUTHERN
BLDG	BUILDING	PROP	PROPOSED
BLK	BLOCK	PUE	PUBLIC UTILITY EASEMENT
BM	BENCHMARK	PVMT	PAVEMENT
BW	BOTTOM OF WALL	RT	RIGHT
CTR	CENTER	R.O.W.	RIGHT OF WAY
CB	CINDER BLOCK	REQD	REQUIRED
C&G	CURB & GUTTER	RR	RAILROAD
CMP	CORRUGATED METAL PIPE	SAN	SANITARY
CONC	CONCRETE	SD	STORM DRAIN
COR	CORNER	SDMH	STORM DRAIN MANHOLE
DBL	DOUBLE	SECT	SECTION
DI	DROP INLET	SS	SANITARY SEWER
DIA	DIAMETER	SSMH	SANITARY SEWER MANHOLE
DE	DRAINAGE EASEMENT	STD	STANDARD
EG	EXISTING SPOT ELEVATION	STO	STORAGE
EP	EDGE OF PAVEMENT	SWPPP	STORMWATER POLLUTION PREVENTION PLAN
ELEC	ELECTRIC	TC	TOP OF CURB
ELEV	ELEVATION	TEL	TELEPHONE
ENTR	ENTRANCE	TRANS	TRANSFORMER
EW	ENDWALL	TW	TOP OF WALL
EX	EXISTING	TYP	TYPICAL
FDN	FOUNDATION	VAR	VARIABLE
FF	FINISHED FLOOR	VESCH	VIRGINIA EROSION & SEDIMENT CONTROL HANDBOOK
FG	FINISH GRADE	VDOT	VIRGINIA DEPARTMENT OF TRANSPORTATION
HPT	HIGH POINT	VERT	VERTICAL
INV	INVERT	YD	YARD
IP	IRON PIN		

SYMBOLS

EXISTING	NEW	
100.5	*100.5*	SPOT ELEVATION
100	*100*	CONTOURS
8"SS	*8"SS*	SANITARY SEWER LINE
4"W	*4"W*	WATERLINE
8"SD	*8"SD*	STORM DRAIN
2"G	*2"G*	GAS LINE
OHE	*OHE*	OVERHEAD ELECTRIC LINE
OHT	*OHT*	OVERHEAD TELEPHONE LINE
CATV	*CATV*	OVERHEAD CABLE TELEVISION LINE
UE / UT	*UE / UT*	UNDERGROUND TEL OR ELEC LINE
M	*M*	WATER OR GAS METER
		VALVE
F.H.	*F.H.*	FIRE HYDRANT
		MANHOLE
C.O.	*C.O.*	CLEANOUT
		DROP INLET (CURB OR GRATE)
		UTILITY POLE, GUY & ANCHOR
		DITCH OR SWALE
		CENTERLINE OR BASELINE
		PROPERTY LINE
y.l.	*Y.L.*	YARD LIGHTING
y.h..	*Y.H.*	YARD HYDRANT
x	x	FENCE
		TREE LINE

ROANOKE

DEPARTMENT OF PUBLIC WORKS
STORMWATER UTILITY
1802 COURTLAND ROAD, NE
ROANOKE, VIRGINIA 24012
PHONE: (540) 853–5900
FAX: (540) 853–5919

PROJECT NAME

STORMWATER C.I.P.
SALEM AVE. & 1ST ST.
"L–TUNNEL"

CITY STORMWATER PLAN NUMBER: 1143

REVISIONS

No.	Date	Remarks	By

DESIGN

Designed:	DAK	X
Drawn:	KHH	X
Checked:	DJR	X
Date:	10–06–23	X
CIP No:		X

COMMONWEALTH OF VIRGINIA
David A. Krisnitski
No. 36465
PROFESSIONAL ENGINEER
10/16/2023

SHEET INDEX

Sheet Number	Sheet Title
C1.0	COVER SHEET
C2.0	GENERAL NOTES AND EROSION & SEDIMENT CONTROL NOTES
C3.0	SITE SURVEY - OVERALL
C4.0	PROPOSED WVWA WATER LINE REPLACEMENT
C4.1	WVWA WATERLINE RELOCATION ENLARGED PLANS AND PROFILES
C4.2	WVWA STANDARD DETAILS
C5.0	ENLARGED PROPOSED SITE PLAN (SALEM AVENUE WEST END)
C5.1	ENLARGED PROPOSED SITE PLAN (1ST STREET)
C6.0	SALEM AVENUE STRUCTURE SECTIONS AND DETAILS
C6.1	CAMPBEL AVENUE STRUCTURE SECTIONS AND DETAILS
C7.0	EROSION & SEDIMENT CONTROL PLAN
C8.0	TRAFFIC MANAGEMENT PLAN NOTES
C8.1	TRAFFIC MANAGEMENT PLAN - PHASE I
C8.2	TRAFFIC MANAGEMENT PLAN - PHASE II
C8.3	TRAFFIC MANAGEMENT PLAN - PHASE III
C8.4	TRAFFIC MANAGEMENT PLAN - PHASE IV
C8.5	TRAFFIC MANAGEMENT PLAN - PHASE V

ANY VARIATION FROM APPROVED PLANS MUST BE APPROVED BY THE CITY OF ROANOKE

CONSTRUCTION PROCEDURE REQUIREMENTS

NOTICE: ALL LANDOWNERS, DEVELOPERS AND CONTRACTORS

FAILURE TO COMPLY WITH THE CONSTRUCTION PROCEDURE REQUIREMENTS LISTED BELOW MAY RESULT IN THE COSTLY REMOVAL OF STRUCTURES, TIME DELAYS OR THE ISSUANCE OF A STOP WORK ORDER.

1. RIGHT–OF–WAY EXCAVATION PERMIT –PRIOR TO THE COMMENCEMENT OF ANY DIGGING, ALTERATION OR CONSTRUCTION WITHIN THE PUBLIC RIGHT–OF–WAY (STREETS, ALLEYS, PUBLIC EASEMENTS), A RIGHT–OF–WAY EXCAVATION PERMIT SHALL BE APPLIED FOR AND OBTAINED BY THE CONTRACTOR FROM THE CITY OF ROANOKE.

2. LAND DISTURBANCE PERMIT –AN APPROVED EROSION AND SEDIMENT CONTROL PLAN FOR ANY BORROW/FILL SITES ASSOCIATED WITH THE PROJECT MUST BE SUBMITTED PRIOR TO THE ISSUANCE OF A LAND DISTURBANCE PERMIT.

3. PLANS AND PERMITS –A COPY OF THE PLANS AS APPROVED BY THE CITY (SIGNED BY THE PROPER CITY OFFICIALS) AND ALL PERMITS ISSUED BY THE CITY SHALL BE AVAILABLE AT THE CONSTRUCTION SITE AT ALL TIMES OF ONGOING CONSTRUCTION.

4. LOCATION OF UTILITIES –THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL EXISTING UTILITIES PRIOR TO THE COMMENCEMENT OF ANY CONSTRUCTION.

5. CONSTRUCTION ENTRANCE –THE CONTRACTOR SHALL INSTALL AN ADEQUATE CONSTRUCTION ENTRANCE FOR ALL CONSTRUCTION RELATED EGRESS FROM THE SITE. SIZE AND COMPOSITION OF CONSTRUCTION ENTRANCE SHALL BE AS SHOWN ON THE PLANS.

6. STREETS TO REMAIN CLEAN –IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO INSURE THAT THE PUBLIC STREET ADJACENT TO THE CONSTRUCTION ENTRANCE REMAINS FREE OF MUD, DIRT, DUST, AND/OR ANY TYPE OF CONSTRUCTION MATERIALS OR LITTER AT ALL TIMES.

7. BARRICADES/DITCHES –THE CONTRACTOR SHALL MAINTAIN THE INTEGRITY OF ALL EXCAVATED DITCHES AND SHALL FURNISH AND ENSURE THAT ALL BARRICADES PROPER AND NECESSARY FOR THE SAFETY OF THE PUBLIC ARE IN PLACE.

8. SEWER AND PAVEMENT REPLACEMENT –CONSTRUCTION OF SANITARY SEWERS AND THE REPLACEMENT OF PAVEMENT SHALL BE IN ACCORDANCE WITH APPROVED STANDARDS AND SPECIFICATIONS OF THE CITY OF ROANOKE AND THE WESTERN VIRGINIA WATER AUTHORITY.

9. APPROVED PLANS/CONSTRUCTION CHANGES –ANY CHANGE OR VARIATION FROM CONSTRUCTION DESIGN AS SHOWN ON THE OFFICIALLY APPROVED PLANS SHALL BE APPROVED BY THE EROSION AND SEDIMENT CONTROL AGENT PRIOR TO SAID CHANGES OR VARIATION IN CONSTRUCTION BEING MADE.

10. FINAL ACCEPTANCE/CITY –THE OWNER OR DEVELOPER SHALL FURNISH THE CITY OF ROANOKE'S PLANNING BUILDING AND DEVELOPMENT DEPARTMENT WITH A FIELD SURVEYED FINAL CORRECT SET OF AS–BUILT PLANS OF THE NEWLY CONSTRUCTED STORM DRAIN AND/OR STORMWATER MANAGEMENT FACILITIES PRIOR TO FINAL ACCEPTANCE AND ISSUANCE OF A CERTIFICATE OF OCCUPANCY BY THE CITY. AS–BUILT PLANS SHALL BE PROVIDED IN THE STATE PLANE VIRGINIA SOUTH COORDINATE SYSTEM, NAD 1983, FIPS 4502 FEET, US SURVEY FEET, DATUM NAD 83, IN THE FORM OF 1–PAPER COPY AND 1–DIGITAL AUTOCAD FILE.

APPROVED FOR CONSTRUCTION

STORMWATER MANAGER	DATE
DIRECTOR OF PUBLIC WORKS	DATE
DEPUTY CITY MANAGER	DATE

APPROVAL BLOCK: PLANNING, BUILDING, & DEVELOPMENT

GENERAL NOTES:

1. ALL PROPOSED WORK SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE VIRGINIA DEPARTMENT OF TRANSPORTATION LATEST EDITION OF ROAD AND BRIDGE SPECIFICATIONS UNLESS OTHERWISE NOTED.
2. CARE SHALL BE TAKEN TO PROTECT FROM DAMAGES ALL EXISTING SURFACES, STRUCTURES, AND IMPROVEMENTS ADJACENT TO THE WORK. ANY DAMAGE TO SUCH ITEMS, AS A RESULT OF THE WORK, SHALL BE RESTORED TO THEIR ORIGINAL CONDITION AT NO ADDITIONAL COST TO THE THE CITY OF ROANOKE.
3. THE CONTRACTOR SHALL PERFORM ALL WORK IN A MANNER THAT WILL ENSURE THE LEAST PRACTICABLE OBSTRUCTION TO TRAFFIC AND IS CONSISTENT WITH ESTABLISHED SAFETY PROCEDURES. THE CONTRACTOR WILL BE RESPONSIBLE FOR THE MAINTENANCE OF TRAFFIC THROUGHOUT THE CONSTRUCTION DURATION.
4. THE CONTRACTOR SHALL MAINTAIN ACCESS TO ALL PRIVATE DRIVEWAYS AT ALL TIMES.
5. REMOVE AND STORE ALL SALVAGEABLE ITEMS SUCH AS TREE GRATES, BRICKS, LIGHT POSTS, ETC. FROM WITHIN WORK AREA. ANY MATERIALS THAT ARE BROKEN SHALL BE REPLACED. ALL SURFACE FEATURES INCLUDING CURB/GUTTER, SIDEWALK, ETC. SHALL BE RESTORED IN KIND.
6. IN THE EVENT THAT THE CONTRACTOR ENCOUNTERS EXISTING UTILITIES AND/OR STRUCTURES NOT SHOWN ON THE PLANS, THE CONTRACTOR SHALL NOTIFY THE CITY INSPECTOR FOR DIRECTIONS PRIOR TO PROCEEDING WITH THE WORK AFFECTING SAID UTILITY AND/OR STRUCTURE.
7. THE CONTRACTOR SHALL NOTIFY THE CITY INSPECTOR IMMEDIATELY UPON ENCOUNTERING ANY HAZARDOUS OR REGULATED MATERIALS DURING THE COURSE OF WORK.
8. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO IMMEDIATELY REMOVE, TRANSPORT OFF-SITE, AND LEGALLY DISPOSE OF ANY AND ALL EXCAVATED/DELETERIOUS MATERIALS.
9. THE CONTRACTOR SHALL OBTAIN A GENERAL VPDES PERMIT FOR DISCHARGES OF STORMWATER FROM CONSTRUCTION ACTIVITIES AND FOLLOW ALL CONDITIONS OF THE PERMIT.
10. EXISTING PAVEMENT SHALL BE SAW CUT IN THE GENERAL LOCATIONS SHOWN ON THE PLANS PRIOR TO INSTALLATION OF STORM DRAIN SYSTEM AND UTILITIES.
11. THE CONTRACTOR SHALL ENSURE THE FINAL GRADES PROVIDE POSITIVE DRAINAGE.
12. THE CONTRACTOR SHALL VERIFY EXISTING CONDITIONS OF ALL EXISTING DRAINAGE STRUCTURES TO REMAIN IN PLACE WHICH CONNECT TO THE NEW STORM DRAIN SYSTEM.
13. THE LOCATION OF SUBSURFACE UTILITIES SHOWN ON THE PLANS ARE APPROXIMATE AND FOR INFORMATION AND GUIDANCE ONLY. PORTIONS OF THESE UTILITIES ARE BASED UPON MISS UTILITY MARKINGS OR RECORD DRAWINGS AND THEREFORE THERE IS NO GUARANTEE TO THE ACCURACY OF LOCATIONS, AS SHOWN ON THE PLANS. IT IS THE CONTRACTOR'S RESPONSIBILITY TO FIELD LOCATE ALL UTILITIES PRIOR TO ANY CONSTRUCTION.
14. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO PROTECT ANY AND ALL EXISTING UTILITIES FROM DAMAGE. CONTRACTOR SHALL BE RESPONSIBLE FOR THE REPAIR AND RE-ESTABLISHMENT OF ANY AND ALL UTILITIES DISRUPTED DURING THE EXCAVATION/CONSTRUCTION.
15. THE CONTRACTOR SHALL, AT A MINIMUM, REMOVE OR RELOCATE ANY UTILITY THAT INTERFERES WITH THE CONSTRUCTION SHOWN ON THESE PLANS. THE CONTRACTOR SHALL NOTIFY THE CITY INSPECTOR OF ANY UTILITY THAT NEEDS TO BE RELOCATED, PRIOR TO CONSTRUCTION, SO THAT EXISTING CONDITIONS CAN BE IDENTIFIED. THE CONTRACTOR SHALL COORDINATE ALL UTILITY REMOVALS OR RELOCATIONS WITH THE APPROPRIATE UTILITY OWNER.
16. UTILITY SERVICE INTERRUPTION SHALL REQUIRE 14 DAYS ADVANCED NOTIFICATION TO THE CITY OF ROANOKE, THE AFFECTED UTILITY OWNER, AND THOSE AFFECTED BY THE INTERRUPTION IN SERVICE.
17. ALL STORM PIPES AND DROP INLETS SHALL BE CLEANED OF DEBRIS AND ERODED MATERIALS AT ALL STAGES OF CONSTRUCTION AND PRIOR TO FINAL ACCEPTANCE.
18. THE CONTRACTOR SHALL CONSTRUCT AND MAINTAIN, THROUGHOUT THE PROJECT, ALL EROSION AND SEDIMENT CONTROL MEASURES, AS SHOWN ON THE CONTRACT DRAWINGS. ALL CONTROL METHODS AND DETAILS SHOWN COMPLY WITH THE VIRGINIA EROSION AND SEDIMENT CONTROL HANDBOOK LATEST EDITION, AND VDOT ROAD AND BRIDGE STANDARDS LATEST EDITION..
19. TEMPORARY TRAFFIC CONTROL SHALL SHALL BE IN ACCORDANCE WITH THE MUTCD, THE WORK AREA PROTECTION MANUAL AND THE VIRGINIA SUPPLEMENT.
20. ALL EXCAVATION FOR UNDERGROUND PIPE INSTALLATION SHALL COMPLY WITH OSHA STANDARDS FOR THE CONSTRUCTION INDUSTRY (29 CFR PART 1926).
21. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL ON-SITE SAFETY.
22. CONSTRUCTION STAKEOUT AND SURVEYING FOR ALL CONSTRUCTION ON THIS PROJECT SHALL BE PERFORMED BY THE CONTRACTOR.
23. CONTRACTOR SHALL COMPLY WITH S59.1-406, ET SEW. OF THE CODE OF VIRGINIA (OVERHEAD HIGH VOLTAGE LINES SAFETY ACT).
24. PROJECT ACCESS WILL BE DICTATED BY CITY OF ROANOKE AND DISCUSSED IN PRE-BID MEETING.
25. THE CONTRACTOR SHALL PERFORM TEST PITS AT LOCATIONS WHERE PROPOSED IMPROVEMENTS CROSS EXISTING UTILITY SERVICES AND WHERE NEW FACILITIES CONNECT TO EXISTING FACILITIES TO OBTAIN THE LOCATION AND ELEVATION OF THE EXISTING UTILITY PRIOR TO INSTALLATION OF STORM DRAIN SYSTEM. CONTRACTOR SHALL PROVIDE THIS INFORMATION TO THE CITY OF ROANOKE SO THE ENGINEER CAN MAKE ADJUSTMENTS TO THE PLANS, IF NECESSARY.
26. THE BIDDER IS RESPONSIBLE FOR COORDINATING WITH THE UTILITY PROVIDERS PRIOR TO SUBMITTING A BID. ALL COSTS ASSOCIATED WITH PROVIDING THE REQUIRED MEASURES FOR PROTECTION OF THE EXISTING UTILITY SERVICES DURING CONSTRUCTION WILL NOT BE PAID FOR SEPARATELY BUT ARE TO BE INCLUDED IN OTHER ITEMS OF WORK.

EROSION CONTROL NARRATIVE

1. PROJECT DESCRIPTION:
   - THIS PROJECT INCLUDES THE INSTALLATION OF A NEW STORM DRAIN SYSTEM ALONG THE SOUTHERN SIDE OF SALEM AVENUE BETWEEN 1st AND 2ND STREETS HEADING EAST TO THE INTERSECTION OF SALEM AVE AND 1st STREET THEN TURNING SOUTH ALONG THE WESTERN SIDE OF 1st STREET AND RECONNECTING WITH THE EXISTING STORM DRAIN SYSTEM AT THE INTERSECTION OF 1st STREET AND CAMPBELL AVENUE. THE NEW STORM DRAIN WILL REPLACE THE EXISTING STORM DRAIN IN THE SAME LOCATION. THE DIAGONAL STORM DRAIN THAT EXTENDS UNDER THE ADJACENT PARKING LOT WILL BE BLOCKED OFF INTERNALLY WITH A WALL TO DIVERT STORM FLOW INTO THE NEW DRAIN LINE.
2. EXISTING SITE CONDITIONS:
   - THE EXISTING SITE CURRENTLY IS A DOWNTOWN CITY WITH CURB AND GUTTER ALONG EACH SIDE. THERE ARE NUMEROUS BURIED UTILITIES ALONG THE PLANNED ALIGNMENT THAT MUST BE MITIGATED THROUGH COORDINATION WITH EACH RESPECTIVE UTILITY PROVIDER. MOST OF SITE CONSIST OF EITHER CONCRETE OR ASPHALT. THE SITE IS RELATIVELY FLAT WITH ELEVATIONS AROUND 917. SOME EXISTING HARDSCAPE AND LANDSCAPING IS EXPECTED TO BE DISTURBED DURING THE PROJECT AND SHALL BE RESTORED PRIOR TO COMPLETION OF PROJECT. SOME ROCK EXCAVATION IS EXPECTED DURING EXCAVATION FOR THE NEW STORM DRAIN AND THE CONTRACTOR SHALL PLAN WORK ACCORDINGLY. NO BLASTING IS PERMITTED.
3. ADJACENT AREAS:
   - AREAS ADJACENT TO THE SITE INCLUDE PARKING LOTS AND PLACES OF BUSINESS. WORK TIMES ARE ESTABLISHED TO MINIMIZE IMPACTS ON ADJACENT AREAS (NOISE POLLUTION, DUST, TRAFFIC INTERRUPTIONS, ETC.) ASSOCIATED WITH THE PROJECT. SEE SHEET C8.0 FOR WORK TIME RESTRICTIONS.
4. OFF-SITE AREAS:
   - NO OFF-SITE LAND DISTURBING ACTIVITIES ASSOCIATED WITH THIS PROJECT ARE KNOWN AT THIS TIME. ANY OFF-SITE LAND DISTURBANCE ACTIVITIES ASSOCIATED WITH THIS PROJECT SHALL REQUIRE A SEPARATE LAND DISTURBANCE PERMIT BY THE CONTRACTOR.
5. SOILS:
   - THE MAJORITY OF THE SOILS ON THE PROJECT ARE CLASSIFIED BY NRCS AS EITHER DUFFIELD-EARNEST COMPLEX OR GROSECLOSE AND POPLIMENTO SOILS. THESE SOILS HAVE A DRAINAGE CLASS RATING OF WELL DRAINED.
6. CRITICAL EROSION AREAS:
   - THERE ARE NO CRITICAL EROSION AREAS ON THIS PROJECT.
7. EROSION AND SEDIMENT CONTROL MEASURES:
   - THE FOLLOWING VESCH CONTROLS ARE TO BE USED INCLUDE:
     - SILT FENCE PER STD. 3.05 AND VDOT EC-5
     - STORM DRAIN INLET PROTECTION PER STD. 3.07 AND VDOT EC-6
     - DEWATERING STRUCTURE PER STD. 3.26 AND VDOT EC-8
     - DUST CONTROL PER STD. 3.39
8. PERMANENT STABILIZATION:
   - ALL DISTURBED AREAS ARE EXPECTED TO BE CONFINED TO THE TRENCH EXCAVATION NECESSARY FOR CONSTRUCTION OF THE NEW STORM DRAIN. THE EXCAVATED MATERIAL SHALL BE STOCKPILED IN THE ADJACENT PARKING LOT AND PROTECTED WITH SILT FENCE. ANY STORM WATER THAT ACCUMULATES IN THE TRENCH DURING CONSTRUCTION SHALL BE PUMPED OUT TO A SEDIMENT BAG. NEARBY STORM INLETS SHALL BE EQUIPPED WITH SUITABLE INLET PROTECTION.
9. STORMWATER RUN-OFF CONSIDERATIONS:
   - THIS PROJECT WILL NOT RESULT IN AN INCREASE IN THE SITE'S PEAK RUNOFF RATE.

EROSION & SEDIMENT CONTROL MAINTENANCE NOTES

ALL EROSION AND SEDIMENT CONTROL MEASURES SHALL BE INSPECTED BY QUALIFIED PERSONNEL AT LEAST ONCE EVERY FIVE (5) BUSINESS DAYS , OR AT LEAST ONCE EVERY TEN (10) BUSINESS DAYS AND NO LATER THAN 48 HOURS FOLLOWING A MEASURABLE STORM EVENT, AND SHALL BE CLEANED AND REPAIRED ACCORDING TO THE FOLLOWING SCHEDULE:

1. EROSION AND SEDIMENT CONTROL WILL BE CHECKED REGULARLY FOR UNDERMINING OR DETERIORATION AND BUILDUP OR CLOGGING WITH SEDIMENT. CORRECTIVE ACTION WILL BE TAKEN IMMEDIATELY.
2. FREQUENT INSPECTIONS AND CLEANING OF MUD AND DEBRIS FOUND OUTSIDE OF THE LIMITS OF DISTURBANCE IS REQUIRED, ALONG WITH ANY OTHER REMEDIES REQUIRED BY THE CITY. ANY MUD, SEDIMENT, DEBRIS, ETC. OBSERVED OUTSIDE THE LIMITS OF DISTURBANCE SHALL IMMEDIATELY BE REMOVED AND DISPOSED OF IN AN APPROPRIATE MANNER.
3. ALL SEEDED AREAS SHALL BE CHECKED REGULARLY TO SEE THAT A GOOD STAND OF GRASS IS MAINTAINED. AREAS SHALL BE FERTILIZED AND RESEEDED AS NEEDED. TEMPORARY STABILIZATION SHALL BE USED AS REQUIRED BY THE CITY OF ROANOKE.
4. ALL TEMPORARY EROSION AND SEDIMENT MEASURES SHALL BE DISPOSED OF WITHIN THIRTY (30) DAYS AFTER FINAL SITE STABILIZATION IS ACHIEVED AND VEGETATION IS ESTABLISHED.

MINIMUM STANDARDS

1. PERMANENT OR TEMPORARY SOIL STABILIZATION SHALL BE APPLIED TO DENUDED AREAS WITHIN SEVEN DAYS AFTER FINAL GRADE IS REACHED ON ANY PORTION OF THE SITE. TEMPORARY SOIL STABILIZATION SHALL BE APPLIED WITHIN SEVEN DAYS TO DENUDED AREAS THAT MAY NOT BE AT FINAL GRADE BUT WILL REMAIN DORMANT FOR LONGER THAN 14 DAYS. PERMANENT STABILIZATION SHALL BE APPLIED TO AREAS THAT ARE TO BE LEFT DORMANT FOR MORE THAN ONE YEAR.
2. DURING CONSTRUCTION OF THE PROJECT, SOIL STOCK PILES AND BORROW AREAS SHALL BE STABILIZED OR PROTECTED WITH SEDIMENT TRAPPING MEASURES. THE APPLICANT IS RESPONSIBLE FOR THE TEMPORARY PROTECTION AND PERMANENT STABILIZATION OF ALL SOIL STOCKPILES ON SITE AS WELL AS BORROW AREAS AND SOIL INTENTIONALLY TRANSPORTED FROM THE PROJECT SITE.
3. A PERMANENT VEGETATIVE COVER SHALL BE ESTABLISHED ON DENUDED AREAS NOT OTHERWISE PERMANENTLY STABILIZED. PERMANENT VEGETATION SHALL NOT BE CONSIDERED ESTABLISHED UNTIL A GROUND COVER IS ACHIEVED THAT IS UNIFORM, MATURE ENOUGH TO SURVIVE AND WILL INHIBIT EROSION.
4. SEDIMENT BASINS AND TRAPS, PERIMETER DIKES, SEDIMENT BARRIERS AND OTHER MEASURES INTENDED TO TRAP SEDIMENT SHALL BE CONSTRUCTED AS A FIRST STEP IN ANY LAND-DISTURBING ACTIVITY AND SHALL BE MADE FUNCTIONAL BEFORE UPSLOPE LAND DISTURBANCE TAKES PLACE.
5. STABILIZATION MEASURES SHALL BE APPLIED TO EARTHEN STRUCTURES SUCH AS DAMS, DIKES AND DIVERSIONS IMMEDIATELY AFTER INSTALLATION.
6. SEDIMENT TRAPS AND SEDIMENT BASINS SHALL BE DESIGNED AND CONSTRUCTED BASED UPON THE TOTAL DRAINAGE AREA TO BE SERVED BY THE TRAP OR BASIN.
   - A. THE MINIMUM STORAGE CAPACITY OF A SEDIMENT TRAP SHALL BE 134 CUBIC YARDS PER ACRE OF DRAINAGE AREA AND THE TRAP SHALL ONLY CONTROL DRAINAGE AREAS LESS THAN THREE ACRES.
   - B. SURFACE RUNOFF FROM DISTURBED AREAS THAT IS COMPRISED OF FLOW FROM DRAINAGE AREAS GREATER THAN OR EQUAL TO THREE ACRES SHALL BE CONTROLLED BY A SEDIMENT BASIN. THE MINIMUM STORAGE CAPACITY OF A SEDIMENT BASIN SHALL BE 134 CUBIC YARDS PER ACRE OF DRAINAGE AREA. THE OUTFALL SYSTEM SHALL, AT A MINIMUM, MAINTAIN THE STRUCTURAL INTEGRITY OF THE BASIN DURING A 25-YEAR STORM OF 24-HOUR DURATION. RUNOFF COEFFICIENTS USED IN RUNOFF CALCULATIONS SHALL CORRESPOND TO A BARE EARTH CONDITION OR THOSE CONDITIONS EXPECTED TO EXIST WHILE THE SEDIMENT BASIN IS UTILIZED.
7. CUT AND FILL SLOPES SHALL BE DESIGNED AND CONSTRUCTED IN A MANNER THAT WILL MINIMIZE EROSION. SLOPES THAT ARE FOUND TO BE ERODING EXCESSIVELY WITHIN ONE YEAR OF PERMANENT STABILIZATION SHALL BE PROVIDED WITH ADDITIONAL SLOPE STABILIZING MEASURES UNTIL THE PROBLEM IS CORRECTED.
8. CONCENTRATED RUNOFF SHALL NOT FLOW DOWN CUT OR FILL SLOPES UNLESS CONTAINED WITHIN AN ADEQUATE TEMPORARY OR PERMANENT CHANNEL, FLUME OR SLOPE DRAIN STRUCTURE.
9. WHENEVER WATER SEEPS FROM A SLOPE FACE, ADEQUATE DRAINAGE OR OTHER PROTECTION SHALL BE PROVIDED.
10. ALL STORM SEWER INLETS THAT ARE MADE OPERABLE DURING CONSTRUCTION SHALL BE PROTECTED SO THAT SEDIMENT-LADEN WATER CANNOT ENTER THE CONVEYANCE SYSTEM WITHOUT FIRST BEING FILTERED OR OTHERWISE TREATED TO REMOVE SEDIMENT.
11. BEFORE NEWLY CONSTRUCTED STORMWATER CONVEYANCE CHANNELS OR PIPES ARE MADE OPERATIONAL, ADEQUATE OUTLET PROTECTION AND ANY REQUIRED TEMPORARY OR PERMANENT CHANNEL LINING SHALL BE INSTALLED IN BOTH THE CONVEYANCE CHANNEL AND RECEIVING CHANNEL.
12. WHEN WORK IN A LIVE WATERCOURSE IS PERFORMED, PRECAUTIONS SHALL BE TAKEN TO MINIMIZE ENCROACHMENT, CONTROL SEDIMENT TRANSPORT AND STABILIZE THE WORK AREA TO THE GREATEST EXTENT POSSIBLE DURING CONSTRUCTION. NONERODIBLE MATERIAL SHALL BE USED FOR THE CONSTRUCTION OF CAUSEWAYS AND COFFERDAMS. EARTHEN FILL MAY BE USED FOR THESE STRUCTURES IF ARMORED BY NONERODIBLE COVER MATERIALS.
13. WHEN A LIVE WATERCOURSE MUST BE CROSSED BY CONSTRUCTION VEHICLES MORE THAN TWICE IN ANY SIX-MONTH PERIOD, A TEMPORARY VEHICULAR STREAM CROSSING CONSTRUCTED OF NONERODIBLE MATERIAL SHALL BE PROVIDED.
14. ALL APPLICABLE FEDERAL, STATE AND LOCAL CHAPTERS PERTAINING TO WORKING IN OR CROSSING LIVE WATERCOURSES SHALL BE MET.
15. THE BED AND BANKS OF A WATERCOURSE SHALL BE STABILIZED IMMEDIATELY AFTER WORK IN THE WATERCOURSE IS COMPLETED.
16. UNDERGROUND UTILITY LINES SHALL BE INSTALLED IN ACCORDANCE WITH THE FOLLOWING STANDARDS IN ADDITION TO OTHER APPLICABLE CRITERIA:
   - A. NO MORE THAN 500 LINEAR FEET OF TRENCH MAY BE OPENED AT ONE TIME.
   - B. EXCAVATED MATERIAL SHALL BE PLACED ON THE UPHILL SIDE OF TRENCHES.
   - C. EFFLUENT FROM DEWATERING OPERATIONS SHALL BE FILTERED OR PASSED THROUGH AN APPROVED SEDIMENT TRAPPING DEVICE, OR BOTH, AND DISCHARGED IN A MANNER THAT DOES NOT ADVERSELY AFFECT FLOWING STREAMS OR OFF-SITE PROPERTY.
   - D. MATERIAL USED FOR BACKFILLING TRENCHES SHALL BE PROPERLY COMPACTED IN ORDER TO MINIMIZE EROSION AND PROMOTE STABILIZATION.
   - E. RESTABILIZATION SHALL BE ACCOMPLISHED IN ACCORDANCE WITH THIS CHAPTER.
   - F. APPLICABLE SAFETY CHAPTERS SHALL BE COMPLIED WITH.
17. WHERE CONSTRUCTION VEHICLE ACCESS ROUTES INTERSECT PAVED OR PUBLIC ROADS, PROVISIONS SHALL BE MADE TO MINIMIZE THE TRANSPORT OF SEDIMENT BY VEHICULAR TRACKING ONTO THE PAVED SURFACE. WHERE SEDIMENT IS TRANSPORTED ONTO A PAVED OR PUBLIC ROAD SURFACE, THE ROAD SURFACE SHALL BE CLEANED THOROUGHLY AT THE END OF EACH DAY. SEDIMENT SHALL BE REMOVED FROM THE ROADS BY SHOVELING OR SWEEPING AND TRANSPORTED TO A SEDIMENT CONTROL DISPOSAL AREA. STREET WASHING SHALL BE ALLOWED ONLY AFTER SEDIMENT IS REMOVED IN THIS MANNER. THIS PROVISION SHALL APPLY TO INDIVIDUAL DEVELOPMENT LOTS AS WELL AS TO LARGER LAND-DISTURBING ACTIVITIES.
18. ALL TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES SHALL BE REMOVED WITHIN 30 DAYS AFTER FINAL SITE STABILIZATION OR AFTER THE TEMPORARY MEASURES ARE NO LONGER NEEDED, UNLESS OTHERWISE AUTHORIZED BY THE VESCP AUTHORITY. TRAPPED SEDIMENT AND THE DISTURBED SOIL AREAS RESULTING FROM THE DISPOSITION OF TEMPORARY MEASURES SHALL BE PERMANENTLY STABILIZED TO PREVENT FURTHER EROSION AND SEDIMENTATION.
19. PROPERTIES AND WATERWAYS DOWNSTREAM FROM DEVELOPMENT SITES SHALL BE PROTECTED FROM SEDIMENT DEPOSITION, EROSION AND DAMAGE DUE TO INCREASES IN VOLUME, VELOCITY AND PEAK FLOW RATE OF STORMWATER RUNOFF FOR THE STATED FREQUENCY STORM OF 24-HOUR DURATION IN ACCORDANCE WITH THE FOLLOWING STANDARDS AND CRITERIA. STREAM RESTORATION AND RELOCATION PROJECTS THAT INCORPORATE NATURAL CHANNEL DESIGN CONCEPTS ARE NOT MAN-MADE CHANNELS AND SHALL BE EXEMPT FROM ANY FLOW RATE CAPACITY AND VELOCITY REQUIREMENTS FOR NATURAL OR MAN-MADE CHANNELS:
   - A. CONCENTRATED STORMWATER RUNOFF LEAVING A DEVELOPMENT SITE SHALL BE DISCHARGED DIRECTLY INTO AN ADEQUATE NATURAL OR MAN-MADE RECEIVING CHANNEL, PIPE OR STORM SEWER SYSTEM. FOR THOSE SITES WHERE RUNOFF IS DISCHARGED INTO A PIPE OR PIPE SYSTEM, DOWNSTREAM STABILITY ANALYSES AT THE OUTFALL OF THE PIPE OR PIPE SYSTEM SHALL BE PERFORMED.
   - B. ADEQUACY OF ALL CHANNELS AND PIPES SHALL BE VERIFIED IN THE FOLLOWING MANNER:
     - (1) THE APPLICANT SHALL DEMONSTRATE THAT THE TOTAL DRAINAGE AREA TO THE POINT OF ANALYSIS WITHIN THE CHANNEL IS ONE HUNDRED TIMES GREATER THAN THE CONTRIBUTING DRAINAGE AREA OF THE PROJECT IN QUESTION; OR
     - (2) (A) NATURAL CHANNELS SHALL BE ANALYZED BY THE USE OF A TWO-YEAR STORM TO VERIFY THAT STORMWATER WILL NOT OVERTOP CHANNEL BANKS NOR CAUSE EROSION OF CHANNEL BED OR BANKS.

       (B) ALL PREVIOUSLY CONSTRUCTED MAN-MADE CHANNELS SHALL BE ANALYZED BY THE USE OF A TEN-YEAR STORM TO VERIFY THAT STORMWATER WILL NOT OVERTOP ITS BANKS AND BY THE USE OF A TWO-YEAR STORM TO DEMONSTRATE THAT STORMWATER WILL NOT CAUSE EROSION OF CHANNEL BED OR BANKS; AND

       (C) PIPES AND STORM SEWER SYSTEMS SHALL BE ANALYZED BY THE USE OF A TEN-YEAR STORM TO VERIFY THAT STORMWATER WILL BE CONTAINED WITHIN THE PIPE OR SYSTEM.
   - C. IF EXISTING NATURAL RECEIVING CHANNELS OR PREVIOUSLY CONSTRUCTED MAN-MADE CHANNELS OR PIPES ARE NOT ADEQUATE, THE APPLICANT SHALL:
     - (1) IMPROVE THE CHANNELS TO A CONDITION WHERE A TEN-YEAR STORM WILL NOT OVERTOP THE BANKS AND A TWO-YEAR STORM WILL NOT CAUSE EROSION TO THE CHANNEL, THE BED, OR BANKS; OR
     - (2) IMPROVE THE PIPE OR PIPE SYSTEM TO A CONDITION WHERE THE TEN-YEAR STORM IS CONTAINED WITHIN THE APPURTENANCES;
     - (3) DEVELOP A SITE DESIGN THAT WILL NOT CAUSE THE PRE-DEVELOPMENT PEAK RUNOFF RATE FROM A TWO-YEAR STORM TO INCREASE WHEN RUNOFF OUTFALLS INTO A NATURAL CHANNEL OR WILL NOT CAUSE THE PRE-DEVELOPMENT PEAK RUNOFF RATE FROM A TEN-YEAR STORM TO INCREASE WHEN RUNOFF OUTFALLS INTO A MAN-MADE CHANNEL; OR
     - (4) PROVIDE A COMBINATION OF CHANNEL IMPROVEMENT, STORMWATER DETENTION OR OTHER MEASURES WHICH IS SATISFACTORY TO THE VESCP AUTHORITY TO PREVENT DOWNSTREAM EROSION.
   - D. THE APPLICANT SHALL PROVIDE EVIDENCE OF PERMISSION TO MAKE THE IMPROVEMENTS.
   - E. ALL HYDROLOGIC ANALYSES SHALL BE BASED ON THE EXISTING WATERSHED CHARACTERISTICS AND THE ULTIMATE DEVELOPMENT CONDITION OF THE SUBJECT PROJECT.
   - F. IF THE APPLICANT CHOOSES AN OPTION THAT INCLUDES STORMWATER DETENTION, HE SHALL OBTAIN APPROVAL FROM THE VESCP OF A PLAN FOR MAINTENANCE OF THE DETENTION FACILITIES. THE PLAN SHALL SET FORTH THE MAINTENANCE REQUIREMENTS OF THE FACILITY AND THE PERSON RESPONSIBLE FOR PERFORMING THE MAINTENANCE.
   - G. OUTFALL FROM A DETENTION FACILITY SHALL BE DISCHARGED TO A RECEIVING CHANNEL, AND ENERGY DISSIPATERS SHALL BE PLACED AT THE OUTFALL OF ALL DETENTION FACILITIES AS NECESSARY TO PROVIDE A STABILIZED TRANSITION FROM THE FACILITY TO THE RECEIVING CHANNEL.
   - H. ALL ON-SITE CHANNELS MUST BE VERIFIED TO BE ADEQUATE.
   - I. INCREASED VOLUMES OF SHEET FLOWS THAT MAY CAUSE EROSION OR SEDIMENTATION ON ADJACENT PROPERTY SHALL BE DIVERTED TO A STABLE OUTLET, ADEQUATE CHANNEL, PIPE OR PIPE SYSTEM, OR TO A DETENTION FACILITY.
   - J. IN APPLYING THESE STORMWATER MANAGEMENT CRITERIA, INDIVIDUAL LOTS OR PARCELS IN A RESIDENTIAL, COMMERCIAL OR INDUSTRIAL DEVELOPMENT SHALL NOT BE CONSIDERED TO BE SEPARATE DEVELOPMENT PROJECTS. INSTEAD, THE DEVELOPMENT, AS A WHOLE, SHALL BE CONSIDERED TO BE A SINGLE DEVELOPMENT PROJECT. HYDROLOGIC PARAMETERS THAT REFLECT THE ULTIMATE DEVELOPMENT CONDITION SHALL BE USED IN ALL ENGINEERING CALCULATIONS.
   - K. ALL MEASURES USED TO PROTECT PROPERTIES AND WATERWAYS SHALL BE EMPLOYED IN A MANNER WHICH MINIMIZES IMPACTS ON THE PHYSICAL, CHEMICAL AND BIOLOGICAL INTEGRITY OF RIVERS, STREAMS AND OTHER WATERS OF THE STATE.
   - L. ANY PLAN APPROVED PRIOR TO JULY 1, 2014, THAT PROVIDES FOR STORMWATER MANAGEMENT THAT ADDRESSES ANY FLOW RATE CAPACITY AND VELOCITY REQUIREMENTS FOR NATURAL OR MAN-MADE CHANNELS SHALL SATISFY THE FLOW RATE CAPACITY AND VELOCITY REQUIREMENTS FOR NATURAL OR MAN-MADE CHANNELS IF THE PRACTICES ARE DESIGNED TO (I) DETAIN THE WATER QUALITY VOLUME AND TO RELEASE IT OVER 48 HOURS; (II) DETAIN AND RELEASE OVER A 24-HOUR PERIOD THE EXPECTED RAINFALL RESULTING FROM THE ONE YEAR, 24-HOUR STORM; AND (III) REDUCE THE ALLOWABLE PEAK FLOW RATE RESULTING FROM THE 1.5, 2, AND 10-YEAR, 24-HOUR STORMS TO A LEVEL THAT IS LESS THAN OR EQUAL TO THE PEAK FLOW RATE FROM THE SITE ASSUMING IT WAS IN A GOOD FORESTED CONDITION, ACHIEVED THROUGH MULTIPLICATION OF THE FORESTED PEAK FLOW RATE BY A REDUCTION FACTOR THAT IS EQUAL TO THE RUNOFF VOLUME FROM THE SITE WHEN IT WAS IN A GOOD FORESTED CONDITION DIVIDED BY THE RUNOFF VOLUME FROM THE SITE IN ITS PROPOSED CONDITION, AND SHALL BE EXEMPT FROM ANY FLOW RATE CAPACITY AND VELOCITY REQUIREMENTS FOR NATURAL OR MAN-MADE CHANNELS AS DEFINED IN ANY REGULATIONS PROMULGATED PURSUANT TO § 62.1-44.15:54 OR 62.1-44.15:65 OF THE ACT.
   - M. FOR PLANS APPROVED ON AND AFTER JULY 1, 2014, THE FLOW RATE CAPACITY AND VELOCITY REQUIREMENTS OF § 62.1-44.15:52 OF THE ACT AND THIS SUBSECTION SHALL BE SATISFIED BY COMPLIANCE WITH WATER QUANTITY REQUIREMENTS IN THE STORMWATER MANAGEMENT ACT (§ 62.1-44.15:24 ET SEQ. OF THE CODE OF VIRGINIA) AND ATTENDANT REGULATIONS, UNLESS SUCH LAND-DISTURBING ACTIVITIES ARE IN ACCORDANCE WITH 9VAC25-870-66 OF THE VIRGINIA STORMWATER MANAGEMENT PROGRAM (VSMP) PERMIT REGULATIONS.
   - N. COMPLIANCE WITH THE WATER QUANTITY MINIMUM STANDARDS SET OUT IN 9VAC25-870-66 OF THE VIRGINIA STORMWATER MANAGEMENT PROGRAM (VSMP) PERMIT REGULATIONS SHALL BE DEEMED TO SATISFY THE REQUIREMENTS OF MINIMUM STANDARD 19.

GENERAL EROSION AND SEDIMENT CONTROL NOTES

FROM THE VIRGINIA EROSION AND SEDIMENT CONTROL HANDBOOK, THIRD EDITION, 1992.

- ES-1: UNLESS OTHERWISE INDICATED, ALL VEGETATIVE AND STRUCTURAL EROSION AND SEDIMENT CONTROL PRACTICES WILL BE CONSTRUCTED AND MAINTAINED ACCORDING TO MINIMUM STANDARDS AND SPECIFICATIONS OF THE VIRGINIA EROSION AND SEDIMENT CONTROL HANDBOOK AND VIRGINIA REGULATIONS 4VAC50-30 EROSION AND SEDIMENT CONTROL REGULATIONS.
- ES-2: THE PLAN APPROVING AUTHORITY MUST BE NOTIFIED ONE WEEK PRIOR TO THE PRE-CONSTRUCTION CONFERENCE, ONE WEEK PRIOR TO THE COMMENCEMENT OF LAND DISTURBING ACTIVITY, AND ONE WEEK PRIOR TO THE FINAL INSPECTION.
- ES-3: ALL EROSION AND SEDIMENT CONTROL MEASURES ARE TO BE PLACED PRIOR TO OR AS THE FIRST STEP IN CLEARING.
- ES-4: A COPY OF THE APPROVED EROSION AND SEDIMENT CONTROL PLAN SHALL BE MAINTAINED ON THE SITE AT ALL TIMES.
- ES-5: THE CONTRACTOR IS RESPONSIBLE FOR INSTALLATION OF ANY ADDITIONAL EROSION CONTROL MEASURES NECESSARY TO PREVENT EROSION AND SEDIMENTATION AS DETERMINED BY THE PLAN APPROVING AUTHORITY.
- ES-6: ALL DISTURBED AREAS ARE TO DRAIN TO APPROVED SEDIMENT CONTROL MEASURES AT ALL TIMES DURING LAND DISTURBING ACTIVITIES AND DURING SITE DEVELOPMENT UNTIL FINAL STABILIZATION IS ACHIEVED.
- ES-7: DURING DEWATERING OPERATIONS, WATER WILL BE PUMPED INTO AN APPROVED FILTERING DEVICE.
- ES-8: THE CONTRACTOR SHALL INSPECT ALL EROSION CONTROL MEASURES PERIODICALLY AND AFTER EACH RUNOFF-PRODUCING RAINFALL EVENT. ANY NECESSARY REPAIRS OR CLEANUP TO MAINTAIN THE EFFECTIVENESS OF THE EROSION CONTROL DEVICES SHALL BE MADE IMMEDIATELY.

POTABLE WATER NOTES

1. ALL WATER SERVICE LINES, APPURTENANCES, ETC. ARE UNDER THE OWNERSHIP OF THE WESTERN VIRGINIA WATER AUTHORITY.
2. WATER SERVICE LINES SHALL BE IN ACCORDANCE WITH THE AWWA STANDARD C600, THE UNIFORM STATEWIDE BUILDING CODE, AND CITY OF ROANOKE MINIMUM STANDARDS AND SPECIFICATIONS FOR WATERLINE DESIGN AND CONSTRUCTION, LATEST EDITIONS.
3. INSTALLATION OF TAPS ON EXISTING WATER MAINS, WATER METERS, AND WATER METER BOXES SHALL BE PERFORMED BY WVWA PERSONNEL AT THE OWNER'S EXPENSE. THE LOCATION AND INSTALLATION OF EACH ITEM SHALL BE COORDINATED BY THE CONTRACTOR.
4. WATER METER AND BOX LOCATIONS SHALL BE AT THE PROPERTY LINE OR EASEMENT LINE UNLESS OTHERWISE APPROVED BY WVWA PERSONNEL.
5. ALL MATERIALS USED SHALL BE IN CONFORMANCE WITH THE MOST RECENT STANDARDS SET FORTH BY THE AWWA AND THE SAFE DRINKING WATER ACT.
6. ALL PIPE USED FOR POTABLE WATER DISTRIBUTION SHALL BE APPROVED BY THE NATIONAL SANITATION FOUNDATION FOR WATER DISTRIBUTION PIPING.
7. COPPER PIPE SHALL BE USED FOR ALL WATER LINES WITH A NOMINAL DIAMETER OF LESS THAN 3 INCHES. COPPER PIPE SHALL BE SEAMLESS, TYPE "K" COPPER, MEETING THE REQUIREMENTS OF ASTM B88.

SANITARY SEWER NOTES

1. ALL SANITARY SEWER SERVICE LINES, APPURTENANCES, ETC. ARE UNDER THE OWNERSHIP OF THE WESTERN VIRGINIA WATER AUTHORITY.
2. ALL SANITARY SEWER LINES SHALL BE CONSTRUCTED, INSPECTED, AND TESTED IN ACCORDANCE WITH THE COMMONWEALTH OF VIRGINIA'S SEWAGE COLLECTION AND TREATMENT REGULATIONS, THE REGULATIONS, STANDARDS, AND SPECIFICATIONS SET FORTH BY THE COMMONWEALTH OF VIRGINIA, AND THE WVWA LOCAL STANDARDS & REVIEW PROGRAM FOR WATER & SEWER LINE EXTENSIONS, LATEST EDITIONS.
3. CONNECTIONS TO EXISTING SANITARY SEWERS SHALL BE PERFORMED BY THE CONTRACTOR, IN ACCORDANCE WITH NOTE #1, AND UNDER THE DIRECT SUPERVISION OF WVWA PERSONNEL.
4. THE CONTRACTOR SHALL INSTALL ALL PROPOSED SERVICE LINES.
5. ALL SANITARY SEWER GRAVITY MAIN LINES TO BE ACCEPTED, OWNED, OPERATED, AND/OR MAINTAINED BY THE WVWA SHALL BE A MINIMUM 8 INCH DIAMETER SDR 35 PVC, EXCEPT WHERE REQUIRED IN ACCORDANCE WITH NOTE #1
6. ALL SANITARY SEWER GRAVITY LATERAL SERVICE LINES TO BE ACCEPTED, OWNED, OPERATED, AN/OR MAINTAINED BY THE WVWA SHALL BE A MINIMUM 6 INCH DIAMETER SDR 35 PVC, FROM THE MAIN LINE TO THE PROPERTY LINE, TERMINATED BY A CLEAN OUT AT THE CONNECTION TO PRIVATELY MAINTAINED SEWER PIPE.
7. A TRAFFIC BEARING CLEANOUT COVER SHALL BE INSTALLED OVER ALL CLEANOUTS THAT WILL BE ACCEPTED, OWNED, OPERATED, AND/OR MAINTAINED BY THE WVWA.
8. ABANDONED SEWER LINES SHALL BE PLUGGED AFTER NEW LINES HAVE BEEN INSTALLED, INSPECTED, TESTED, ACCEPTED, AND IN USE.

CONCRETE

1. SUBMITTALS
   - A. PRODUCT DATA FOR PROPRIETARY MATERIALS AND ITEMS, INCLUDING REINFORCEMENT AND FORMING ACCESSORIES, ADMIXTURES, PATCHING COMPOUNDS, WATERSTOPS, JOINT SYSTEMS, CURING COMPOUNDS, FLY ASH, AND OTHERS AS REQUESTED BY ENGINEER.
   - B. SUBMIT LABORATORY TEST REPORTS FOR CONCRETE MATERIALS AND MIX DESIGN TESTS.
   - C. MATERIALS CERTIFICATES IN LIEU OF MATERIALS LABORATORY REPORTS WHEN PERMITTED BY ENGINEER. MATERIAL CERTIFICATES SHALL BE SIGNED BY MANUFACTURER AND CONTRACTOR, CERTIFYING THAT EACH MATERIAL ITEM COMPLIES WITH OR EXCEEDS SPECIFIED REQUIREMENTS. PROVIDE CERTIFICATION FROM ADMIXTURE MANUFACTURERS THAT CHLORIDE CONTENT COMPLIES WITH SPECIFICATION REQUIREMENTS.
2. QUALITY ASSURANCE
   - A. CODES AND STANDARD: COMPLY WITH PROVISIONS OF FOLLOWING CODES, SPECIFICATIONS, AND STANDARDS, EXCEPT WHERE MORE STRINGENT REQUIREMENTS ARE SHOWN OR SPECIFIED:
     ACI 318, "BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE."
     CONCRETE REINFORCING STEEL INSTITUTE (CRSI), "MANUAL OF STANDARD PRACTICE."
     ACI 301, "SPECIFICATION FOR STRUCTURAL CONCRETE FOR BUILDINGS."
     ACI 306, ACI 309, ACI 305, ACI 304, ACI 315, ACI 308
   - B. CONCRETE TESTING SERVICE: A TESTING LABORATORY ACCEPTABLE TO ENGINEER RETAINED BY OWNER TO PERFORM MATERIAL EVALUATION TESTS AND TO DESIGN CONCRETE MIXES AS SPECIFIED.
   - C. MATERIALS AND INSTALLED WORK MAY REQUIRE TESTING AND RETESTING AT ANY TIME DURING PROGRESS OF WORK. RETESTING OF REJECTED MATERIALS FOR INSTALLED WORK, SHALL BE DONE AT CONTRACTOR'S EXPENSE.
   - D. THE PRE-CONSTRUCTION CONFERENCE AT PROJECT SITE SHOULD INCLUDE A REVIEW OF PROCEDURES FOR SATISFACTORY CONCRETE OPERATIONS. REVIEW REQUIREMENTS FOR SUBMITTALS, STATUS OF COORDINATING WORK, AND AVAILABILITY OF MATERIALS. ESTABLISH PRELIMINARY WORK PROGRESS SCHEDULE AND PROCEDURES FOR MATERIALS INSPECTION, TESTING, AND CERTIFICATIONS
   - E. WHEN PROPRIETARY ITEMS ARE USED, FOLLOW MANUFACTURER'S RECOMMENDATIONS.
   - F. THE CONTRACTOR SHALL NOTIFY THE OWNER'S REPRESENTATIVE 48 HOURS BEFORE PLACING CONCRETE IN ORDER TO GIVE THE OWNER'S REPRESENTATIVE AN OPPORTUNITY TO INSPECT THE FORMWORK, REINFORCING, AND RELATED ITEMS PRIOR TO PLACEMENT OF THE CONCRETE.
3. CONCRETE MATERIALS
   - A. CONCRETE SHALL BE VDOT A4 4000 PSI MIX WITH 4.5-7.5% AIR CONTENT AND SLUMP OF 3-5 INCHES.
   - B. WATER: ASTM C94 AND POTABLE.
   - C. EPOXY JOINT FILLER SHALL BE A 100% SOLID SEMI-RIGID EPOXY COMPOUND WITH A MINIMUM SHORE D HARDNESS OF FIFTY (50).
   - D. PREFORMED JOINT FILLER SHALL BE PRE-FORMED JOINT FILLER CONFORMING TO ASTM D1751.
4. REINFORCEMENT
   - A. STEEL BAR REINFORCEMENT SHALL CONFORM TO ASTM A615, GRADE 60 FOR ALL BARS.
   - B. REINFORCEMENT SHALL BE FABRICATED ACCORDING TO PROVISIONS OF ACI 315 "MANUAL OF STANDARDS AND PRACTICES FOR DETAILING REINFORCED CONCRETE STRUCTURES."
   - C. ALL REINFORCEMENT STEEL SHALL BE FREE FROM MUD, OIL , OR NON-METALIC COATINGS AT TIME OF CONCRETING.
   - D. EMBEDMENT OF LAP SPLICE LENGTHS FOR ALL REINFORCING STEEL BARS SHALL BE 48 BARS DIAMETERS.
   - E. FABRICATED BARS NOT CONFORMING TO DIMENSIONS AND DETAILS SHALL BE REJECTED.
   - F. WELDING OF CROSSING BARS FOR ASSEMBLY OF REINFORCEMENT IS NOT PERMITTED. THE FOLLOWING MINIMUM COVER WILL BE PROVIDED FOR REINFORCING BARS:

CAST AGAINST & PERMANENTLY EXPOSED TO EARTH	MIN COVER
EXPOSED TO EARTH OR WEATHER:	3"
#6 BARS AND LARGER	2"
#5 BARS AND SMALLER	1 1/2"

5. CONCRETE MIXING
   - A. PROVIDE BATCH TICKET FOR EACH BATCH DISCHARGED AND USED IN WORK, INDICATING PROJECT IDENTIFICATION NAME AND NUMBER, DATE, MIX TYPE, MIX TIME, QUANTITY, AND AMOUNT OF WATER INTRODUCED.
   - B. READY-MIX CONCRETE: COMPLY WITH REQUIREMENTS OF ASTM C94, AND AS SPECIFIED. WHEN AIR TEMPERATURE IS BETWEEN 85 DEG F. (30 DEG C.) AND 90 DEG F. (32 DEG C.), REDUCE MIXING AND DELIVERY TIME FROM 1-1/2 HOURS TO 75 MINUTES, AND WHEN AIR TEMPERATURE IS ABOVE 90 DEG. F (32 DEG. C), REDUCE MIXING AND DELIVERY TIME TO 60 MINUTES.
6. TESTING REQUIREMENTS
   - A. ONE SET OF COMPRESSION TEST CYLINDERS IS REQUIRED FOR EACH DAY'S POUR AND FOR EACH 50 CY OF EACH CONCRETE MIX.
   - B. ONE SET OF FIVE COMPRESSION CYLINDERS SHALL BE CAST FROM THE SAME TRUCKLOAD OF CONCRETE. ONE CYLINDER SHALL BE BROKEN AT 7 DAYS AND THREE CYLINDERS SHALL BE BROKEN AT 28 DAYS. THE FIFTH CYLINDER SHALL BE HELD FOR RE-TESTING, OR FOR A 56 DAY STRENGTH TEST, SHOULD THE 28 DAY TEST FAIL TO MEET THE REQUIREMENTS. TESTS SHALL BE MADE BY AN INDEPENDENT LABORATORY RETAINED BY OWNER.
   - C. SLUMP TEST SHALL BE MADE WHENEVER CYLINDERS ARE MADE.
   - D. AIR TEST SHALL BE MADE WHENEVER CYLINDER ARE MADE.
   - E. CYLINDERS SHALL BE PLACED IN A FIELD STORAGE BOX CONTAINING A THERMOMETER. THE TEMPERATURE IN THE BOX SHALL BE KEPT BETWEEN 70°F TO 75°F WHEN POSSIBLE. IN NO EVENT SHALL THE STORAGE BOX TEMPERATURE BE ALLOWED TO FALL BELOW 40°F OR RISE ABOVE 90°F.
7. NOTES TO CONCRETE PLACEMENT SCHEDULE:
   - A. AIR-ENTRAINED CONCRETE MIX THAT DOES NOT MEET THE MINIMUM OR EXCEEDS THE MAXIMUM AIR-CONTENT REQUIREMENTS SHALL BE REJECTED.
   - B. CONCRETE DISPATCHED MORE THAN 90 MINUTES BEFORE PLACEMENT SHALL BE REJECTED.
   - C. CONCRETE MORE THAN 5" SLUMP SHALL BE REJECTED UNLESS A SUPER-PLASTIZER ADMIXTURE IS USED, THEN THE SLUMP SHOULD NOT EXCEED 8"

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STORMWATER C.I.P.
SALEM AVE & 1st ST SW
"L-TUNNEL"
CITY OF ROANOKE, VIRGINIA

MARK	DATE	DESCRIPTION

100% DESIGN

PROJECT NO:	18-1108.007
SCALE:	AS SHOWN
DESIGNED BY:	DAK
DRAWN BY:	KHH
CHECKED BY:	DJR

SHEET TITLE

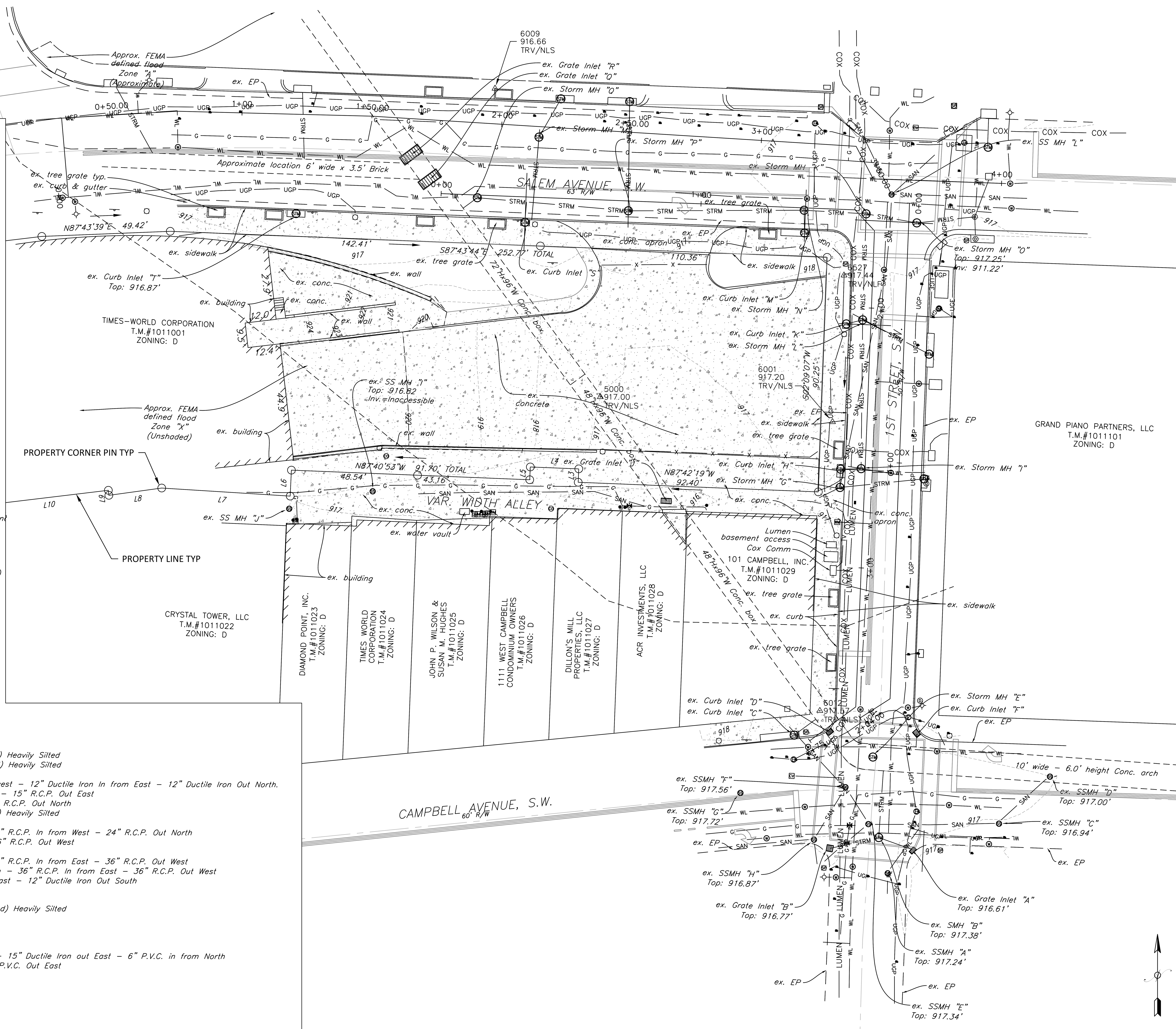
GENERAL NOTES AND EROSION & SEDIMENT CONTROL NOTES

C2.0

LEGEND

These standard symbols will be found in the drawing.

- Signal Pole
- Utility Vault
- Chain Barricade Post
- Bollard
- San. Clean Out
- Utility M.H.
- Gas Meter
- Gas Valve
- Light Pole
- San. M.H.
- Sign
- Storm M.H.
- Water Meter
- Water M.H.
- SAN —— SAN —— SAN: WVWA Sanitary Sewer (Painted Green Line)
- G —— G —— G —— G: Roanoke Gas (Painted Yellow Line)
- COX LUMEN COX LUMEN COX: Cox or Lumen Telecom (Painted Orange Line)
- WL —— WL —— WL: WVWA Water Line (Painted Blue Line)
- X —— X —— X: Chain Fencing
- UGP —— UGP —— UGP: AEP Underground Power (Painted Red Line)
- Approximate Location FEMA Floodplain
- HATCH CONC



Storm Structure	Top	Invert Out	Size / Material
Curb Inlet C	917.51	913.91	20" Ductile Iron
Curb Inlet D	917.06	910.06	8'w x 6'h Drain Culvert (Boxed) Heavily Silted
Storm MH E	917.53	909.00	10'w x 6'h Drain Culvert (Arced) Heavily Silted
Curb Inlet F	916.72	914.12	16" Ductile Iron
Storm MH G	916.60	913.73	12" Ductile Iron In from Southwest – 12" Ductile Iron In from East – 12" Ductile Iron Out North.
Curb Inlet H	917.07	913.14	12" Ductile Iron In from South – 15" R.C.P. Out East
Storm MH I	916.62	912.99	15" R.C.P. In from West – 15" R.C.P. Out North
Grate Inlet J	915.67	910.37	7'w x 6'h Drain Culvert (Boxed) Heavily Silted
Curb Inlet K	917.21	913.16	18" R.C.P. Out East
Storm MH L	916.78	911.33	15" R.C.P. In from South – 18" R.C.P. In from West – 24" R.C.P. Out North
Storm MH K	917.19	911.12	24" R.C.P. In from South – 36" R.C.P. Out West
Curb Inlet M	917.50	912.33	15" R.C.P. Out North
Storm MH N	917.07	911.12	15" R.C.P. In from South – 36" R.C.P. In from East – 36" R.C.P. Out West
Storm MH P	916.51	910.38	Dual 10" P.V.C.'s In from North – 36" R.C.P. In from East – 36" R.C.P. Out West
Storm MH M	916.18	913.69	12" Ductile Iron in from Northeast – 12" Ductile Iron Out South
Curb Inlet S	916.54	912.28	15" R.C.P. Out North
Storm MH Q	916.51	Inaccessible due to parked car.	
Grate Inlet Q	916.54	908.04	7'w x 4.5'h Drain Culvert (Boxed) Heavily Silted
Grate Inlet R	916.54		

Sanitary Structure	Top	Invert Out	Size / Material
Sanitary MH J	916.94	912.81	15" Ductile Iron in from West – 15" Ductile Iron out East – 6" P.V.C. in from North
Sanitary MH L	917.26	913.09	8" P.V.C. in from South – 8" P.V.C. Out East

Inverts South of the work area were inaccessible due to heavy traffic conditions.

TOPOGRAPHIC SURVEY NOTE:
THIS PARTIAL TOPOGRAPHIC SURVEY WAS COMPLETED UNDER THE DIRECT AND RESPONSIBLE CHARGE OF, DONALD S. HADDON, III, L.S. FROM AN ACTUAL GROUND SURVEY MADE UNDER MY SUPERVISION; THAT THE IMAGERY AND/OR ORIGINAL DATA WAS OBTAINED ON DECEMBER 25, 2021; AND THAT THIS PLAT, MAP, OR DIGITAL GEOSPATIAL DATA INCLUDING METADATA MEETS MINIMUM ACCURACY STANDARDS UNLESS OTHERWISE NOTED.

VERTICAL DATUM: NAVD 1988

1 SITE SURVEY - OVERALL

SCALE: 1"=20'

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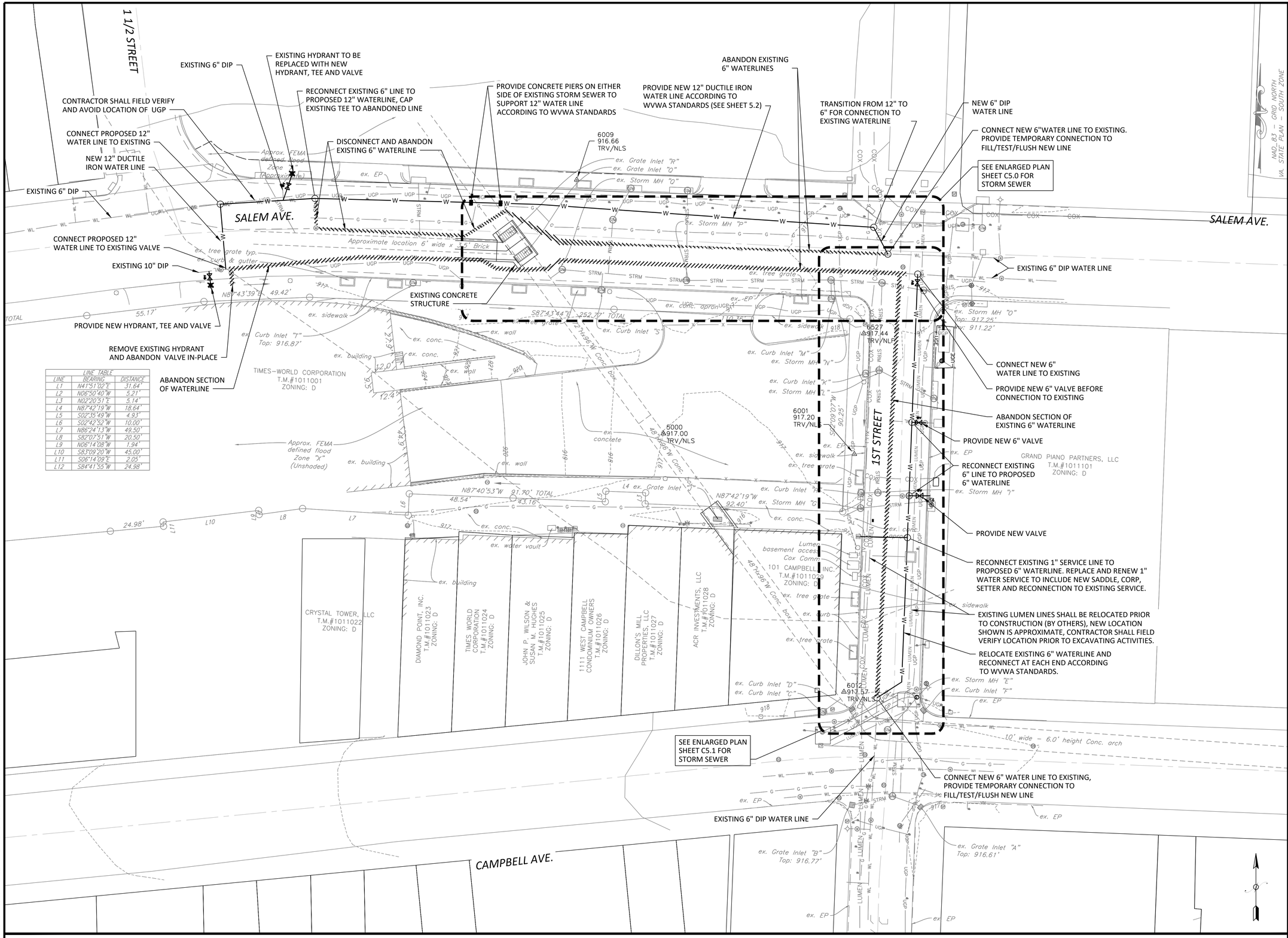
DRAWN BY:	KHH
CHECKED BY:	DJR

SHEET TITLE

SITE SURVEY - OVERALL

C3.0

SHEET 3 OF 17



LINE TABLE		
LINE	BEARING	DISTANCE
L1	N41°51'02"E	31.64'
L2	N06°50'40"W	5.21'
L3	N02°20'51"E	5.14'
L4	N87°42'19"W	18.64'
L5	S02°35'49"W	4.93'
L6	S02°42'52"W	10.00'
L7	N86°24'13"W	49.50'
L8	S82°07'51"W	20.50'
L9	N06°14'08"W	1.94'
L10	S83°09'20"W	45.00'
L11	S06°14'09"E	2.05'
L12	S84°41'55"W	24.98'

1 PROPOSED SITE PLAN
SCALE: 1" = 15'

0 20' 40'

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SITE PLAN LEGEND

ASPHALT OVERLAY

MARK	DATE	DESCRIPTION

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PROPOSED WVWA WATER LINE REPLACEMENT

C4.0

SHEET 4 OF 17

C4.0
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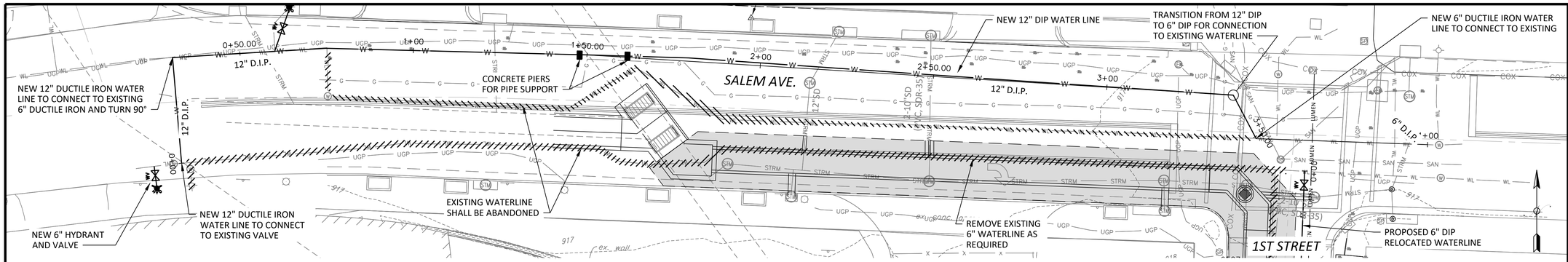
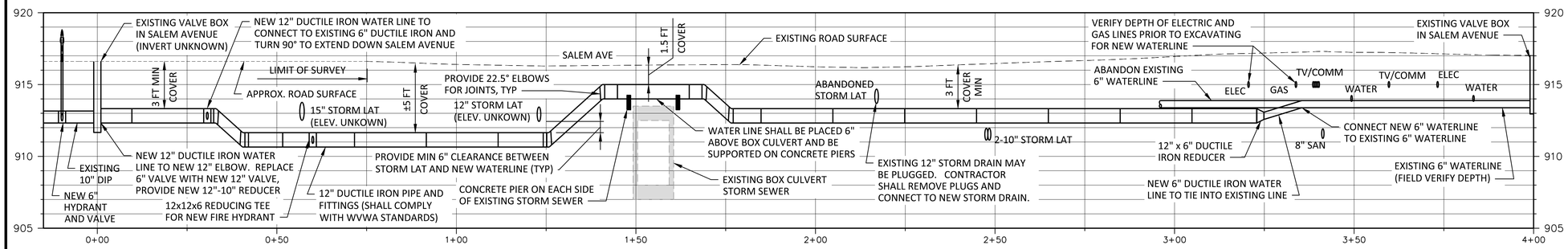


1 SITE PLAN FOR PROPOSED 12" WATERLINE ALONG SALEM AVENUE

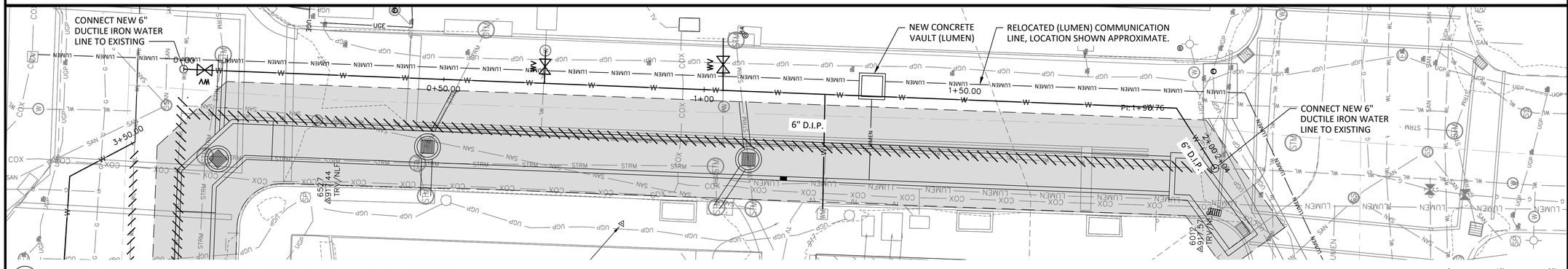
0 15' 30'



2 PROPOSED 12" DUCTILE IRON PIPE WATER LINE PROFILE

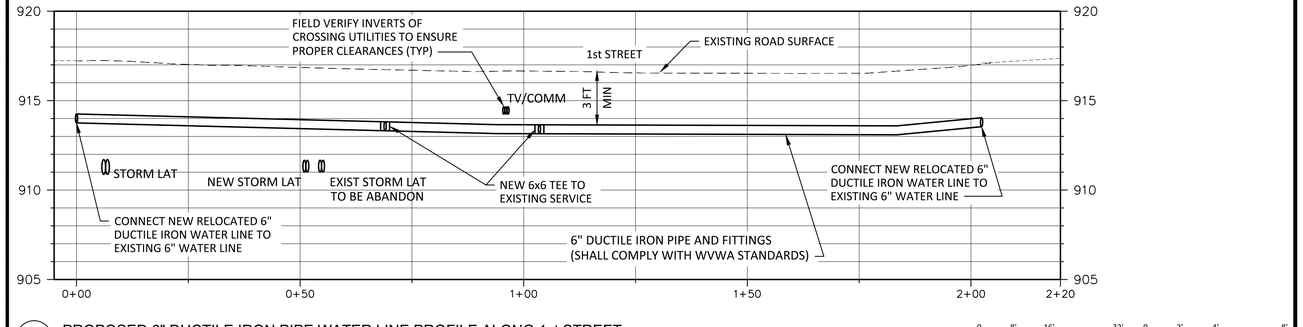
0 8' 16' 32' HORIZONTAL SCALE: 1" = 16'

0 2' 4' 8' VERTICAL SCALE: 1" = 4'



3 SITE PLAN FOR PROPOSED 6" WATER LINE RELOCATION ALONG 1st STREET

0 10' 20'



4 PROPOSED 6" DUCTILE IRON PIPE WATER LINE PROFILE ALONG 1st STREET

0 8' 16' 32' HORIZONTAL SCALE: 1" = 16'

0 2' 4' 8' VERTICAL SCALE: 1" = 4'

WVWA WATER AND SEWER NOTES:

1. ALL CONSTRUCTION METHODS AND MATERIALS SHALL CONFORM TO THE LATEST EDITION OF THE DESIGN AND CONSTRUCTION STANDARDS AND SPECIFICATIONS OF THE WESTERN VIRGINIA WATER AUTHORITY (WVWA) AVAILABLE AT WWW.WESTERNVAWATER.ORG OR BY CONTACTING THE AUTHORITY AT 540-853-5700. THE PROJECT SHALL ALSO COMPLY WITH THE GOVERNING JURISDICTION'S STANDARDS AND OTHER AGENCY STANDARDS (E.G., VDOT, DEQ, DCR, VDH, ETC.) WHERE APPLICABLE.
2. A MINIMUM COVER OF THREE (3) FEET IS REQUIRED ON ALL WVWA WATER AND SEWER LINES.
3. ALL EXISTING UTILITIES MAY NOT BE SHOWN IN THEIR EXACT LOCATIONS. THE CONTRACTOR SHALL NOTIFY MISS UTILITY AND SHALL VERIFY LOCATION AND ELEVATION OF ALL UNDERGROUND UTILITIES IN THE AREAS OF CONSTRUCTION PRIOR TO STARTING WORK.
4. PLEASE SHOW ALL WVWA WATER AND SEWER UTILITIES ON ANY DEVELOPMENT PLAN.
5. THE LOCATION OF EXISTING UTILITIES ACROSS OR ALONG THE LINE OF PROPOSED WORK ARE NOT NECESSARILY SHOWN ON THE PLANS AND WHERE SHOWN ARE ONLY APPROXIMATELY CORRECT. THE CONTRACTOR SHALL ON HIS OWN INITIATIVE AND AT NO EXTRA COST, LOCATE ALL UNDERGROUND LINES AND STRUCTURES AND POTHOLE AS NECESSARY. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY DAMAGE TO UNDERGROUND STRUCTURES. ALL DAMAGE INCURRED TO EXISTING UTILITIES DURING CONSTRUCTION SHALL BE REPAIRED AT THE CONTRACTOR'S EXPENSE.
6. PLAN APPROVAL BY THE WVWA DOES NOT REMOVE THE CONTRACTOR'S RESPONSIBILITY TO REMOVE OR RELOCATE ANY EXISTING CONFLICTS FOUND DURING CONSTRUCTION.
7. ALL PRIVATE UTILITY CONSTRUCTION, I.E. PIPING, VALVES, HYDRANTS, METERS AND BOXES, CLEAN OUTS, SANITARY SEWER MANHOLES, BEDDING, ETC. SHALL COMPLY WITH THE CURRENT VIRGINIA UNIFORM STATEWIDE BUILDING CODE (INCLUDING AMENDMENTS).
8. THE CONTRACTOR SHALL MAINTAIN A MINIMUM OF 18" CLEARANCE VERTICALLY AND TWO (2) FOOT MINIMUM HORIZONTALLY FROM THE OUTSIDE OF PIPE TO OUTSIDE OF PIPE WITH ALL OTHER UNDERGROUND UTILITIES. WHERE THIS CANNOT BE ACHIEVED, ADDITIONAL MEASURES IN ACCORDANCE WITH WVWA STANDARDS SHALL BE ENFORCED.
9. ALL UTILITY GRADE ADJUSTMENTS SHALL BE IN ACCORDANCE WITH WVWA STANDARDS AND ARE THE RESPONSIBILITY OF THE CONTRACTOR.
10. FIELD CHANGES SHALL BE SUBMITTED BY THE ENGINEER OF RECORD TO THE LOCALITY AND APPROVED BY THE WVWA.

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SITE PLAN LEGEND

ASPHALT OVERLAY

MARK	DATE	DESCRIPTION

100% DESIGN

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DRAWN BY:	KHH
CHECKED BY:	DJR
SHEET TITLE	

WVWA WATERLINE RELOCATION ENLARGED PLANS AND PROFILES

C4.1

SHEET 5 OF 17

C4.1
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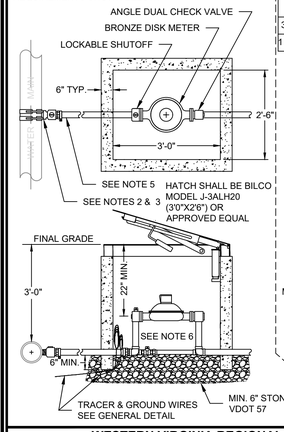
1. ALL METERS ARE TO BE PROVIDED AND INSTALLED BY PARTICIPATING UTILITY AT OWNER/DEVELOPER'S EXPENSE. METER BOX, SERVICE, AND SETTER TO BE FURNISHED AND INSTALLED BY OWNER/DEVELOPER IN ACCORDANCE WITH THE MINIMUM REQUIREMENTS SHOWN BELOW.
2. SADDLES MUST BE USED WITH ALL PLASTIC & DUCTILE IRON PIPE. SERVICE SADDLES SHALL BE USED IN ACCORDANCE WITH WATER DISTRIBUTION PIPING SPECIFICATION. SERVICE SADDLES FOR PLASTIC PIPE SHALL BE: POWERSEAL 3417, OR 3412AS, ROMAC 202S, OR 306, OR FORD METER FS202 OR FS303. FOR DUCTILE IRON PIPE USE THE ABOVE OR POWERSEAL 3413, ROMAC 202 OR FORD METER F202.
3. CORPORATION STOP SHALL BE FORD FB1000-4-G-NL, MUELLER B-25008 OR APPROVED EQUAL.
4. METER BOXES LOCATED IN AREAS SUBJECT TO VEHICULAR TRAFFIC SHALL BE CONCRETE WITH H-20 RATED TRAFFIC BEARING HATCH. ALL OTHER METER BOXES SHALL BE CARSON/MID-STATES PLASTICS, INC. PLASTIC BOX, ADS CORRUGATED HDPE BOX, OR APPROVED EQUAL. MINIMUM METER BOX & LID DIAMETERS SHALL BE IN ACCORDANCE WITH SIZING CHART BELOW.
5. SERVICE SHALL BE "K" TYPE COPPER OR P.E. 4710 ,CTS O.D., MINIMUM CELL CLASS 445474E AND 445474D.
6. COPPER METER SETTER TO BE FORD, A.Y. MCDONALD OR APPROVED EQUAL WITH ANGLE DUAL CHECK VALVE AND BYPASS HAVING LOCKABLE SHUTOFF VALVE.
7. SERVICES REQUIRING METERS LARGER THAN 2-INCH SHALL BE REVIEWED BY THE PARTICIPATING UTILITY ON A CASE BY CASE BASIS.

TRAFFIC BEARING LOCATION

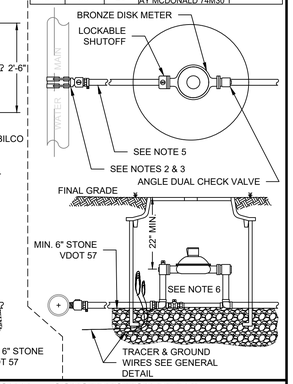
TRAFFIC BEARING VAULT AND H-20 RATED HATCH SHALL BE SIZED IN ACCORDANCE WITH DIMENSIONAL REQUIREMENTS SHOWN BELOW.



NON TRAFFIC BEARING LOCATION

SIZING CHART LID

METER SIZE	BOX DIA (MIN.)	LID DIA (MIN.)	COVER & LID MODEL (OR APPROVED EQUAL)
5/8"	18"	11¾"	FORD "A" SERIES FRAME & NICOR DOMESTIC 12.25 CX LID WITH SENSUS RECESS AND WVWA LOGO
3/4"- 1"	24"	20"	FORD MC-24-T OR AY MCDONALD 74M24 T
1 1/2"-2"	30"	20"	FORD MC-30-T OR AY MCDONALD 74M30 T

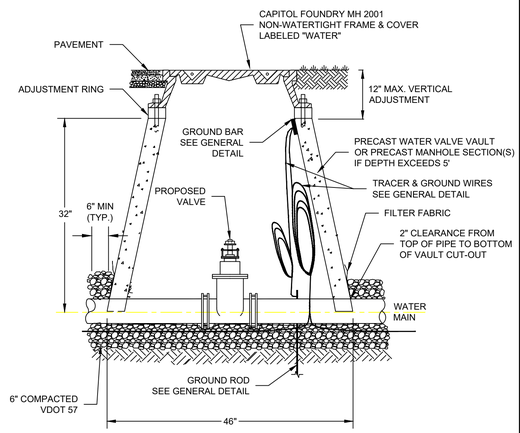


WESTERN VIRGINIA REGIONAL - CONSTRUCTION DETAIL

COMMERCIAL WATER SERVICE METER SIZES 5/8" - 2"

09/07/17 — **W-5**

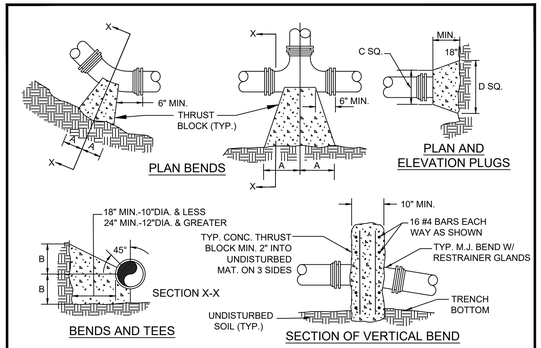
1. FILTER FABRIC TO BE INSTALLED BETWEEN BOTTOM OF PIPE AND STONE BEDDING. FABRIC TO EXTEND VERTICALLY A MINIMUM OF 6" FROM BOTTOM OF VAULT (FULL CIRCUMFERENCE).



WESTERN VIRGINIA REGIONAL - CONSTRUCTION DETAIL

WATER LINE VALVE & VAULT

01/01/14 — **W-9**



NOTES

1. FOR VERT. BEND DOWN IN EXCESS OF 11 1/4" BEND, ANCHORAGE SHALL BE DESIGNED BY ENGINEER.
2. FOR VERT. BEND UPWARD, BLOCKING TO BE SIMILAR TO THAT FOR HORZ. BEND.
3. GLANDS & BOLTS SHALL BE PROTECTED FROM CONC. WITH PLASTIC SHEETING WHEN POURING THRUST BLOCKS.
4. ALL THRUST BLOCK & SUPPORT CONCRETE SHALL BE 3000 PSI READY MIX CONCRETE.
5. THRUST BLOCKS WITH "B" DIMENSION GREATER THAN 30" SHALL HAVE THE RESTRAINED PIPE INSTALLED WITH A MINIMUM OF 4' OF COVER.
6. REFER TO "MINIMUM THRUST RESTRAINT OF PIPE JOINTS DESIGN LENGTHS" DETAIL FOR WHEN THRUST BLOCKS ARE REQUIRED TO BE USED.
7. WHEN THRUST BLOCK IS REQUIRED BUT NOT FEASIBLE TO CONSTRUCT, THRUST COLLAR SHALL BE USED. SEE "THRUST COLLAR" DETAIL.

PRESSURE = 200psi
BEARING = 2000psf
FACTOR OF SAFETY = 1.5

PIPE SIZE	90° BEND		45° BEND		22½° BEND		11¼° BEND		TEE		PLUG	
	A	B	A	B	A	B	A	B	A	B	C	D
4"	8"	12"	8"	8"	6"	6"	6"	6"	11"	9"	10"	6"
6"	18"	12"	8"	10"	8"	8"	8"	8"	11"	10"	12"	18"
8"	18"	13"	10"	10"	8"	8"	8"	8"	11"	12"	12"	24"
10"	20"	16"	12"	14"	8"	12"	8"	12"	14"	16"	16"	30"
12"	20"	16"	12"	14"	8"	12"	8"	12"	14"	16"	16"	30"
16"	26"	20"	16"	18"	11"	13"	11"	13"	18"	20"	20"	36"
24"	82"	42"	62"	30"	44"	22"	22"	16"	82"	42"	82"	42"
30"	185"	42"	100"	42"	52"	42"	40"	30"	185"	42"	185"	42"

WESTERN VIRGINIA REGIONAL - CONSTRUCTION DETAIL

THRUST BLOCK REQUIREMENTS

02/10/15 — **W-18**

FACTOR OF SAFETY = 1.5

PIPE SIZE	PIPE MAT'L	90° BEND	45° BEND	22½° BEND	11¼° BEND	VALVE/ PLUG (NOTE 2)	TEE BRANCH (NOTE 3)	REDUCER (NOTE 4)	45° VERT.	22½° VERT.	11¼° VERT.
6"	D.I.	28'	21'	6'	3'	50'	26'	26'	21'	10'	5'
8"	D.I.	36'	21'	8'	4'	65'	41'	27'	27'	13'	7'
10"	D.I.	43'	21'	9'	5'	77'	53'	26'	32'	16'	8'
12"	D.I.	51'	21'	10'	5'	91'	67'	27'	38'	18'	9'
6"	PVC	29'	21'	6'	3'	78'	25'	40'	32'	16'	8'
8"	PVC	37'	21'	8'	4'	102'	49'	43'	42'	21'	10'
10"	PVC	44'	21'	9'	5'	122'	68'	41'	51'	25'	12'
12"	PVC	51'	21'	11'	6'	143'	89'	42'	60'	29'	15'

1. ALL JOINTS SHALL BE RESTRAINED ON BOTH SIDES OF THE FITTING AND DOCUMENTED BY THE INSPECTOR FOR THE LENGTH SHOWN UNLESS OTHERWISE INDICATED.
2. RESTRAINED LENGTH SHOWN REFERS TO ANY DESIGNED OR POTENTIAL LINE STOP, INCLUDING ALL GATE VALVES.
3. RESTRAINED LENGTH SHOWN REFERS TO THE BRANCH LINE ONLY. THE CONTINUOUS PIPE LENGTH OF THE MAIN RUN SHALL BE A MINIMUM OF 10' ON EACH SIDE OF THE TEE.
4. RESTRAINED LENGTH SHOWN IS BASED ON REDUCING PIPE DIAMETER TO ONE SIZE SMALLER THAN PIPE LISTED (ANY OTHER DIAMETER REDUCTION WILL REQUIRE ADDITIONAL CALCULATIONS BEFORE INSTALLATION). RESTRAINED LENGTH SHOWN IS UPSTREAM ON THE LARGE SIDE OF THE REDUCER.
5. 12" AND SMALLER DIAMETER: IF UNDER 150 PSI WORKING PRESSURE, RESTRAINED JOINT(S) ARE TO BE USED. IF EQUAL TO OR OVER 150 PSI WORKING PRESSURE, BOTH THRUST BLOCK(S) AND RESTRAINED JOINT(S) SHALL BE USED.

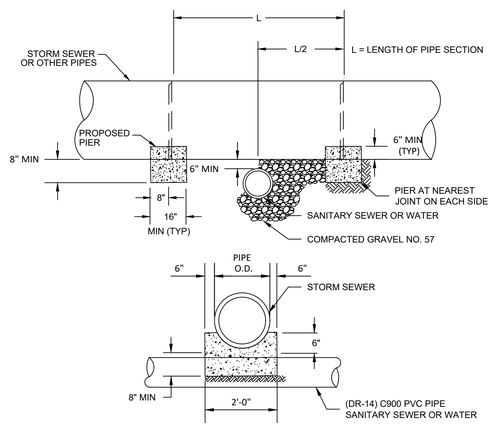
   LARGER THAN 12" DIAMETER: IF UNDER 100 PSI WORKING PRESSURE, RESTRAINED JOINT(S) ARE TO BE USED. IF EQUAL TO OR OVER 100 PSI WORKING PRESSURE, BOTH THRUST BLOCK(S) AND RESTRAINED JOINT(S) SHALL BE USED (UNLESS OTHERWISE APPROVED BY THE PARTICIPATING UTILITY).
6. FOR RESTRAINED JOINT PIPING REQUIREMENTS AT FITTING R.J. PVC AND R.J. DIP MAY BE USED INTERCHANGEABLY WITH APPROVAL FROM PARTICIPATING UTILITY. CONTRACTOR MUST PLAN ACCORDINGLY FOR THE DIFFERENCE IN PVC AND DIP BELL AND SPIGOT DIMENSIONS.

WESTERN VIRGINIA REGIONAL - CONSTRUCTION DETAIL

MINIMUM THRUST RESTRAINT OF PIPE JOINTS DESIGN LENGTHS

02/10/15 — **W-19**

1. PIER REQUIRED WHEN STORM DRAIN OR OTHER PIPES CROSSES OVER THE OTHER UTILITY WITH A VERTICAL CLEARANCE OF LESS THAN 18".
2. PIER TO BE BUILT ON UNDISTURBED EARTH.
3. CONCRETE TO BE READY MIX, CLASS A3.

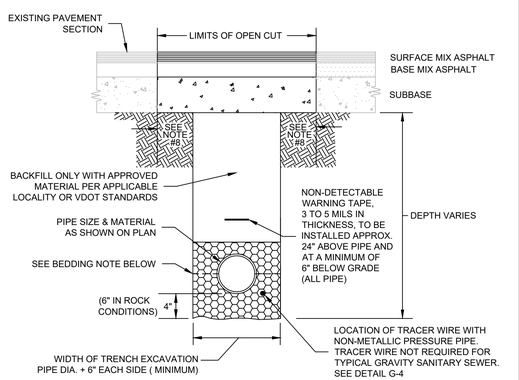


WESTERN VIRGINIA REGIONAL - CONSTRUCTION DETAIL

CONCRETE PIER

01/01/14 — **G-8**

1. BEDDING, HAUNCHING AND INITIAL BACKFILL CONSTRUCTION SHALL BE IN ACCORDANCE WITH THIS DETAIL AND MANUFACTURER'S RECOMMENDATION.
2. ALL PVC PIPE SHALL BE BEDDED IN COMPACTED VDOT #57 OR #68 STONE.
3. IN VDOT ROW, THE CONTRACTOR SHALL REPLACE THE PAVEMENT AS REQUIRED AND SPECIFIED BY VDOT. IN ROANOKE CITY, CONTRACTOR SHALL REPLACE PAVEMENT AS REQUIRED BY CITY OF ROANOKE RIGHT OF WAY EXCAVATION AND RESTORATION STANDARDS, LATEST EDITION.
4. ALL CONSTRUCTION WITHIN THE PUBLIC RIGHT-OF-WAY SHALL BE AS SPECIFIED BY VDOT OR APPLICABLE LOCALITY.
5. PRIOR TO CONSTRUCTION, CONTRACTOR IS RESPONSIBLE FOR SECURING ALL REQUIRED PERMITS FROM VDOT AND/OR APPLICABLE LOCALITY.
6. IN AREAS SUBJECTED TO VEHICULAR TRAFFIC, BEDDING STONE AND FILL SHALL BE PLACED IN 6" LIFTS AND SHALL BE COMPACTED TO AT LEAST 95% OF MAXIMUM DENSITY AS DETERMINED BY ASTM D 698.
7. ALL SEWER LINE PIPE SHALL BE BEDDED IN COMPACTED GRANULAR MATERIAL. BEDDING REQUIREMENTS FOR DUCTILE SEWER LINE ARE DEPENDENT ON MANUFACTURER'S BEDDING CRITERIA.
8. BENCH CUT ON EACH SIDE OF PAVEMENT SHALL BE IN ACCORDANCE WITH VDOT OR APPLICABLE LOCALITY'S SPECIFICATIONS.
9. ALL EXCAVATIONS SHALL COMPLY WITH OSHA TECHNICAL MANUAL, CHAPTER 2, TITLED "EXCAVATIONS: HAZARD RECOGNITION IN TRENCHING AND SHORING."
10. THE TRACER WIRE SHALL BE PLACED ALONG THE LOWER QUADRANT OF THE PIPE. THE WIRE SHALL NOT TOUCH THE PIPE, BUT SHALL BE A MAXIMUM OF 6" FROM THE PIPE. NON-METALLIC SPACERS MAY BE USED TO MAINTAIN A SET DISTANCE FROM THE UTILITY.



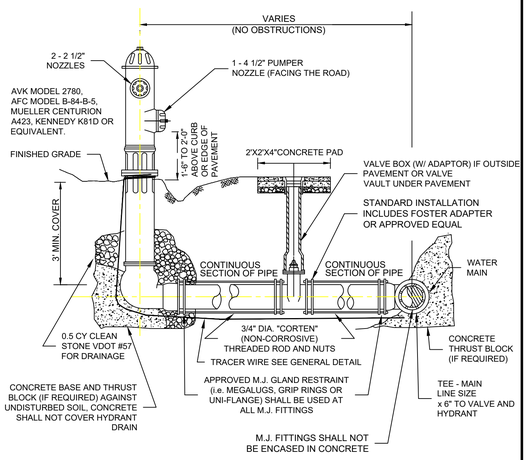
BEDDING: FOR WATERLINES, INSTALL BEDDING STONE TO SPRING LINE OF PIPE AT A MINIMUM, OR PER MANUFACTURER'S RECOMMENDATION. FOR SEWER LINES, BEDDING SHALL BE MINIMUM 6" ABOVE PIPE.

WESTERN VIRGINIA REGIONAL - CONSTRUCTION DETAIL

BEDDING AND BACKFILL UNDER PAVEMENT AND IN RIGHT-OF-WAY

08/01/15 — **G-12**

1. PUBLIC HYDRANTS SHALL BE PAINTED SILVER WITH AN OIL-BASED PAINT. PRIVATE HYDRANTS SHALL ALSO BE PAINTED SILVER WITH AN OIL-BASED PAINT UNLESS OTHERWISE SPECIFIED BY THE JURISDICTIONAL FIRE MARSHALL.
2. FIRE HYDRANT SHALL BE INSTALLED 2' MIN. AND 4' MAX. FROM BACK OF CURB OR 6' MIN. AND 12' MAX. FROM EDGE OF PAVEMENT WHEN CURB IS NOT PRESENT. FIRE HYDRANT TO BE INSTALLED WITHIN RIGHT-OF-WAY OR EASEMENT LINE.
3. AREA AROUND HYDRANT AT A RADIUS OF 4' TO BE LEVEL AND UNOBSTRUCTED.
4. WATERPROOF BAGS OR OUT OF SERVICE RINGS SHALL BE PLACED OVER ALL NEWLY INSTALLED FIRE HYDRANTS.
5. HYDRANT ASSEMBLIES SHALL BE RODDED AND RESTRAINED WITH APPROVED M.J. GLAND RESTRAINTS. HIGH PRESSURE (OVER 150 PSI) ALSO REQUIRES CONCRETE THRUST BLOCKS AS SHOWN BELOW.
6. IF DURING CONSTRUCTION THE SEASONAL WATER LEVEL IS NOTED TO BE ABOVE THE DRAIN OUTLETS OF THE PROPOSED HYDRANT, THE PARTICIPATING UTILITY WILL BE NOTIFIED IMMEDIATELY SO THAT THE HYDRANT CAN BE RELOCATED TO A SUITABLE LOCATION, OMITTED, OR THE DRAIN HOLE PLUGGED.
7. TWO WRAPS OF TRACER WIRE SHALL BE WRAPPED AROUND BASE OF HYDRANT.
8. APPROVED MODELS - AVK MODEL 2780, AFC MODEL B-84-B-5, MUELLER CENTURION A423, KENNEDY K81D OR EQUIVALENT.
9. WHERE HYDRANT LATERAL(S) IS APPROVED BY THE PARTICIPATING UTILITY TO BE LONGER IN LENGTH, MAKING THE CONTINUOUS SECTION OF PIPE ON EACH SIDE OF THE GATE VALVE UNFEASIBLE, RESTRAINED PIPE JOINTS SHALL BE INSTALLED BETWEEN THE TEE AND GATE VALVE IN LIEU OF RODDING. HOWEVER, A RODDED CONTINUOUS SECTION OF PIPE SHALL ALWAYS BE INSTALLED BETWEEN THE GATE VALVE AND HYDRANT.



WESTERN VIRGINIA REGIONAL - CONSTRUCTION DETAIL

FIRE HYDRANT ASSEMBLY

02/10/15 — **W-17**

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COMMONWEALTH OF VIRGINIA
David A Krisnitski
No. 36465
PROFESSIONAL ENGINEER
10/16/2023

STORMWATER C.I.P.
SALEM AVE & 1st ST SW "L-TUNNEL"
CITY OF ROANOKE, VIRGINIA

MARK	DATE	DESCRIPTION

100% DESIGN

PROJECT NO:	18-1108.007
SCALE:	AS SHOWN
DESIGNED BY:	DAK
DRAWN BY:	KHH
CHECKED BY:	DJR

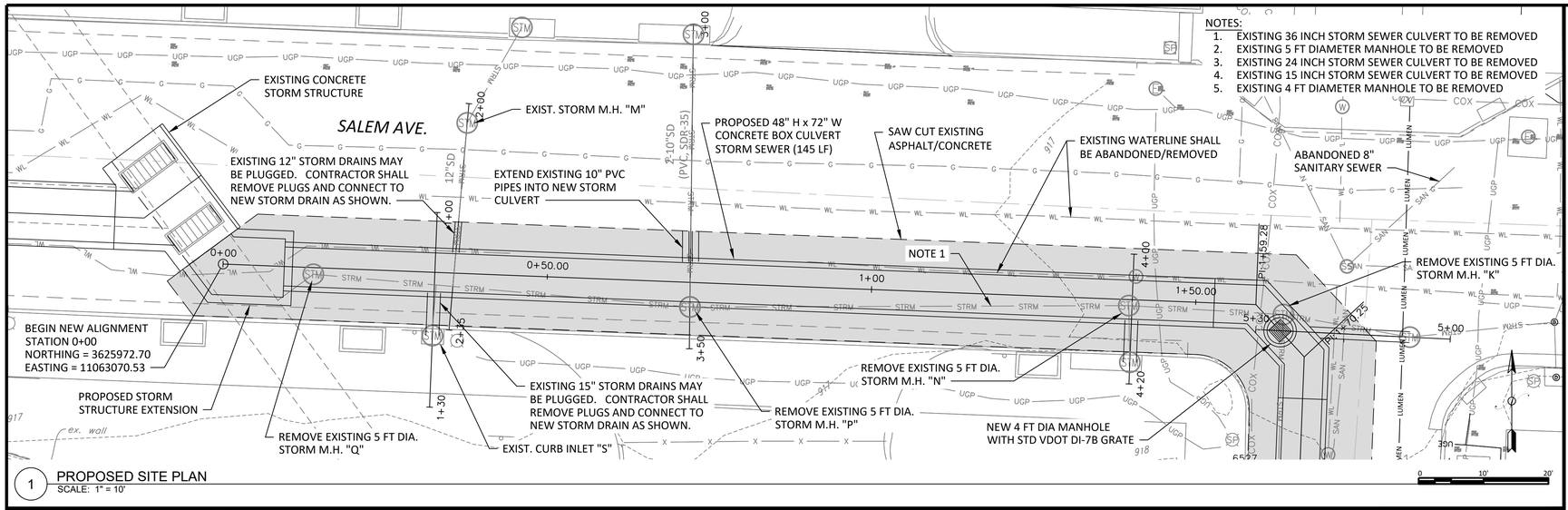
SHEET TITLE

WVWA STANDARD DETAILS

C4.2

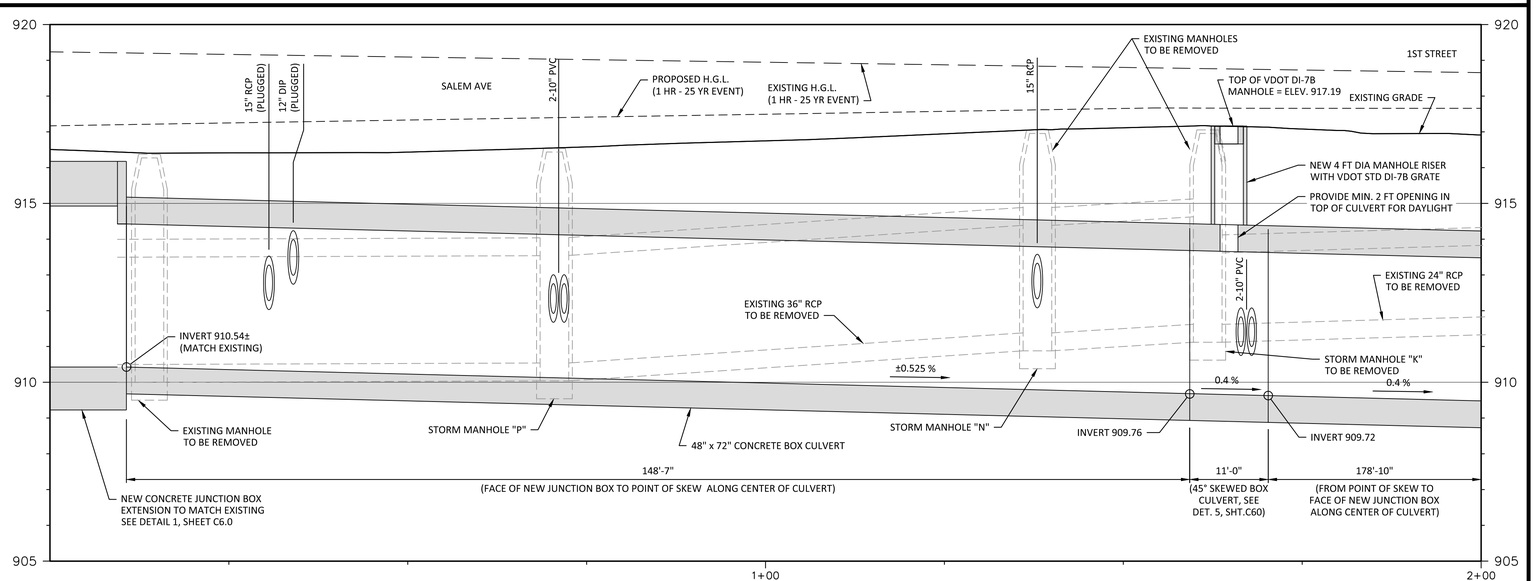
SHEET 6 OF 17

C4.2
X:\RICHMOND\18-1108.007 - SALEM AVE AND 1ST ST – L-SHAPED TUNNEL\05-CAD\C3.0 - 181108007.DWG, 10/16/2023 6:44 PM, KHYLTON



NOTES:
1. EXISTING 36 INCH STORM SEWER CULVERT TO BE REMOVED
2. EXISTING 5 FT DIAMETER MANHOLE TO BE REMOVED
3. EXISTING 24 INCH STORM SEWER CULVERT TO BE REMOVED
4. EXISTING 15 INCH STORM SEWER CULVERT TO BE REMOVED
5. EXISTING 4 FT DIAMETER MANHOLE TO BE REMOVED

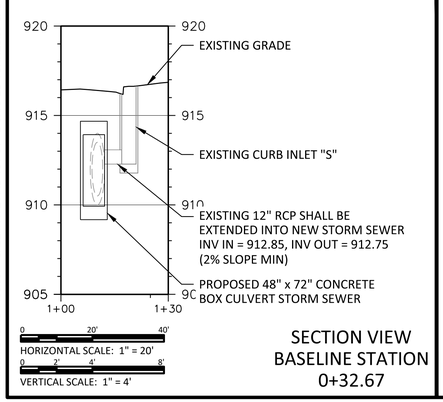
1 PROPOSED SITE PLAN
SCALE: 1" = 10'



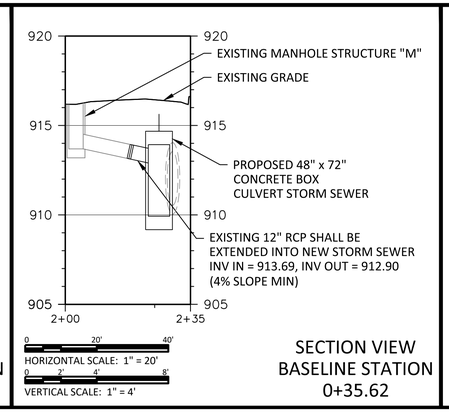
PROPOSED STORM SEWER PROFILE - SALEM AVENUE (1)
SCALE: HORZ 1"=20'
VERT 1"=4'

2 PROPOSED STORM SEWER PROFILE (SALEM AVENUE)

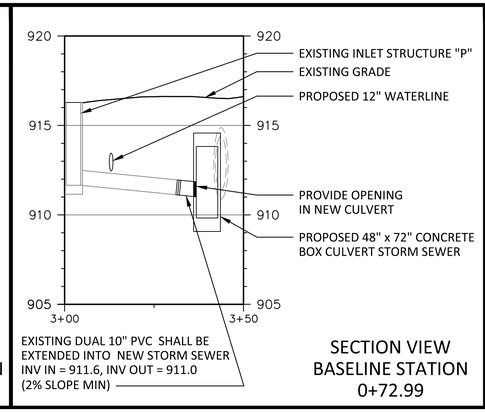
HORIZONTAL SCALE: 1" = 10'
VERTICAL SCALE: 1" = 2'



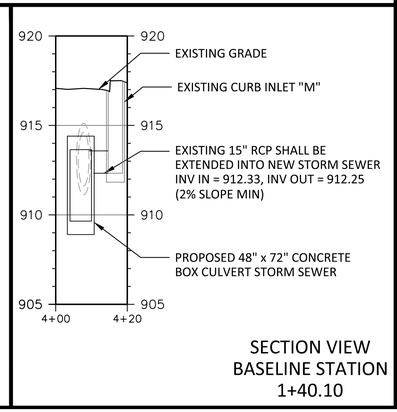
SECTION VIEW
BASELINE STATION
0+32.67



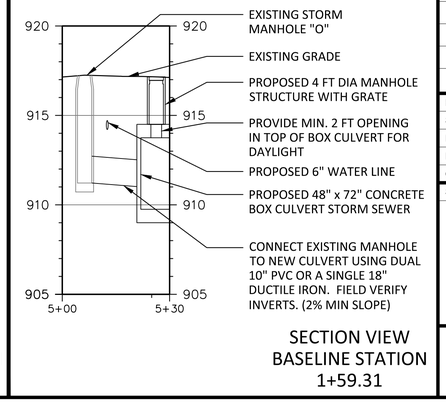
SECTION VIEW
BASELINE STATION
0+35.62



SECTION VIEW
BASELINE STATION
0+72.99



SECTION VIEW
BASELINE STATION
1+40.10



SECTION VIEW
BASELINE STATION
1+59.31

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STORMWATER C.I.P.
SALEM AVE & 1st ST SW
"L-TUNNEL"
CITY OF ROANOKE, VIRGINIA

SITE PLAN LEGEND

ASPHALT OVERLAY

MARK	DATE	DESCRIPTION

100% DESIGN

PROJECT NO:	18-1108.007
SCALE:	AS SHOWN
DESIGNED BY:	DAK
DRAWN BY:	KHH
CHECKED BY:	DJR

SHEET TITLE

ENLARGED PROPOSED SITE PLAN (SALEM AVENUE WEST END)

C5.0

SHEET 7 OF 17

C5.0
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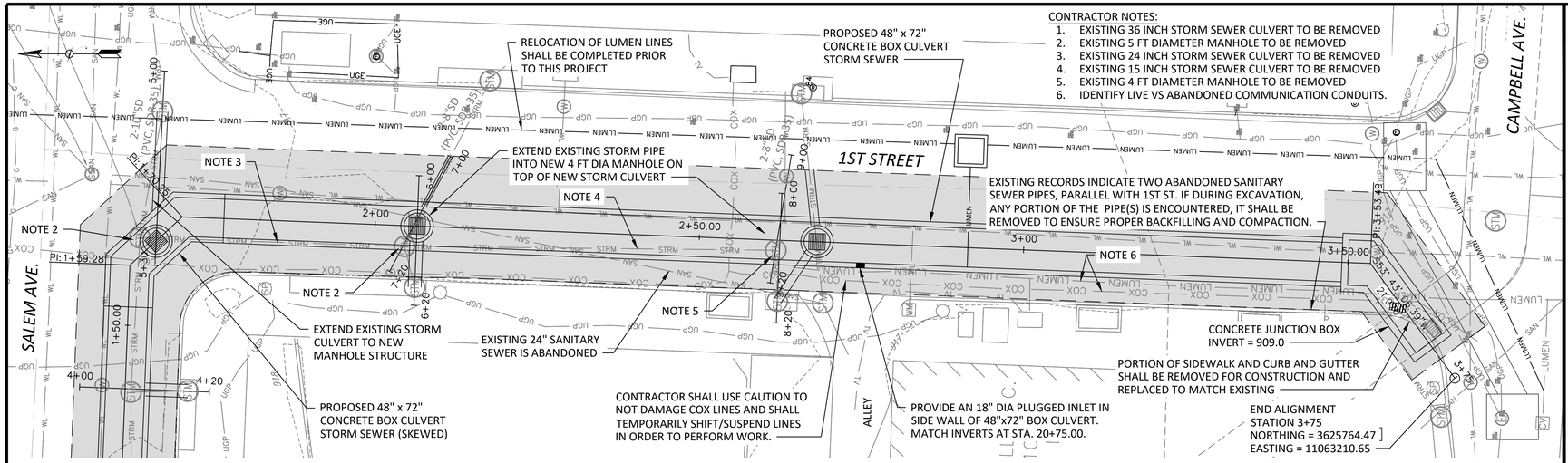
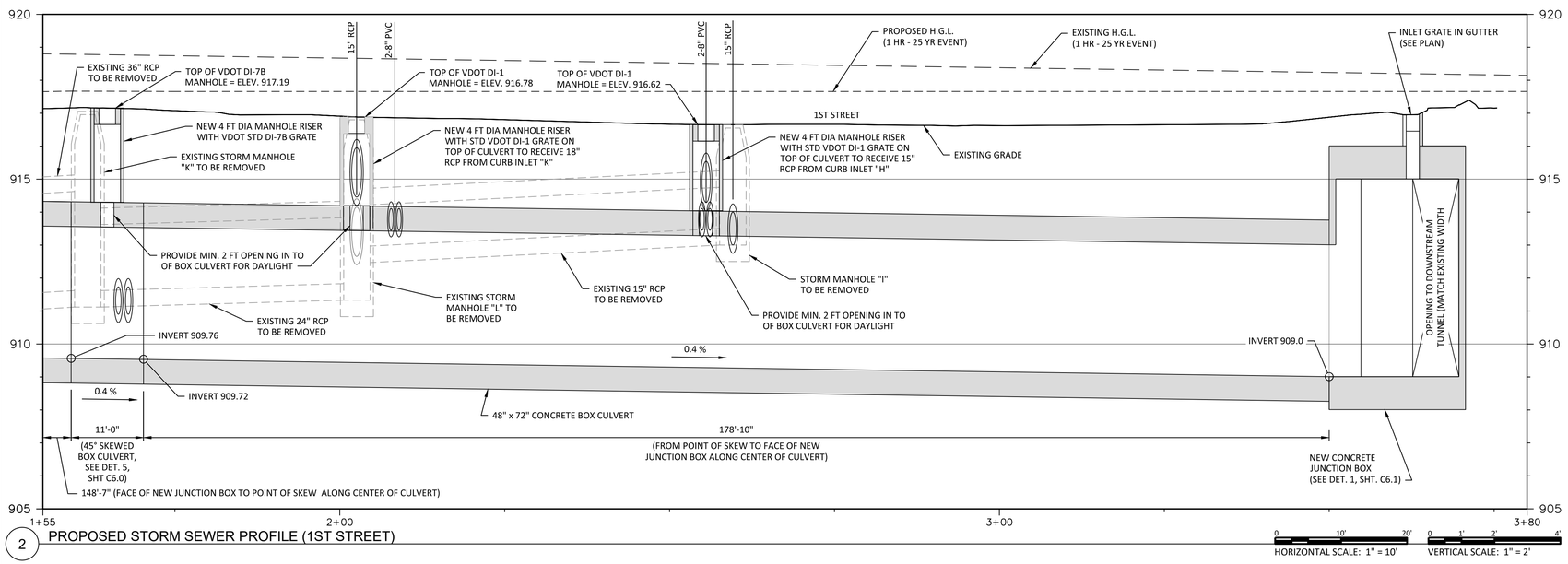
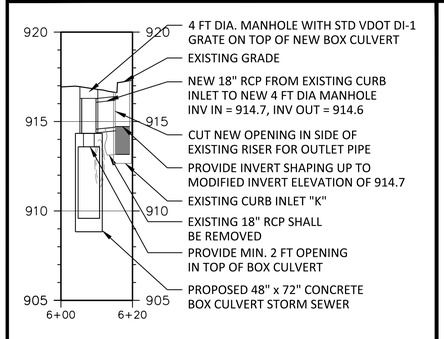


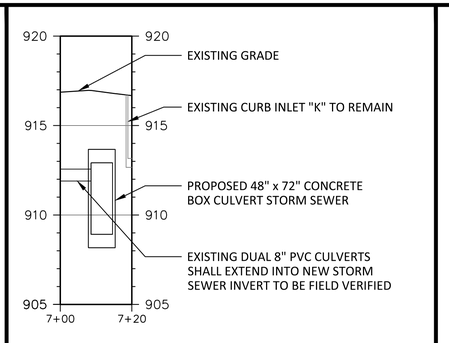
1 PROPOSED SITE PLAN
SCALE: 1" = 10'



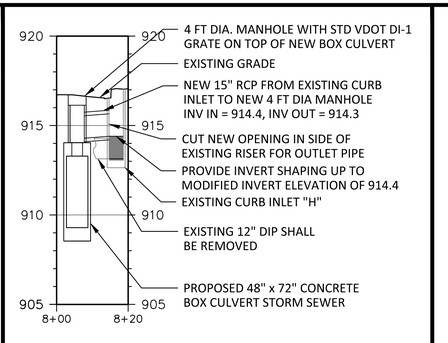
2 PROPOSED STORM SEWER PROFILE (1ST STREET)
HORIZONTAL SCALE: 1" = 10'
VERTICAL SCALE: 1" = 2'



BASELINE STATION
2+11.00



BASELINE STATION
2+11.00



BASELINE STATION
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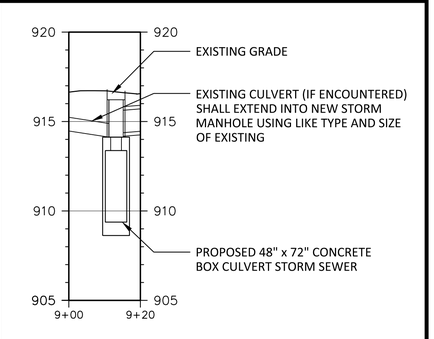

BASELINE STATION
2+64.13

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SITE PLAN LEGEND

ASPHALT OVERLAY

MARK	DATE	DESCRIPTION

100% DESIGN

PROJECT NO:	18-1108.007
SCALE:	AS SHOWN
DESIGNED BY:	DAK
DRAWN BY:	KHH
CHECKED BY:	DJR

SHEET TITLE

ENLARGED
PROPOSED SITE PLAN
(1ST STREET)

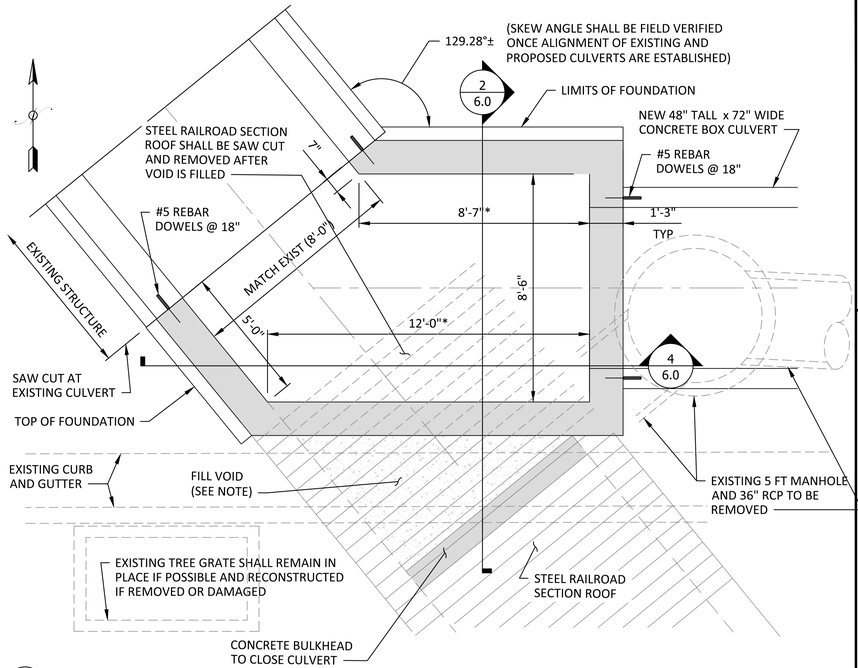
C5.1

SHEET 8 OF 17

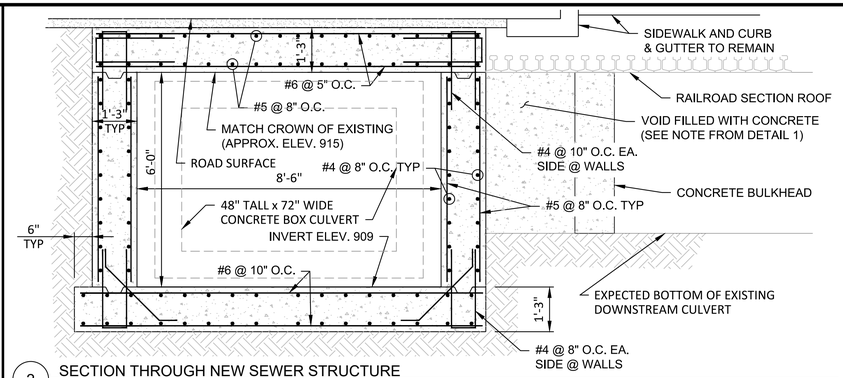
C5.1
X:\RICHMOND\18-1108.007 - SALEM AVE AND 1ST ST - L-SHAPED TUNNEL\05-CAD\C3.0 - 181108007.DWG, 10/16/2023 6:44 PM, KHYLTON

NOTE:
PRIOR TO REMOVAL OF RAILROAD SECTION ROOF CONSTRUCT FORMWORK WITH FILL TUBE AND FILL VOID WITH FLOWABLE FILL CONCRETE. ONCE CURED THE RAILROAD SECTIONS CAN BE CUT AND REMOVED TO ALLOW CASTING OF JUNCTION BOX WITHOUT DISTURBING SIDEWALK AND GUTTER.

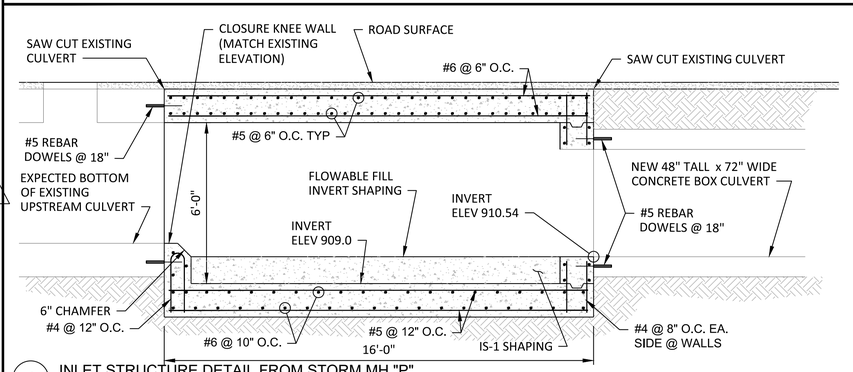
* CONTRACTOR SHALL ADJUST LENGTH TO ENSURE CONNECTION BETWEEN STRUCTURE AND NEW BOX CULVERT



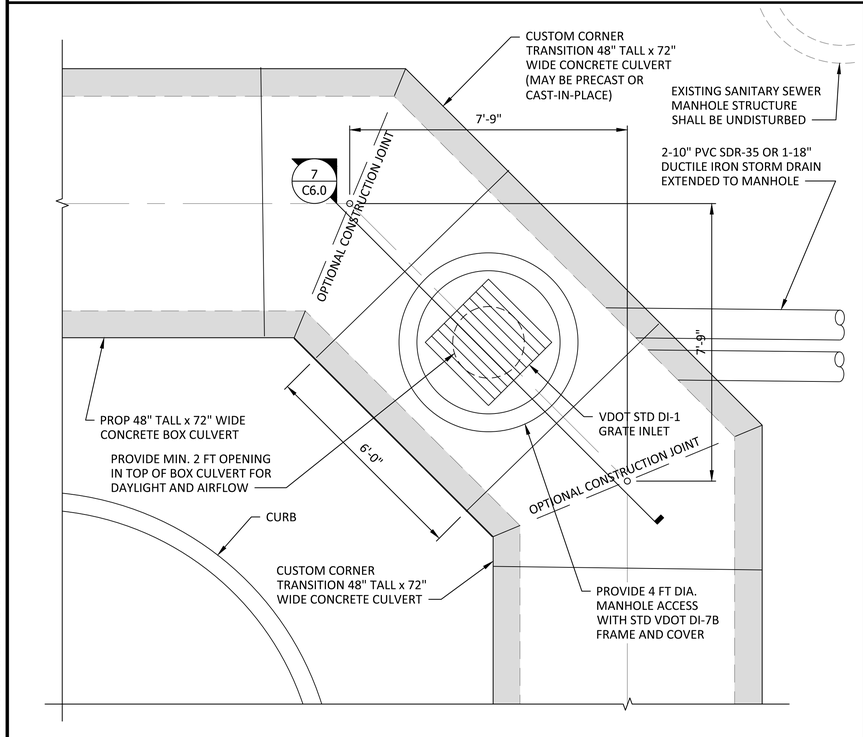
1 PLAN - SALEM AVENUE CONNECTION STRUCTURE
SCALE: 3/8" = 1'-0"



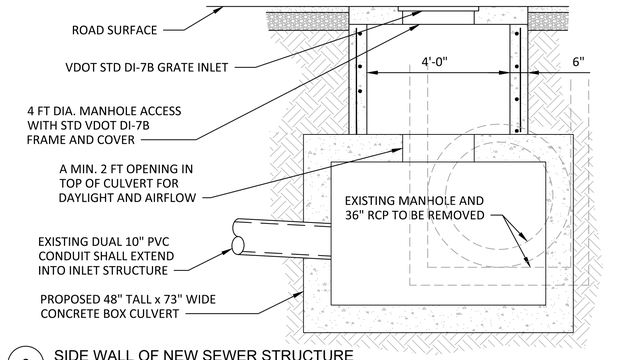
2 SECTION THROUGH NEW SEWER STRUCTURE
SCALE: 1/2" = 1'-0"



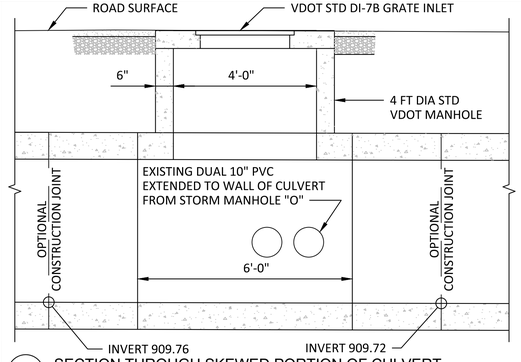
4 INLET STRUCTURE DETAIL FROM STORM MH "P"
SCALE: 1/2" = 1'-0"



5 PLAN - SKEWED CULVERT AT INERSECTION OF SALEM AVENUE & 1ST STREET
SCALE: 3/8" = 1'-0"



6 SIDE WALL OF NEW SEWER STRUCTURE
SCALE: 1/2" = 1'-0"



7 SECTION THROUGH SKEWED PORTION OF CULVERT
SCALE: 1/2" = 1'-0"

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COMMONWEALTH OF VIRGINIA
David A. Krisnitski
No. 36465
PROFESSIONAL ENGINEER
10/16/2023

STORMWATER C.I.P.
SALEM AVE & 1st ST SW "L-TUNNEL"
CITY OF ROANOKE, VIRGINIA

MARK	DATE	DESCRIPTION

100% DESIGN

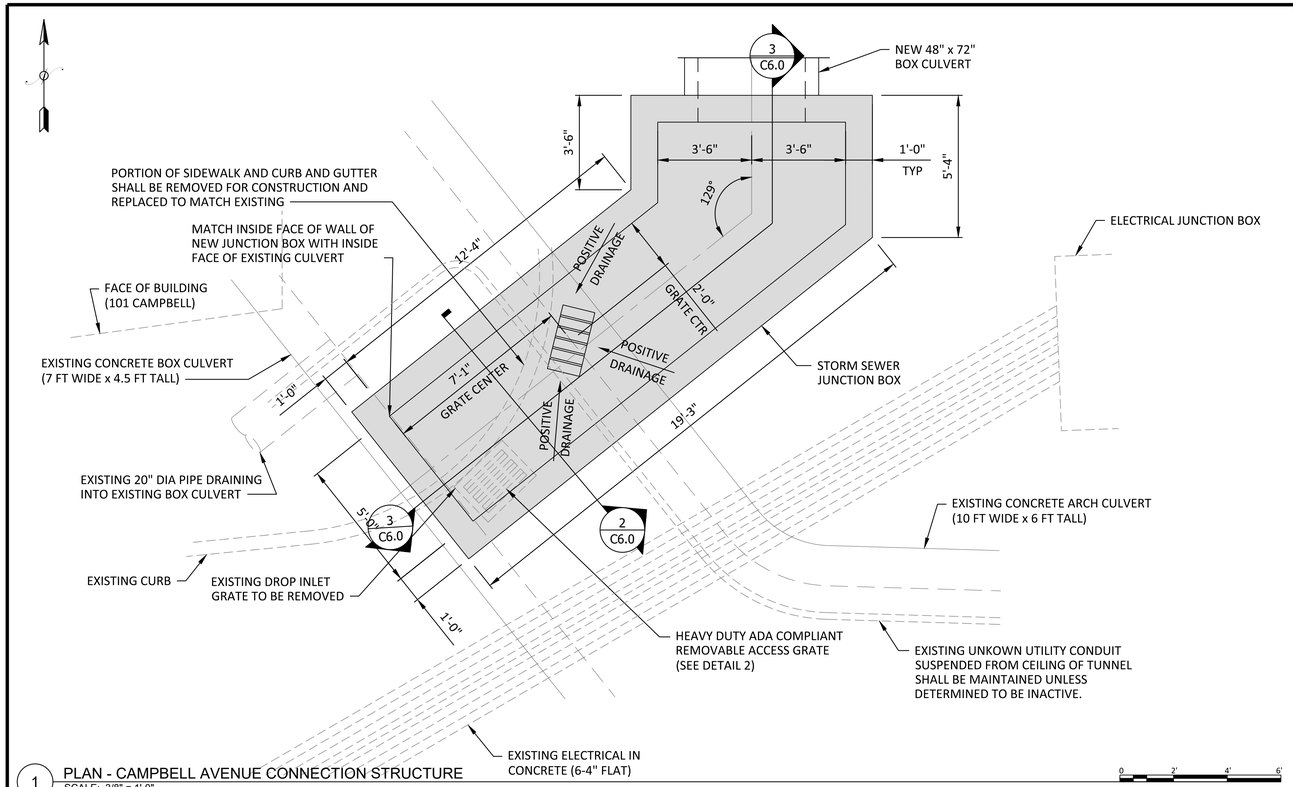
PROJECT NO:	18-1108.007
SCALE:	AS SHOWN
DESIGNED BY:	DAK
DRAWN BY:	KHH
CHECKED BY:	DJR

SHEET TITLE

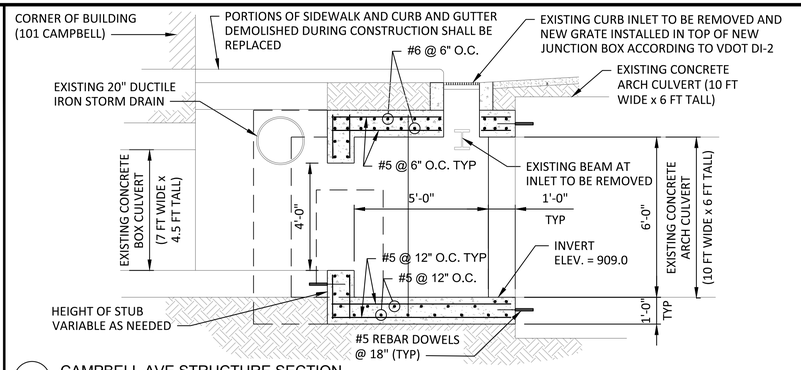
SALEM AVENUE STRUCTURE SECTIONS AND DETAILS

C6.0

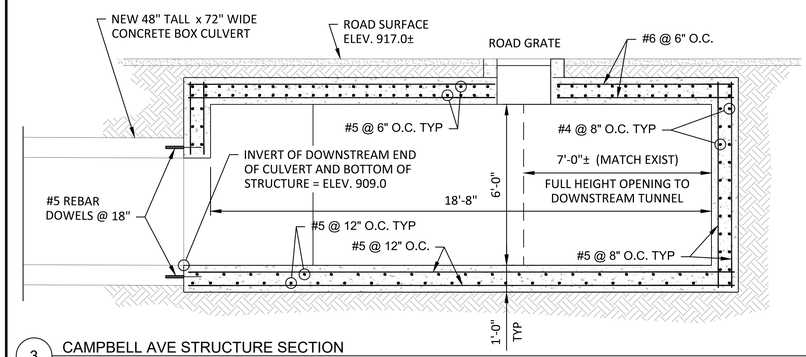
SHEET 9 OF 17



1 PLAN - CAMPBELL AVENUE CONNECTION STRUCTURE
SCALE: 3/8" = 1'-0"

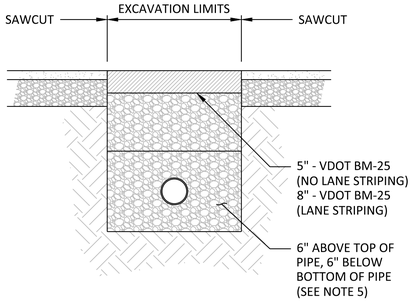


2 CAMPBELL AVE STRUCTURE SECTION
SCALE: 3/8" = 1'-0"



3 CAMPBELL AVE STRUCTURE SECTION
SCALE: 3/8" = 1'-0"

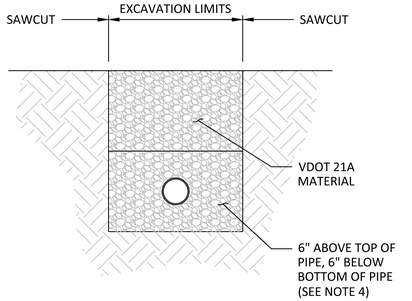
EXCAVATION OF CURB, GUTTER AND SIDEWALK IS NOT ANTICIPATED IN THIS PROJECT AND AS SUCH, THIS DETAIL IS ONLY TO BE USED IN THE EVENT OF A DEVIATION FROM PLAN THAT IS APPROVED BY THE PROJECT MANAGER AND CONSTRUCTION MANAGER.



NOTES:

1. VDOT 21A SHALL BE COMPACTED TO 95% (ASTM D698)
2. THE BM-25 SHALL BE INSTALLED TO THE TOP OF THE TRENCH AS A TEMPORARY RIDING SURFACE. AS PART OF THE FINAL RESTORATION THE MILL AND OVERLAY OPERATION WILL MILL OFF THE TOP 2" OF BM-25 AND OVERLAY WITH SURFACE MIX.
3. BM-25 SHALL BE INSTALLED IN TWO LIFTS AND COMPACTED TO VDOT RBS.
4. DISPOSE OF EXCESS EXCAVATED SOIL/MATERIAL AT AN OFF-SITE LOCATION IN ACCORDANCE WITH LOCAL, STATE, AND FEDERAL LAWS. STOCKPILING ON-SITE SHALL BE LIMITED.
5. IF PIPE IS GREATER THAN OR EQUAL TO 6" IN DIAMETER THEN BEDDING SHALL BE VDOT NO. 57 AGGREGATRE. IF PIPE IS LESS THAN 6" IN DIAMETER THEN BEDDING SHALL BE VDOT NO. 10 SCREENING COMPACTED TO 95% (ASTM D698)

4 UTILITY BACKFILL DETIL
N.T.S.



NOTES:

1. VDOT 21A SHALL BE COMPACTED TO 95% (ASTM D698)
2. THIS DETAIL ALSO APPLES TO ANY AREA WITHIN 5' OF CURB, GUTTER OR SIDEWALK.
3. DISPOSE OF EXCESS EXCAVATED SOIL/MATERIAL AT AN OFF-SITE LOCATION IN ACCORDANCE WITH LOCAL, STATE, AND FEDERAL LAWS. STOCKPILING ON-SITE SHALL BE LIMITED.
4. IF PIPE IS GREATER THAN OR EQUAL TO 6" IN DIAMETER THEN BEDDING SHALL BE VDOT NO. 57 AGGREGATRE. IF PIPE IS LESS THAN 6" IN DIAMETER THEN BEDDING SHALL BE VDOT NO. 10 SCREENING COMPACTED TO 95% (ASTM D698)

5 UTILITY BACKFILL UNDER CURB, GUTTER AND SIDEWALK
N.T.S.

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MARK	DATE	DESCRIPTION

100% DESIGN

PROJECT NO:	18-1108.007
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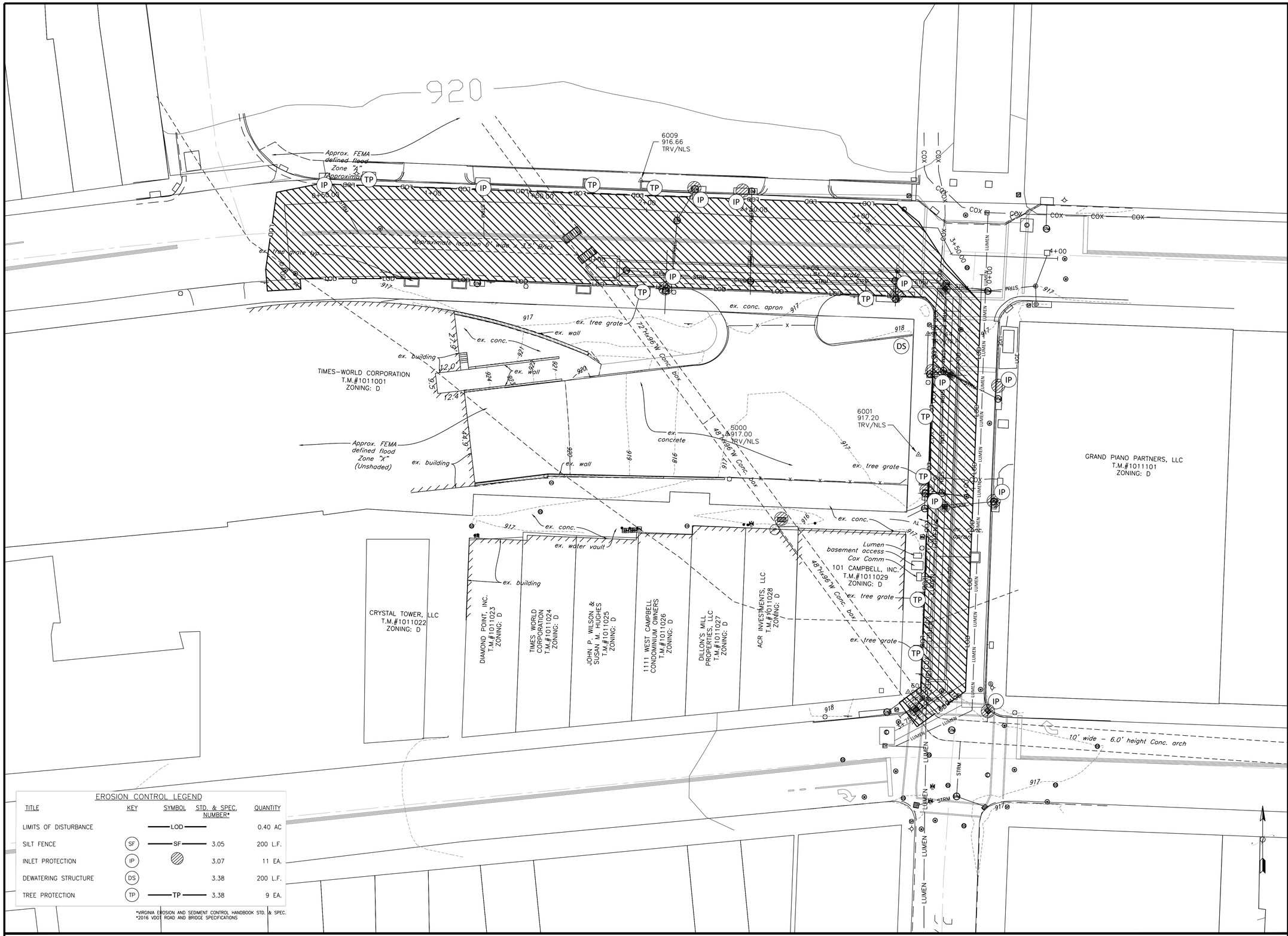
DRAWN BY:	KHH
CHECKED BY:	DJR

SHEET TITLE

CAMPBEL AVENUE STRUCTURE SECTIONS AND DETAILS

C6.1
SHEET 10 OF 17



EROSION CONTROL LEGEND

TITLE	KEY	SYMBOL	STD. & SPEC. NUMBER*	QUANTITY
LIMITS OF DISTURBANCE		LOD		0.40 AC
SILT FENCE	SF	SF	3.05	200 L.F.
INLET PROTECTION	IP		3.07	11 EA.
DEWATERING STRUCTURE	DS		3.38	200 L.F.
TREE PROTECTION	TP	TP	3.38	9 EA.

*VIRGINIA EROSION AND SEDIMENT CONTROL HANDBOOK STD. & SPEC.
*2016 VDOT ROAD AND BRIDGE SPECIFICATIONS

1 ERISION AND SEDIMENT CONTROL PLAN

0 10' 20' 40'
SCALE: 1"=20'

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CHECKED BY:	DJR

SHEET TITLE

EROSION & SEDIMENT CONTROL PLAN

C7.0

SHEET 11 OF 17

C7.0
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TEMPORARY TRAFFIC CONTROL PLAN

GENERAL NOTES:

1. TMP/SOC TYPE A PROJECT INFORMATION:

   A. IDENTIFY THE PROJECT'S TMP TYPE:

   THIS PROJECT'S TMP/SOC PLAN HAS BEEN DESIGNED IN CONFORMANCE WITH A TYPE A TMP/SOC PLAN.

   B. IDENTIFY THE WORK ZONE LOCATION, LENGTH, AND WIDTHS:

   THE PROJECT LOCATION IS AS SHOWN ON SHEET C4.0.

   THE WORK ZONE LENGTH AND WIDTH ARE SHOWN ON THE TMP/SOC PLAN SHEET C8.1, C8.2, C8.3, C8.4, C8.5

   C. NOTE THE HOURS THE CONSTRUCTION AREA WILL BE ACTIVE:

   CONSTRUCTION AREA SHALL BE CONSIDERED ACTIVE WHEN ANY IMPACT TO TRAFFIC OCCURS. (1ST CONE IN ROAD)

   CONSTRUCTION AREA HOURS HAVE THE FOLLOWING LIMITATIONS:

	SINGLE LANE CLOSURES (MINOR ARTERIAL)		
	MONDAY TO FRIDAY	SATURDAY	SUNDAY
DAY TIME	9:00 AM TO 3:30 PM	*NOT ALLOWED	*NOT ALLOWED
NIGHT TIME	*NOT ALLOWED	*NOT ALLOWED	*NOT ALLOWED

* NIGHT TIME AND WEEKEND WORK SHALL NOT BE ALLOWED UNLESS APPROVED BY CITY OF ROANOKE.

FULL ROADWAY CLOSURE IS REQUIRED: CAMPBELL AVENUE SW, 1ST STREET SW, AND SALEM AVENUE SW (SEE PROPOSED DETOUR PLAN ON SHEETS C8.1, C8.2, C8.3,C8.4 AND C8.5)

NO LANE CLOSURES WILL BE ALLOWED FROM NOON ON THE DAY BEFORE A HOLIDAY UNTIL NOON ON THE WORKDAY FOLLOWING THE HOLIDAY. HOLIDAYS INCLUDE ALL STATE AND FEDERAL HOLIDAYS.

DESIGNATION OF PEAK HOUR TIMES:

PEAK HOURS ARE 6:OOAM THROUGH 9:OOAM & 3:30PM THROUGH 7:00PM.

D. THE TMP/SOC PLAN, DURING CONSTRUCTION, SHALL BE IN ACCORDANCE WITH SECTIONS 512, 701, 703 & 704 OF THE VIRGINIA DEPARTMENT OF TRANSPORTATION ROAD AND BRIDGE SPECIFICATIONS, DATED 2016; THE VIRGINIA WORK AREA PROTECTION MANUAL, DATED AUGUST 2011, REVISION 2.1, DATED NOVEMBER 2020; THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD), DATED 2009; THE VIRGINIA SUPPLEMENT TO THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES, DATED 2011; AND LLM-LD-241.5 OF THE INSTRUCTIONAL AND INFORMATIONAL MEMORANDA.

E. NOTE ANY EXISTING ENTRANCES, EXISTING INTERSECTIONS, OR EXISTING PEDESTRIAN ACCESS POINTS THAT WILL BE AFFECTED BY THE CONSTRUCTION AREA OR BY THE TRAFFIC CONTROL DEVICES:

EXISTING ENTRANCES:

THERE ARE FOUR(4) COMMERCIAL ENTRANCES/EXITS ALONG SALEM AVENUE SW WITHIN THE LIMITS OF CONSTRUCTION. THERE IS ONE(1) COMMERCIAL ENTRANCE/EXIT ALONG 1ST STREET SW WITHIN THE LIMITS OF CONSTRUCTION. ACCESS TO ALL ENTRANCES SHALL BE MAINTAINED FOR THE DURATION OF CONSTRUCTION.

EXISTING INTERSECTIONS:

SALEM AVENUE SW AND 1ST STREET SW INTERSECTION IS AT THE NORTHERN LIMITS OF THE PROJECT. CAMPBELL AVENUE SW AND 1ST STREET SW INTERSECTION IS AT THE SOUTHERN LIMITS OF THE PROJECT.

EXISTING PEDESTRIAN ACCESS POINTS:

PEDESTRIAN ACCESS IS AVAILABLE ALONG BOTH SIDES OF SALEM AVENUE SW, 1ST STREET SW, AND CAMPBELL AVENUE SW. CONTRACTOR SHALL FOLLOW VWAPM AND MUTCD STANDARDS FOR PEDESTRIAN ACCESS POINTS.

EXISTING BUS STOPS:

THERE ARE NO BUS STOPS WITHIN THE PROJECT LIMITS.

F. IDENTIFY THE MAJOR TYPES OF TRAVELERS:

THE TRAFFIC ON THE ROADWAY CONSISTS PRIMARILY OF PASSENGER VEHICLES, BUSES AND LIGHT TRUCKS. THERE IS SIDEWALK ALONG BOTH SIDES OF SALEM AVENUE SW, 1ST STREET SW, AND CAMPBELL AVENUE SW FOR PEDESTRIANS.

G. THE CONTRACTOR SHALL:

DESIGNATE A PERSON ASSIGNED TO THE PROJECT WHO WILL HAVE THE PRIMARY RESPONSIBILITY, WITH SUFFICIENT AUTHORITY, FOR IMPLEMENTING THE TMP/SOC AND OTHER SAFETY AND MOBILITY ASPECTS OF THE PERMIT WORK. THIS PERSON SHALL COORDINATE WITH THE CITY OF ROANOKE CONSTRUCTION INSPECTOR FOR THE DURATION OF CONSTRUCTION.

ENSURE THAT PERSONNEL ASSIGNED TO THE PROJECT ARE TRAINED IN TRAFFIC CONTROL TO A LEVEL COMMENSURATE WITH THEIR RESPONSIBILITIES IN ACCORDANCE WITH VDOT'S WORK ZONE TRAFFIC CONTROL TRAINING GUIDELINES.

INFORM THE INSPECTOR OF ANY WORK REQUIRING LANE SHIFTS, LANE CLOSURES, AND/OR PHASE CHANGES A MINIMUM OF TWO WORKING DAYS PRIOR TO IMPLEMENTING THIS ACTIVITY.

PERFORM REVIEWS OF THE CONSTRUCTION AREA TO ENSURE COMPLIANCE WITH CONTRACT DOCUMENTS AT REGULARLY SCHEDULED INTERVALS AT THE DIRECTION OF THE INSPECTOR. CONTRACTOR SHALL MAINTAIN AN APPROVED COPY OF THE TEMPORARY TRAFFIC CONTROL PLAN AT THE WORK SITE AT ALL TIMES.

COORDINATE WITH THE CITY OF ROANOKE POLICE DEPARTMENT AND THE CITY OF ROANOKE FIRE/RESCUE DEPARTMENT FOR ANY LANE CLOSURES AND ANY DETOURS OF ANY NATURE.

SCHEDULE ALL PHASES OF CONSTRUCTION IN SUCH A MANNER THAT WATER, SANITARY SEWER, CABLE, FIBER CABLE/OPTIC CABLE, ANY OVERHANGING UTILITIES, AND ANY UNDERGROUND UTILITIES SERVICES WILL NOT BE INTERRUPTED.

2. THIS TMP/SOC PLAN IS INTENDED AS A GUIDE. IT IS NOT TO ENUMERATE EVERY DETAIL WHICH MUST BE CONSIDERED IN THE CONSTRUCTION OF EACH PHASE, BUT ONLY TO SHOW THE GENERAL HANDLING OF EXISTING TRAFFIC. IF THE CONTRACTOR IS TO DEVIATE FROM THE APPROVED TMP, A NEW OR REVISED TMP MUST BE SUBMITTED TO THE ENGINEER FOR REVIEW AND APPROVAL.
3. CONTRACTOR SHALL CLOSE NO MORE THAN ONE LANE OF TRAFFIC ON SALEM AVENUE SW, AND CAMPBELL AVENUE SW DURING CONSTRUCTION OF THIS PROJECT WITH A MINIMUM CLEAR ROADWAY LANE WIDTH NO LESS THAN EXISTING CONDITIONS UNLESS OTHERWISE APPROVED BY THE INSPECTOR. CONTRACTOR SHALL CLOSE BOTH LANES OF 1ST STREET SW AS REQUIRED DURING CONSTRUCTION OF THIS PROJECT. FOR STREET INTERSECTIONS, COMMERCIAL CONNECTIONS, OR PRIVATE ENTRANCES, A MINIMUM WIDTH NO LESS THAN EXISTING WIDTH SHALL BE MAINTAINED AT ALL TIMES, UNLESS APPROVED BY THE ENGINEER.
4. ALL AREAS EXCAVATED BELOW THE EXISTING PAVEMENT SURFACE AND WITHIN THE CLEAR ZONE AT THE CONCLUSION OF EACH WORKDAY, SHALL BE BACKFILLED TO FORM AN APPROXIMATE 6:1 WEDGE AGAINST THE EXISTING PAVEMENT OR NEWLY CONSTRUCTED PAVEMENT SURFACE FOR THE SAFETY AND PROTECTION OF VEHICULAR TRAFFIC.
5. ALL EXCAVATED MATERIALS SHALL BE DISPOSED OF OFFSITE AND ARE NOT TO BE USED FOR ANY PART OF CONSTRUCTION. EXISTING SURFACE, AGGREGATE BASE, AND SUBBASE MATERIAL WHICH WILL BE DEMOLISHED OR OBLITERATED DURING CONSTRUCTION, AND WHICH ARE SUITABLE FOR MAINTENANCE OF TRAFFIC, SHOULD BE UTILIZED PRIOR TO THE USE OF COMMERCIAL MATERIAL.
6. EACH PHASE OF CONSTRUCTION SHALL BE COMPLETED TO THE INSTALLATION OF INTERMEDIATE COURSE ASPHALT PRIOR TO THE START OF THE NEXT PHASE UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
7. CONTRACTOR SHALL ENSURE POSITIVE DRAINAGE FOR THE DURATION OF THE PROJECT. CONTRACTOR SHALL ADD ANY ADDITIONAL TEMPORARY MEASURES NECESSARY TO FACILITATE PROPER, POSITIVE DRAINAGE FOR THE DURATION OF CONSTRUCTION.
8. UNLESS SPECIFIED ON THE PLANS, ALL EXISTING TURN LANES SHALL BE MAINTAINED AT ALL TIMES FOR THE DURATION OF CONSTRUCTION.
9. WHERE GROUP 2 CHANNELIZING DEVICES ARE USED TO SEPARATE THE CONSTRUCTION AREA AND TRAFFIC, A MINIMUM CLEAR ZONE AREA AS DEFINED IN THE VWAPM IS TO BE MAINTAINED.
10. THE CONTRACTOR IS TO COORDINATE WITH THE CITY OF ROANOKE FOR LOCATION(S) OF THE CONSTRUCTION STAGING AREA. CONTRACTOR IS RESPONSIBLE FOR OBTAINING ALL PERMITS AND/OR EASEMENTS AS NECESSARY.
11. IMPLEMENTING THE TRANSPORTATION MANAGEMENT PLAN

    DURING THE FIRST DAY OF THE NEW WORK ZONE TRAFFIC PATTERN, THE PROJECT'S MANAGER AND PROJECT'S CONSTRUCTION INSPECTOR SHALL INSPECT THE WORK ZONE TO ENSURE COMPLIANCE WITH THE TMP. ON THE THIRD TO FIFTH DAY OF IMPLEMENTATION OF THE TMP'S NEW WORK ZONE TRAFFIC PATTERN, THE CONSTRUCTION INSPECTOR SHALL CONDUCT AN ON-SITE REVIEW OF THE WORK ZONE'S PERFORMANCE IN COORDINATION WITH VDOT AND RECOMMEND TO THE CONTRACTOR ANY REQUIRED CHANGES TO THE TMP TO ENHANCE THE WORK ZONE'S SAFETY AND MOBILITY. ALL SUCH CHANGES SHALL BE DOCUMENTED. AN ON-SITE REVIEW OF THE PROJECT'S WORK ZONE TRAFFIC CONTROL BY THE CITY'S CONSTRUCTION INSPECTOR AND THE CONTRACTOR SHALL BE CONDUCTED (WITH COORDINATION FROM VDOT) WITHIN 48 HOURS OF ANY FATAL INCIDENT/CRASH WITHIN THE WORK ZONE.

12. EVALUATION OF THE TRANSPORTATION MANAGEMENT PLAN

    A PERFORMANCE ASSESSMENT OF THE TMP INCLUDING AREA-WIDE IMPACTS ON ADJACENT ROADWAYS SHALL BE PERFORMED BY THE CITY OF ROANOKE WITH COORDINATION FROM THE ENGINEER DURING CONSTRUCTION. AS CIRCUMSTANCES DICTATE, A REVIEW OF THE OVERALL EFFECTIVENESS OF THE PROJECTS TMP SHALL BE COMPLETED DURING THE POST CONSTRUCTION MEETING AND INCLUDED WITH THE POST CONSTRUCTION REPORT. A COPY OF THE SPECIFIC INFORMATION ON THE EFFECTIVENESS OF THE TMP WILL BE FORWARDED TO THE CITY OF ROANOKE FOR REVIEW. A COPY OF THE TMP INTERIM/POST CONSTRUCTION REPORT FORM CAN BE OBTAINED FROM THE CITY OF ROANOKE.

13. PUBLIC COMMUNICATIONS PLAN

    A. THE CONTRACTOR SHALL BE RESPONSIBLE FOR:

    NOTIFYING THE PROJECT MANAGER AND CONSTRUCTION INSPECTOR TWO WEEKS IN ADVANCE OF ANY SCHEDULED WORK PLANS AND TRAFFIC DELAYS.

    B. NOTIFYING THE PROJECT MANAGER, CONSTRUCTION INSPECTOR, AND CORRESPONDING ENGINEER OF ANY UNSCHEDULED TRAFFIC DELAYS.

14. TRANSPORTATION OPERATIONS

    THE CONTRACTOR SHALL BE RESPONSIBLE FOR IMPLEMENTING AND PROVIDING THE FOLLOWING:

    A. NOTIFY THE REGIONAL TRANSPORTATION OPERATIONS CENTER (TOC) 48 HOURS IN ADVANCE IN ORDER TO PLACE LANE CLOSURE INFORMATION ON THE 511 SYSTEM AND VA-TRAFFIC.

    B. POST A LIST OF LOCAL EMERGENCY RESPONSE AGENCIES INSIDE THE PROJECT'S CONSTRUCTION OFFICE/TRAILER.

    C. IMMEDIATELY REPORT ANY TRAFFIC INCIDENTS THAT MAY OCCUR IN THE WORK ZONE.

    D. NOTIFY THE PROJECT'S CONSTRUCTION INSPECTOR AND CORRESPONDING ENGINEER OF ANY INCIDENTS AND EXPECTED TRAFFIC DELAYS.

    E. WITHIN 24 HOURS OF ANY INCIDENTS WITHIN THE CONSTRUCTION WORK ZONE, A REVIEW OF THE TRAFFIC CONTROLS SHALL BE COMPLETED AND NECESSARY ADJUSTMENTS MADE TO REDUCE THE FREQUENCY AND SEVERITY OF ANY FUTURE INCIDENTS.

CONTACT NUMBERS:

CITY PROJECT MANAGER	MARK LEWIS,	(804) 646-5201
CITY R.O.W. PERMIT COORDINATOR	MICHAEL BOITNOTT,	(540) 853-6784
CITY CONSTRUCTION MANAGER	TBD	
CITY CONSTRUCTION INSPECTOR	TBD	
EMERGENCY CALL		911
NON-EMERGENCY NUMBERS:		
CITY OF ROANOKE POLICE		(804) 646-6842
CITY OF ROANOKE FIRE DEPARTMENT		(804) 646-2500

GENERAL SEQUENCE OF CONSTRUCTION:

GENERAL PHASING NOTES:

1. VWAPM = VDOT'S CURRENT EDITION OF THE VIRGINIA WORK AREA PROTECTION MANUAL
2. THE CONTRACTOR SHALL FOLLOW THE APPROVED TEMPORARY TRAFFIC CONTROL PLAN THAT PRESCRIBES THE NECESSARY TRAFFIC CONTROL MEASURES FOR THE WORK TO BE PERFORMED.
3. PRIOR TO THE START OF CONSTRUCTION, THE CONTRACTOR SHALL INSTALL PROJECT LIMIT SIGNAGE IN ACCORDANCE WITH VWAPM TTC-53.0. FOR THE DURATION OF CONSTRUCTION, THE CONTRACTOR SHALL ENSURE THIS SIGNAGE REMAINS IN COMPLIANCE IF THE PROJECT LIMITS CHANGE.
4. THE CONTRACTOR IS RESPONSIBLE FOR ENSURING PROPER DRAINAGE FOR THE DURATION OF ALL PHASES AND INSTALLING ANY NECESSARY MEASURES TO FACILITATE PROPER DRAINAGE.
5. THE CONTRACTOR IS TO MAKE ANY NECESSARY ADJUSTMENTS DURING BOTH WORK AND NON-WORK HOURS TO ENSURE THE PROTECTION AND SAFETY OF THE ADJACENT PROPERTY OWNERS, PEDESTRIANS, VEHICULAR TRAFFIC, AND THE GENERAL PUBLIC FROM ANY CONSTRUCTION-RELATED ACTIVITY, CONSTRUCTION EQUIPMENT, AND THE CONSTRUCTION SITE ITSELF.

CONSTRUCTION NOTES:

1. THE CONTRACTOR SHALL IMPLEMENT TCP AND DETOUR PLAN DESIGNS AS SHOWN ON SHEETS C8.1, C8.2, C8.3, C8.4 AND C8.5. SEE C5 SERIES FOR THE CONSTRUCTION OF THE STORM SEWER PIPE AND STRUCTURES.
2. THE CONTRACTOR SHALL REMOVE ALL TRAFFIC CONTROL DEVICES UPON COMPLETION OF THE PROJECT.

PAVEMENT MARKING GENERAL NOTES {DURING CONSTRUCTION}

1. ALL CONSTRUCTION PAVEMENT MARKINGS SHALL BE IN ACCORDANCE WITH THE MOST CURRENT EDITION OF EACH OF THE FOLLOWING AND ANY REVISION THEREOF:
   A. MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD), 2009
   B. THE VIRGINIA SUPPLEMENT TO THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES, 2011
   C. THE VIRGINIA DEPARTMENT OF TRANSPORTATION ROAD AND BRIDGE SPECIFICATIONS, 2016
   D. THE VIRGINIA DEPARTMENT OF TRANSPORTATION ROAD AND BRIDGE STANDARDS, 2016
2. ANY PAVEMENT MARKINGS THAT WILL CONFLICT WITH THE PROPOSED OR EXISTING PAVEMENT MARKINGS SHALL BE COMPLETELY ERADICATED.
3. LIMITS OF PROPOSED PAVEMENT MARKINGS AND SNOW PLOWABLE RAISED MARKERS ARE APPROXIMATE AND SHALL BE MODIFIED IN THE FIELD TO ENSURE THAT PROPOSED PAVEMENT MARKINGS AND SNOW PLOWABLE RAISED MARKERS CONTINUE UNTIL EXISTING PAVEMENT MARKINGS CAN BE MATCHED.
4. ELONGATED ARROWS SHALL BE IN ACCORDANCE WITH MUTCD AND VDOT ROAD AND BRIDGE SPECIFICATIONS.
5. RAISED MARKERS (IF ANY) SHALL BE PLACED IN ACCORDANCE WITH STANDARD PM-8 AND PM-9 OF THE VDOT ROAD AND BRIDGE STANDARDS AND MUTCD.
6. ALL CONSTRUCTION PAVEMENT MARKINGS SHALL BE OF TYPE D, CLASS I OR II, UNLESS OTHERWISE DIRECTED BY THE VDOT ENGINEER. DURING CONSTRUCTION ANY PAVEMENT MARKINGS WHICH WILL CONFLICT WITH THOSE SHOWN ON THE TMP /SOC PLANS, OR AS DIRECTED BY THE VDOT ENGINEER SHALL BE COVERED WITH TYPE E, NON-REFLECTIVE BLACK TAPE (OR ERADICATED AT THE DIRECTION OF THE VDOT ENGINEER).

SEQUENCE OF CONSTRUCTION

1. LOCATE OR SET CONTROL POINTS SUCH THAT THEY ARE VISIBLE AND CAN BE RE-ESTABLISHED.
2. LOCATE PROPERTY CORNER PINS, VDOT RIGHT OF WAY, AND UTILITIES TO ENSURE DISTURBING ONLY THE AREAS THAT ARE INTENDED TO BE DURING THE COURSE OF THE PROJECT.
3. PLACE TRAFFIC CONTROL MEASURES AND CLOSE OFF PEDESTRIAN AND VEHICULAR ACCESS AS SHOWN ON TRAFFIC CONTROL PLAN.
4. INSTALL SAFETY FENCE AND PEDESTRIAN DIRECTIONAL SIGNS.
5. INSTALL EROSION AND SEDIMENT CONTROL MEASURES AS SHOWN ON PLANS.
6. REMOVE AND STORE ALL SALVAGEABLE ITEMS SUCH AS TREE GRATES, BRICKS, LIGHT POSTS, ETC FROM WITHIN WORK AREA FOR RE-USE, ANY THAT ARE BROKEN SHALL BE REPLACED.

PHASE I

7. CONSTRUCT NEW WATERLINE ALONG 1ST STREET FROM CAMPBELL AVENUE TO SALEM AVENUE.
8. CONNECT ALL LATERAL LINES TO NEW WATERLINE.
9. TEST NEW LINE AND SWITCH SERVICE FROM EXISTING WATERLINE TO NEW WATERLINE.
10. ABANDON EXISTING WATERLINE
11. BACKFILL AND PAVE TRENCH.

PHASE II

12. SET TRAFFIC CONTROL FOR PHASE II
13. BEGIN CONSTRUCTION OF THE JUNCTION BOX AT CAMPBELL AVENUE BY REMOVING ASPHALT FROM WORK AREA AND HAUL OFF-SITE TO A SUITABLE DISPOSAL AREA.
14. EXPOSE COX COMMUNICATION CONDUITS WITHIN WORK AREA. TEMPORARILY PULL CONDUITS FROM TRENCH AND SECURE BEHIND CURB AND OUT OF THE WAY. EXISTING CONDUITS MAY BE PARTIALLY DISASSEMBLED IF NECESSARY PROVIDED NO DAMAGE TO COMMUNICATION LINES WITHIN.
15. CONDUIT MAY BE SECURE BY VARIOUS METHODS, I.E. TIE-BACK OR TEMPORARY FRAMING. CONTRACTOR SHALL NOT ANCHOR TO TREES, LIGHT POSTS OR EMBEDDED ANCHORS IN SIDEWALK.
16. LOCATE AND SECURE ANY EXPOSED UTILITIES THAT HAVE NOT PREVIOUSLY BEEN RELOCATED OUT OF THE EXCAVATION AREA IN ACCORDANCE WITH THE UTILITY OWNERS REQUIREMENTS.
17. ONCE THE UTILITIES HAVE BEEN RELOCATED OR SECURED EXCAVATE AND INSTALL TRENCH SHORING AND APPROX. 5-6 FT DEEP OF THE EARTHEN OVERBURDEN AS NEEDED TO REMOVE THE REQUIRED LENGTH OF THE ARCH STORM TUNNEL.
18. REMOVE TOP ARCH SECTION FROM THE STORM TUNNEL AND INSTALL STORM SEWER CLEAN WATER BYPASS TO ALLOW WORK IN THE DRY.
19. SAW CUT AND REMOVE THE EXISTING CULVERT AS REQUIRED TO THE LIMITS SHOWN IN THE PLANS. DEMOLISH AND REMOVE THE BOTTOM OF THE CULVERT AND EXCAVATE TO BOTTOM AS REQUIRED TO CONSTRUCT THE NEW JUNCTION BOX. SOME ROCK EXCAVATION IS EXPECTED.
20. INSTALL REINFORCING STEEL AND CAST IN PLACE BOTTOM FOR THE NEW JUNCTION BOX.
21. INSTALL FIRST SECTION OF NEW 4FTx6FT BOX CULVERT THEN FORM AND POUR SIDES OF THE NEW JUNCTION BOX. WHEN CURED REMOVE SHORING AND PLACE BACKFILL.
22. REINSTALL UTILITIES INCLUDING COX COMMUNICATIONS CONDUITS PRIOR TO COMPLETING BACKFILL AND REPAIR ANY CONDUIT SECTIONS PREVIOUSLY DISASSEMBLED.
23. INSTALL BACKFLOW PREVENTION ON THE NEW PIPE AND REMOVE THE CLEAN WATER BYPASS SYSTEM.
24. INSTALL PRECAST TOP SECTION OF THE NEW JUNCTION BOX OR FORM AND POUR TOP SLAB OF THE NEW JUNCTION BOX.
25. REINSTALL ANY UTILITIES THAT WILL CROSS THE NEW JUNCTION BOX AND BACKFILL TO SUBGRADE ELEVATION.
26. ONCE THE JUNCTION BOX CONCRETE MEETS MINIMUM STRENGTH REQUIREMENTS PAVE AND RESTORE ROADWAY SURFACE AND MARKINGS SO THAT CAMPBELL AVENUE MAY BE REOPENED TO TRAFFIC.

PHASE III-A

27. SET TRAFFIC CONTROL FOR PHASE III-A.
28. CONTINUE EXCAVATION FOR INSTALLATION OF STORM CULVERT ALONG 1st ST. USING VDOT 21A STONE TO BACKFILL. ALL EXCAVATED MATERIAL SHALL BE DISPOSED OF OFF-SITE SOME ROCK EXCAVATION IS EXPECTED.
29. PLACE NEW CULVERTS AND MANHOLE STRUCTURES FOR SIDE INLETS ACCORDING TO THE PLANS AS THEY ARE REACHED AND MOVE BACKFLOW PREVENTION BARRIER UPSTREAM OF EACH CONNECTION AS IT IS MADE.
30. CONSTRUCT STORM CULVERT AS FAR AS THE ALLEY WHILE MAINTAINING ACCESS TO AND FROM THE NORTH.
31. BACKFILL CONSTRUCTED PORTION OF STORM CULVERT USING VDOT 21A STONE.

PHASE III-B

32. SET TRAFFIC CONTROL FOR PHASE III-B.
33. CONTINUE EXCAVATION ALONG 1ST ST. AND INSTALL STORM CULVERT UP TO SALEM AVENUE.
34. BACKFILL COMPLETED STORM CULVERT USING VDOT 21A STONE.

PHASE IV

35. SET TRAFFIC CONTROL FOR PHASE IV.
36. EXCAVATE AND CONSTRUCT NEW WATERLINE ALONG SALEM AVE. FROM WEST LIMIT TO 1ST ST.
37. CONNECT ALL LATERAL LINES TO NEW WATERLINE.
38. TEST NEW LINE AND SWITCH SERVICE FROM EXISTING WATERLINE TO NEW WATERLINE.
39. ABANDON EXISTING WATERLINE
40. BACKFILL AND PAVE TRENCH.

PHASE V

41. SET TRAFFIC CONTROL FOR PHASE V.
42. SET UP DETOUR FOR SALEM AVENUE PRIOR TO EXCAVATING FOR THE SKEWED SECTION OF BOX CULVERT.
43. EXCAVATE AND INSTALL THE JUNCTION BOX AND THE FIRST SALEM AVE SECTION OF 4FTx6FT BOX CULVERT.
44. CONTINUE EXCAVATION FOR INSTALLATION OF STORM PIPE ALONG SALEM AVENUE STILL USING VDOT 21A STONE TO BACKFILL. ALL EXCAVATED MATERIAL SHALL BE DISPOSED OF OFF-SITE.
45. EXCAVATE AND INSTALL THE REMAINDER OF THE CULVERT IN SALEM AVENUE UP TO NEW JUNCTION BOX WITH THE EXISTING TUNNEL.
46. ENSURE BACKFLOW PREVENTION CONTINUES TO MOVE UPSTREAM OF EACH INLET AS IT IS CONNECTED SO THAT ALL STORMWATER IS DIRECTED TOWARD CAMPBELL AVENUE.
47. REMOVE TOP SECTION FROM THE STORM TUNNEL AND INSTALL STORM SEWER CLEAN WATER BYPASS TO ALLOW WORK IN THE DRY.
48. SAW CUT AND REMOVE THE EXISTING CULVERT AS REQUIRED TO THE LIMITS SHOWN IN THE PLANS. DEMOLISH AND REMOVE THE BOTTOM OF THE CULVERT AND EXCAVATE TO BOTTOM AS REQUIRED TO CONSTRUCT THE NEW JUNCTION BOX. SOME ROCK EXCAVATION IS EXPECTED.
49. INSTALL REINFORCING STEEL AND CAST IN PLACE BOTTOM FOR THE NEW JUNCTION BOX.
50. INSTALL FINAL SECTION OF NEW BOX CULVERT THEN FORM AND POUR SIDES OF THE NEW JUNCTION BOX.
51. INSTALL PRECAST TOP SECTION OF THE NEW JUNCTION BOX OR FORM AND POUR TOP SLAB OF THE NEW JUNCTION BOX.
52. BACKFILL TO SUBGRADE ELEVATION.
53. ONCE THE JUNCTION BOX CONCRETE MEETS MINIMUM STRENGTH REQUIREMENTS PAVE AND RESTORE ROADWAY SURFACE AND MARKINGS SO THAT SALEM AVENUE MAY BE REOPENED TO TRAFFIC.
54. RE-INSTALL ALL SURFACE LANDSCAPING PREVIOUSLY REMOVED.
55. RE-CAST SIDEWALK AND CURB AS NEEDED AND REPLACE ALL PAVERS AND OTHER AMENTIES.
56. REPAVE ROADWAY ACCORDING TO VDOT STANDARDS.
57. ANY DAMAGE TO THE EXISTING ROADWAY SHALL BE REPAIRED PRIOR TO VACATING THE SITE.
58. CLEAN UP AND DEMOBILIZE.

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elizabeth.paden@roanokeva.gov

COMMONWEALTH OF VIRGINIA
David A. Krisnitski
No. 36465
PROFESSIONAL ENGINEER
10/16/2023

STORMWATER C.I.P.
SALEM AVE & 1st ST SW "L-TUNNEL"
CITY OF ROANOKE, VIRGINIA

ATSSA AMERICAN TRAFFIC SAFETY SERVICES ASSOCIATION
This is to affirm that
Jack A Goode
has satisfied the requirements to be designated as a
Traffic Control Design Specialist
Cert. #: 228819
Issue Date: 4/26/2021
Expiration Date: 4/25/2025
Certification Board

MARK	DATE	DESCRIPTION

100% DESIGN

PROJECT NO:	18-1108.007
SCALE:	AS SHOWN
DESIGNED BY:	DAK
DRAWN BY:	KHH
CHECKED BY:	DJR

SHEET TITLE

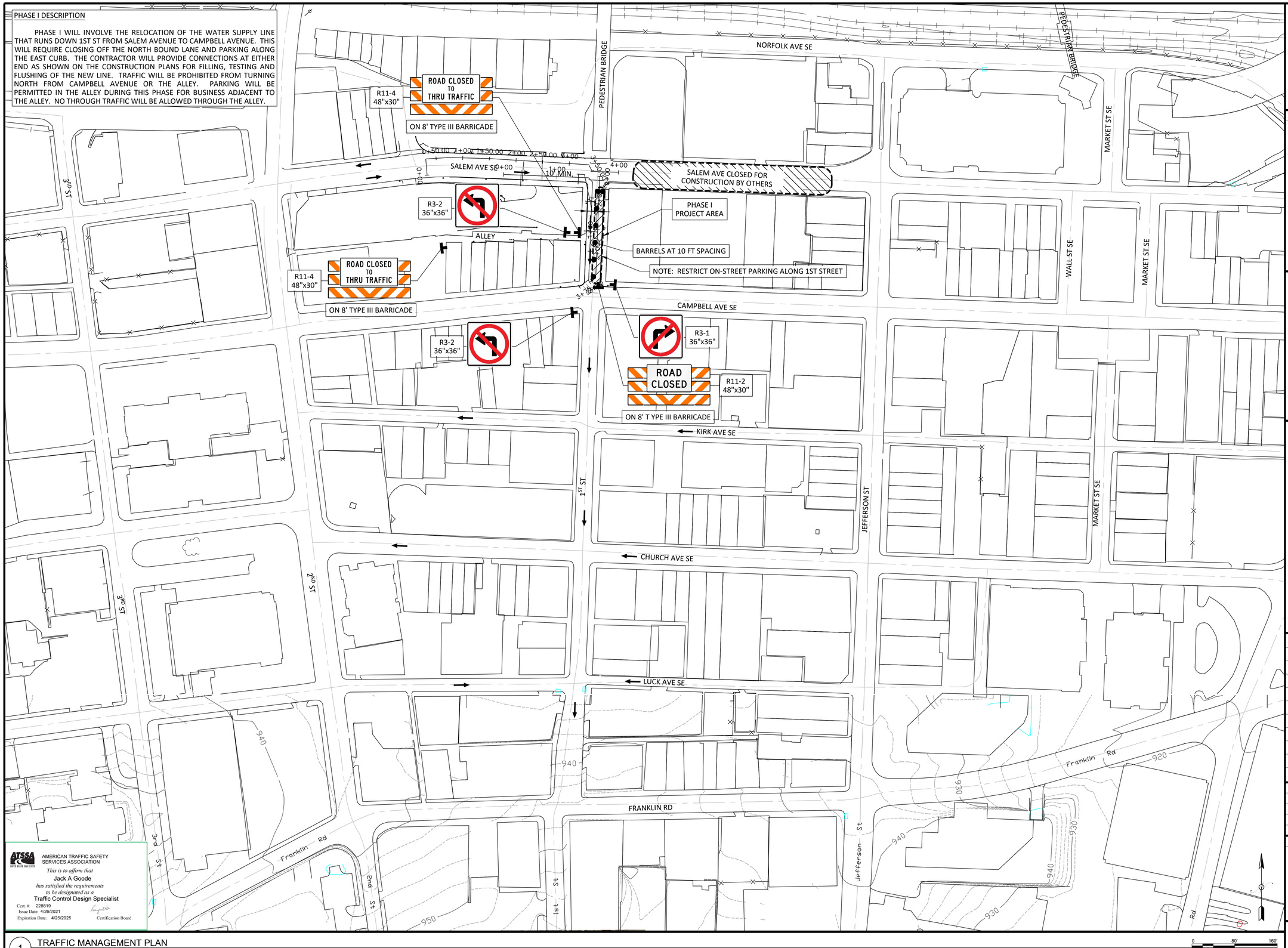
TRAFFIC MANAGEMENT PLAN NOTES

C8.0

SHEET 12 OF 17

PHASE I DESCRIPTION

PHASE I WILL INVOLVE THE RELOCATION OF THE WATER SUPPLY LINE THAT RUNS DOWN 1ST ST FROM SALEM AVENUE TO CAMPBELL AVENUE. THIS WILL REQUIRE CLOSING OFF THE NORTH BOUND LANE AND PARKING ALONG THE EAST CURB. THE CONTRACTOR WILL PROVIDE CONNECTIONS AT EITHER END AS SHOWN ON THE CONSTRUCTION PLANS FOR FILLING, TESTING AND FLUSHING OF THE NEW LINE. TRAFFIC WILL BE PROHIBITED FROM TURNING NORTH FROM CAMPBELL AVENUE OR THE ALLEY. PARKING WILL BE PERMITTED IN THE ALLEY DURING THIS PHASE FOR BUSINESS ADJACENT TO THE ALLEY. NO THROUGH TRAFFIC WILL BE ALLOWED THROUGH THE ALLEY.



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1 TRAFFIC MANAGEMENT PLAN

0 80' 160'
SCALE: 1"=80'

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STORMWATER C.I.P.
SALEM AVE & 1st ST SW
"L-TUNNEL"
CITY OF ROANOKE, VIRGINIA

MOT LEGEND
- TEMPORARY SIGN
- TEMPORARY WORK ZONE
- TEMPORARY TYPE III BARRICADE
- TRAFFIC FLOW (ONE WAY)

MARK	DATE	DESCRIPTION

100% DESIGN

PROJECT NO:	18-1108.007
SCALE:	AS SHOWN
DESIGNED BY:	DAK
DRAWN BY:	KHH
CHECKED BY:	DJR

SHEET TITLE

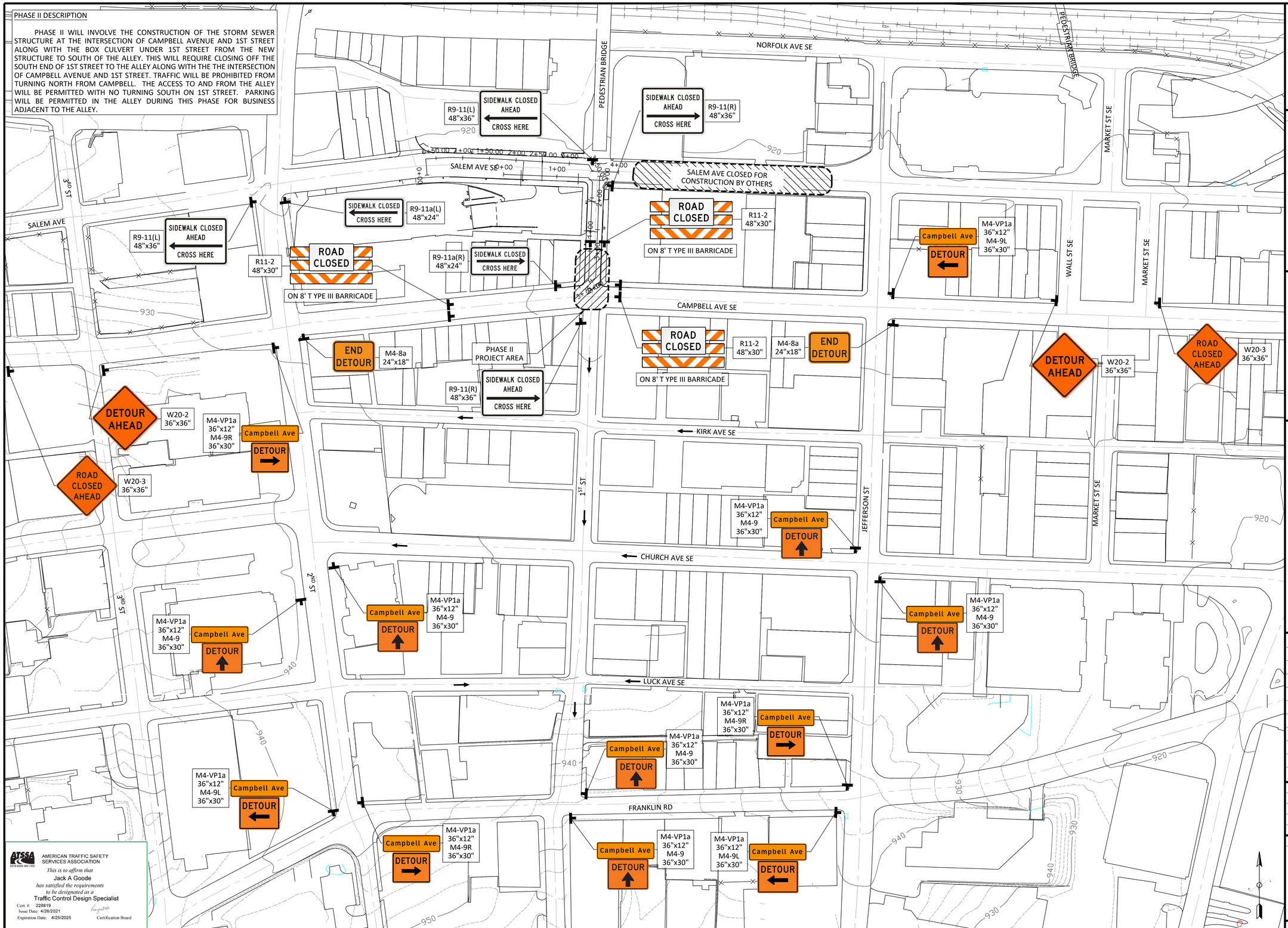
TRAFFIC MANAGEMENT PLAN - PHASE I

C8.1

SHEET 13 OF 17

PHASE II DESCRIPTION

PHASE II WILL INVOLVE THE CONSTRUCTION OF THE STORM SEWER STRUCTURE AT THE INTERSECTION OF CAMPBELL AVENUE AND 1ST STREET ALONG WITH THE BOX CULVERT UNDER 1ST STREET FROM THE NEW STRUCTURE TO SOUTH OF THE ALLEY. THIS WILL REQUIRE CLOSING OFF THE SOUTH END OF 1ST STREET TO THE ALLEY ALONG WITH THE THE INTERSECTION OF CAMPBELL AVENUE AND 1ST STREET. TRAFFIC WILL BE PROHIBITED FROM TURNING NORTH FROM CAMPBELL. THE ACCESS TO AND FROM THE ALLEY WILL BE PERMITTED WITH NO TURNING SOUTH ON 1ST STREET. PARKING WILL BE PERMITTED IN THE ALLEY DURING THIS PHASE FOR BUSINESS ADJACENT TO THE ALLEY.



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SCALE: 1"=80'

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CITY OF ROANOKE, VIRGINIA

MOT LEGEND

- TEMPORARY SIGN
- TEMPORARY WORK ZONE
- TEMPORARY TYPE III BARRICADE
- TRAFFIC FLOW (ONE WAY)

MARK	DATE	DESCRIPTION

100% DESIGN

PROJECT NO:	18-1108.007
SCALE:	AS SHOWN
DESIGNED BY:	DAK
DRAWN BY:	KHH
CHECKED BY:	DJR

SHEET TITLE

TRAFFIC MANAGEMENT PLAN - PHASE II

C8.2

SHEET 14 OF 17

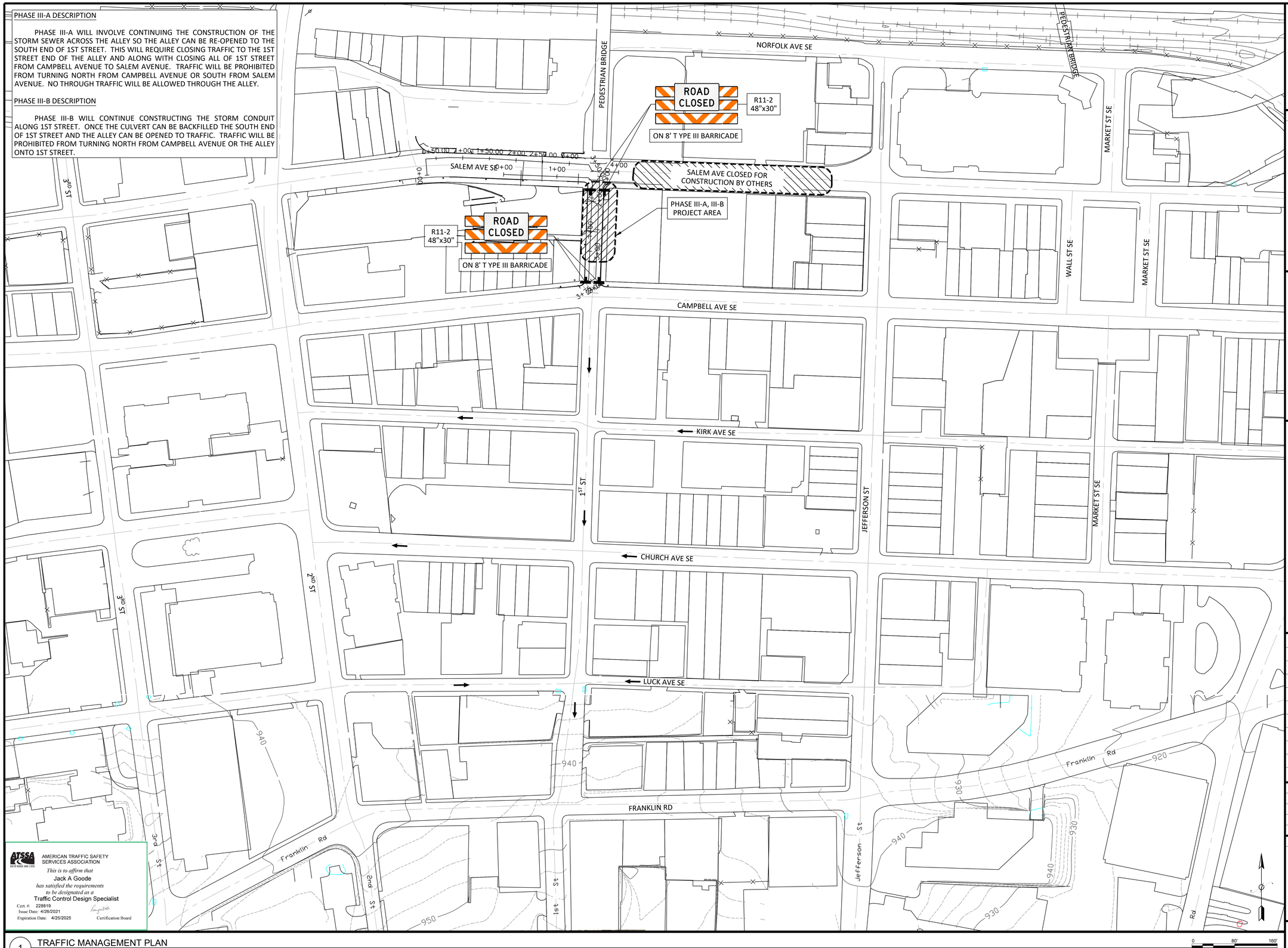
C8.2
X:\RICH\MOND\18-1108.007 - SALEM AVE AND 1ST ST - L-SHAPED TUNNEL\05-CAD\C3.0 - 181108007.DWG, 10/16/2023 6:45 PM, KHYLTON

PHASE III-A DESCRIPTION

PHASE III-A WILL INVOLVE CONTINUING THE CONSTRUCTION OF THE STORM SEWER ACROSS THE ALLEY SO THE ALLEY CAN BE RE-OPENED TO THE SOUTH END OF 1ST STREET. THIS WILL REQUIRE CLOSING TRAFFIC TO THE 1ST STREET END OF THE ALLEY AND ALONG WITH CLOSING ALL OF 1ST STREET FROM CAMPBELL AVENUE TO SALEM AVENUE. TRAFFIC WILL BE PROHIBITED FROM TURNING NORTH FROM CAMPBELL AVENUE OR SOUTH FROM SALEM AVENUE. NO THROUGH TRAFFIC WILL BE ALLOWED THROUGH THE ALLEY.

PHASE III-B DESCRIPTION

PHASE III-B WILL CONTINUE CONSTRUCTING THE STORM CONDUIT ALONG 1ST STREET. ONCE THE CULVERT CAN BE BACKFILLED THE SOUTH END OF 1ST STREET AND THE ALLEY CAN BE OPENED TO TRAFFIC. TRAFFIC WILL BE PROHIBITED FROM TURNING NORTH FROM CAMPBELL AVENUE OR THE ALLEY ONTO 1ST STREET.



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STORMWATER C.I.P.
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CITY OF ROANOKE, VIRGINIA

MOT LEGEND
- TEMPORARY SIGN
- TEMPORARY WORK ZONE
- TEMPORARY TYPE III BARRICADE
- TRAFFIC FLOW (ONE WAY)

MARK	DATE	DESCRIPTION

100% DESIGN

PROJECT NO:	18-1108.007
SCALE:	AS SHOWN
DESIGNED BY:	DAK
DRAWN BY:	KHH
CHECKED BY:	DJR

SHEET TITLE

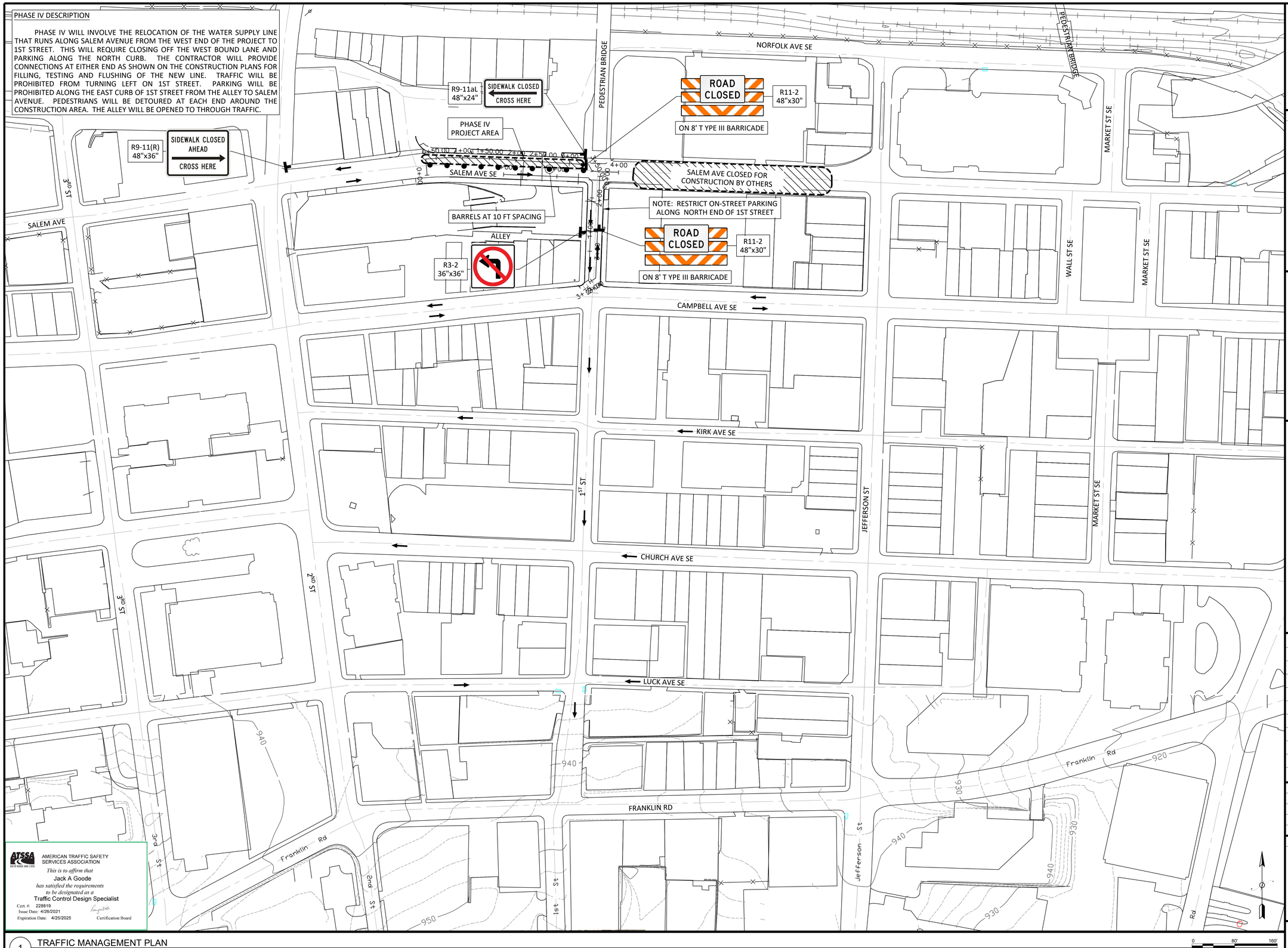
TRAFFIC MANAGEMENT PLAN - PHASE III

C8.3

SHEET 15 OF 17

PHASE IV DESCRIPTION

PHASE IV WILL INVOLVE THE RELOCATION OF THE WATER SUPPLY LINE THAT RUNS ALONG SALEM AVENUE FROM THE WEST END OF THE PROJECT TO 1ST STREET. THIS WILL REQUIRE CLOSING OFF THE WEST BOUND LANE AND PARKING ALONG THE NORTH CURB. THE CONTRACTOR WILL PROVIDE CONNECTIONS AT EITHER END AS SHOWN ON THE CONSTRUCTION PLANS FOR FILLING, TESTING AND FLUSHING OF THE NEW LINE. TRAFFIC WILL BE PROHIBITED FROM TURNING LEFT ON 1ST STREET. PARKING WILL BE PROHIBITED ALONG THE EAST CURB OF 1ST STREET FROM THE ALLEY TO SALEM AVENUE. PEDESTRIANS WILL BE DETOURED AT EACH END AROUND THE CONSTRUCTION AREA. THE ALLEY WILL BE OPENED TO THROUGH TRAFFIC.



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MOT LEGEND
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- TEMPORARY WORK ZONE
- TEMPORARY TYPE III BARRICADE
- TRAFFIC FLOW (ONE WAY)

MARK	DATE	DESCRIPTION

100% DESIGN

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CHECKED BY:	DJR

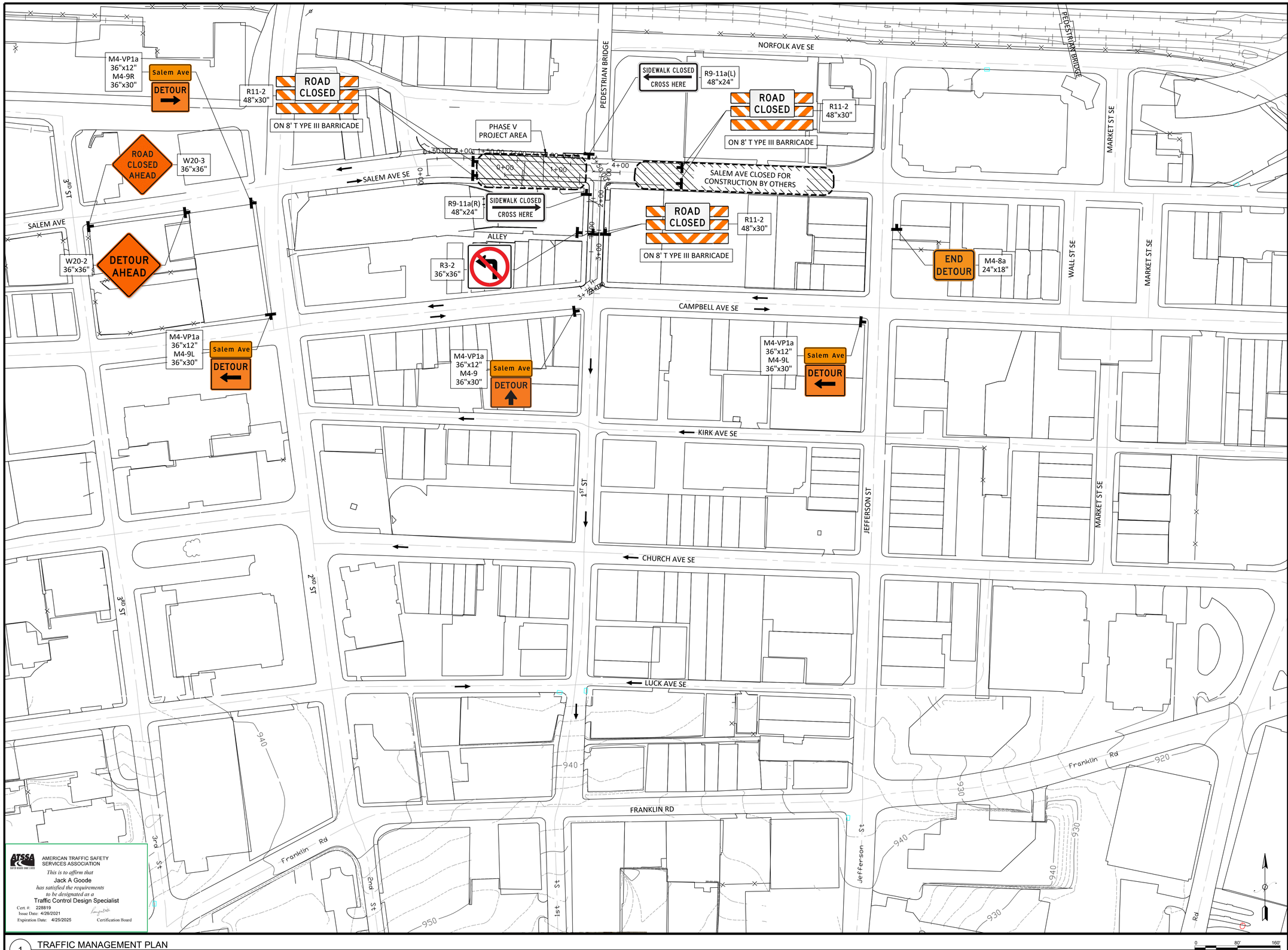
SHEET TITLE

TRAFFIC MANAGEMENT PLAN - PHASE IV

C8.4

SHEET 16 OF 17

C8.4
X:\R\CHMOND\18-1108.007 - SALEM AVE AND 1ST ST - L-SHAPED TUNNEL\05-CADD\C3.0 - 181108007.DWG, 10/16/2023 6:46 PM, KHYLTON



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SALEM AVE & 1st ST SW
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CITY OF ROANOKE, VIRGINIA

MOT LEGEND
- TEMPORARY SIGN
- TEMPORARY WORK ZONE
- TEMPORARY TYPE III BARRICADE
- TRAFFIC FLOW (ONE WAY)

MARK	DATE	DESCRIPTION

100% DESIGN

PROJECT NO:	18-1108.007
SCALE:	AS SHOWN
DESIGNED BY:	DAK
DRAWN BY:	KHH
CHECKED BY:	DJR

SHEET TITLE

TRAFFIC MANAGEMENT PLAN - PHASE V

C8.5

SHEET 17 OF 17

C8.5
X:\R\CHMOND\18-1108.007 - SALEM AVE AND 1ST ST - L-SHAPED TUNNEL\05-CADD\C3.0 - 181108007.DWG, 10/16/2023 6:46 PM, KHYLTON

APPENDIX F - DCR RECOMMENDATION ON PROJECT TYPE

FW: [EXTERNAL] CFPF Project characterization

Ian Shaw <ian.shaw@roanokeva.gov>
Mon 9/25/2023 8:34 AM

To:Marcus Aguilar <Marcus.Aguilar@Roanokeva.gov>
Cc:McKenzie S. Brocker <McKenzie.Brocker@roanokeva.gov>

Hey Marcus,

In the DCR training session on Thursday last week, DCR was talking about the ability to phase projects. Our downtown work is in some ways a giant phased effort. Thinking of 1st and Salem, it's a gray infrastructure project by itself (may not score as highly as other projects), but it's completion sets up future green infrastructure work. I asked if we could consider 1st and Salem as the first phase in implementing our Downtown Flood Reduction PER and as such we can look at it as part of a larger hybrid project. As noted below, the answer from DCR is yes, we can identify it as a hybrid project for scoring purposes.

Thanks,
Ian

Ian D. Shaw, PE AICP | Stormwater Manager
Department of Public Works
Stormwater Utility
1802 Courtland Rd, NE
Roanoke, VA 24012
540-853-5901

From: Ian Shaw
Sent: Monday, September 25, 2023 8:29 AM
To: 'Farinholt, Stacey (DCR)' <Stacey.Farinholt@dcr.virginia.gov>
Cc: Davis, Angela (DCR) <Angela.Davis@dcr.virginia.gov>; Huffman, Sidney (DCR) <Sidney.Huffman@dcr.virginia.gov>; McKenzie S. Brocker <McKenzie.Brocker@roanokeva.gov>; Snead, Ginny <gsnead@amtengineering.com>
Subject: RE: [EXTERNAL] CFPF Project characterization

Stacey,

Thank you for the quick response and good news, as well. I spoke with our consultant for our Resilience Plan and they should have a key to us today that matches plan sections with the DCR required content. Once I have that I'll forward to you for a review. I know you all are really busy so any feedback on completeness/other observations will be very helpful.

Thanks,
Ian

Ian D. Shaw, PE AICP | Stormwater Manager
Department of Public Works
Stormwater Utility
1802 Courtland Rd, NE
Roanoke, VA 24012
540-853-5901

From: Farinholt, Stacey (DCR) <Stacey.Farinholt@dcr.virginia.gov>
Sent: Friday, September 22, 2023 10:51 AM
To: Ian Shaw <ian.shaw@roanokeva.gov>
Cc: Davis, Angela (DCR) <Angela.Davis@dcr.virginia.gov>; Huffman, Sidney (DCR) <Sidney.Huffman@dcr.virginia.gov>
Subject: [EXTERNAL] CFPF Project characterization

Ian,

I spoke to Angela this morning about how to characterize nature-based / hybrid / gray infrastructure across a phased project. The conclusion is that you may describe each fundable phase as "hybrid" if that is the **overall** outcome of a large project broken into discrete phases. Be sure to make that very clear in your project description so that the reviewer understands the totality of the multiphase approach.

Thanks again for joining us for the training.

Stacey Farinholt, CFM PLA
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APPENDIX G - DOWNTOWN ROANOKE FLOOD MITIGATION PRELIMINARY ENGINEERING REPORT

Preliminary Engineering Report

for

Flood Mitigation in the City of Roanoke's Central Business District (CBD)

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Disclaimer: This Preliminary Engineering Report is an internal planning document for the City of Roanoke Stormwater Division and has not been considered or adopted by City Council. The content in this document is intended for planning only and is not for regulatory, design or construction purposes.

CHAPTER 1 – INTRODUCTION

The City of Roanoke's Central Business District (CBD) is an economic hub, and its long-term sustainability and resiliency is vital to the Commonwealth, however the CBD is subject to flash flooding during intense rainfall since it sits atop the confluence of two major streams – Trout Run and Lick Run. These streams are conveyed under city streets in large drainage tunnels dating back to the 1880's.

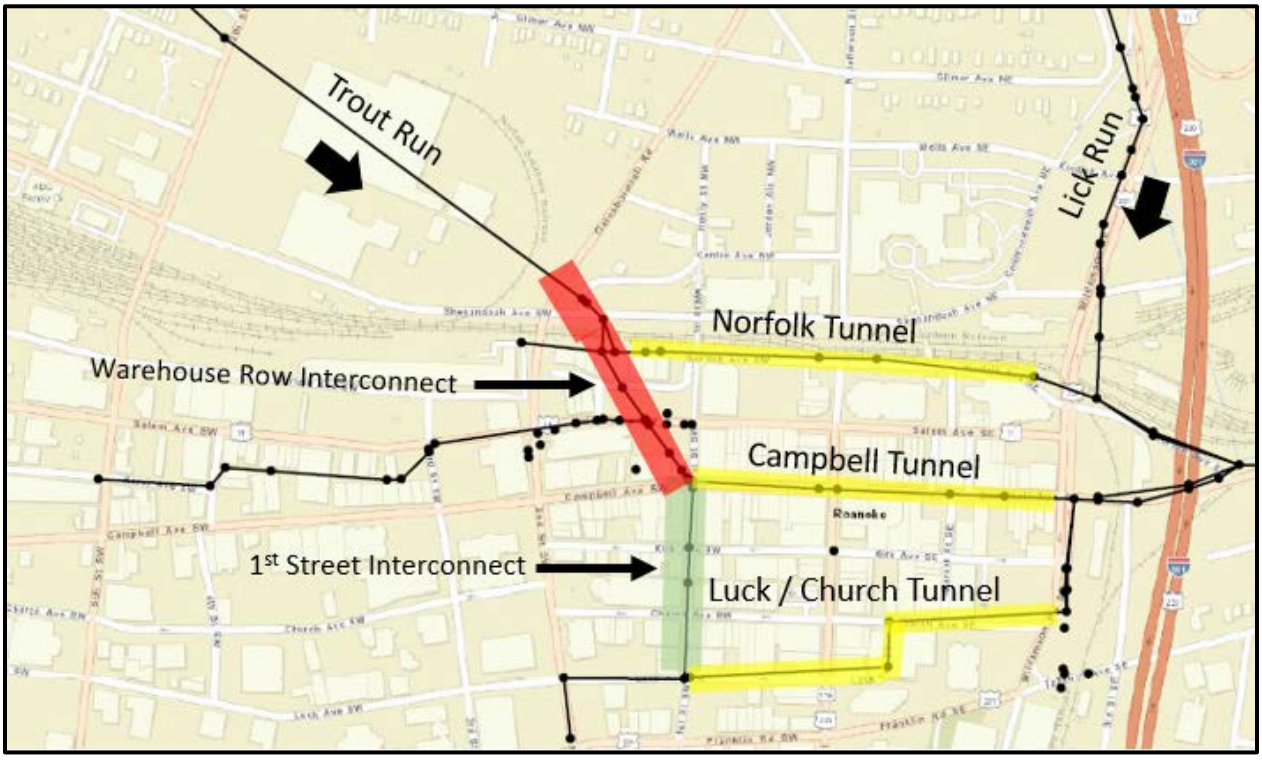
Purpose

This engineering study evaluates historic flooding in the CBD and compares traditional and emerging practices in flood mitigation to establish recommendations for the City of Roanoke that will reduce or eliminate identified flood risks. The implementation of the recommendations in this flood mitigation plan to improve resiliency is the "next great challenge" for the City of Roanoke's Stormwater Utility team.

Existing Tunnel System

The existing CBD tunnel system dates back to the 1880's - prior to modern engineering standards - when wood tunnels were first constructed to enclose the open marshlands around a salt lick, that generally follows what is now called Campbell Avenue. As downtown prospered, development encroached further into the salt lick, and by 1904, rotting wood structures were being replaced by more permanent steel and concrete structures that still exist today.

Figure 1-1: Existing Tunnel System



Today, city workers need to exercise great care in planning for their safe entry and exit into this aging tunnel system. There is little natural light and poor ventilation in some areas. Access can also be difficult since many of the manholes were built without steps or safety slabs to help climb down into the tunnel system with equipment and materials for proper maintenance.

The largest pipes in the CBD tunnel system carry stormwater runoff in an easterly direction using three main tunnels: the Norfolk Tunnel, Campbell Tunnel and a large diameter pipe generally following Luck / Church Avenue. These main tunnels are shown with yellow highlights and there are two interconnect tunnels shown with red and green highlights (Figure 1-1). The Warehouse Row Interconnect Tunnel (red highlights) runs from Trout Run downstream of the Coca Cola Bottling Company, under the Railroad Tracks to the Norfolk Tunnel, then continuing under the buildings on Warehouse Row towards the Campbell Tunnel. The 1st Street Interconnect Tunnel (green highlights) runs from the Luck/Church Tunnel at 1st Street, down to the Campbell Tunnel. Both interconnect tunnels convey excess runoff between the main tunnels, with prevailing slopes towards the Campbell Tunnel where they both connect in the same location, creating a large, interconnected network of pipes for the Roanoke CBD.

The entire tunnel system in the CBD outfalls into a large concrete channel just east of Williamson Road near the intersection of Campbell Avenue and Norfolk Avenue. At this point, essentially the entire downtown Roanoke area and its upstream contributing watershed of 7.9 square miles, drains to one location or “outfall”. From here, there is a concrete channel that follows Campbell Avenue from the intersection with Norfolk Avenue to its confluence with Tinker Creek, then conveying runoff to the Roanoke River.

Figure 1-2: Tunnel Outfall

During the largest storm events, these interconnecting pipes and tunnels fill with water, allowing runoff to drain in the upstream or downstream direction - as floodwaters rise and fall. This makes the tunnel system complex in how it handles different-sized storm events and creates “surcharged conditions” that can back water up into the streets above, causing recurring flooding during the largest storm events.

Flood of Record

This engineering study focuses on the storm events that have backed-up the tunnel system, and while there are several recorded flood events including three events from 2016 to 2018 recently, the largest flood in Roanoke’s modern history occurred on November 4, 1985 when remnants of Hurricane Juan stalled over the Roanoke Valley. This is commonly referred to as the “Flood of 1985” during which there were 10 deaths, including 3 who drove into flooded rivers, and 3 others who failed to evacuate. The floods damaged about 3,000 homes and 100 businesses, with overall monetary damage in the City of Roanoke an estimated $225 million, making it the city’s worst flood on record, to date.

The Flood of 1985 began with 4.46" of rainfall over 5 days, from October 30th to November 3rd, followed by 6.61" of rainfall on November 4th for a total weekly rainfall depth of 11.07". The downtown area flooded on November 4, 1985, and then flooded a second time - due to the Roanoke River rising fifteen feet (15') as the watershed continued to feed the river. This type of rise in the Roanoke River has been accounted for in the recently completed Roanoke River Flood Reduction Project that will reduce river backwater affects in the central business district - so the focus of this study is on the 24-hour rainfall depths that occurred on November 4, 1985.

Design Rainfall

In assessing the Flood of 1985, we decided to propose higher design storm events for this engineering study to closely match the 1985 Flood of Record. For a longer duration, larger rainfall depth we are using the 25-Year, 24-Hour event in this study which has a rainfall depth of 5.72" that is approximately 85% of the 1985 rainfall depth of 6.61" in 24-hours. For evaluating a shorter duration "flash flood" type of event - we are using the 25-Year, 1-Hour Storm event which has a rainfall depth of 2.30" and almost exactly matches the 2.29" that fell in 1-hour on November 4, 1985. In both cases, we are seeking to develop a flood mitigation solution that reduces flooding depths in city streets to less than 6-inches at any time during the storm event. Any remaining street flooding would be contained within city streets at a maximum 6-inch depth and the time durations would be minimal before the underground tunnel systems could re-capture that runoff as a result of the storm event receding.

Watershed Modeling

To establish a hydrologic and hydraulic model for existing conditions in the CBD tunnel system, we began with EPA SWMM modeling that had already been developed and calibrated by the City of Roanoke over the course of several years as our starting point[1]. We then helped the city expand and refine that modeling of existing conditions, moving into PC-SWMM modeling as part of the H&H model enhancements for this study. Model enhancements include a 2-D mesh to better represent flood depths due to overtopping into city streets and modeling the storage effects of that shallow depth flooding for selected 25-year design events. Also, we have utilized city GIS databases and supplemental surveying of the existing storm drain systems to refine and expand the existing conditions modeling to some upper watershed locations where proposed flood mitigation solutions are being explored in this study.

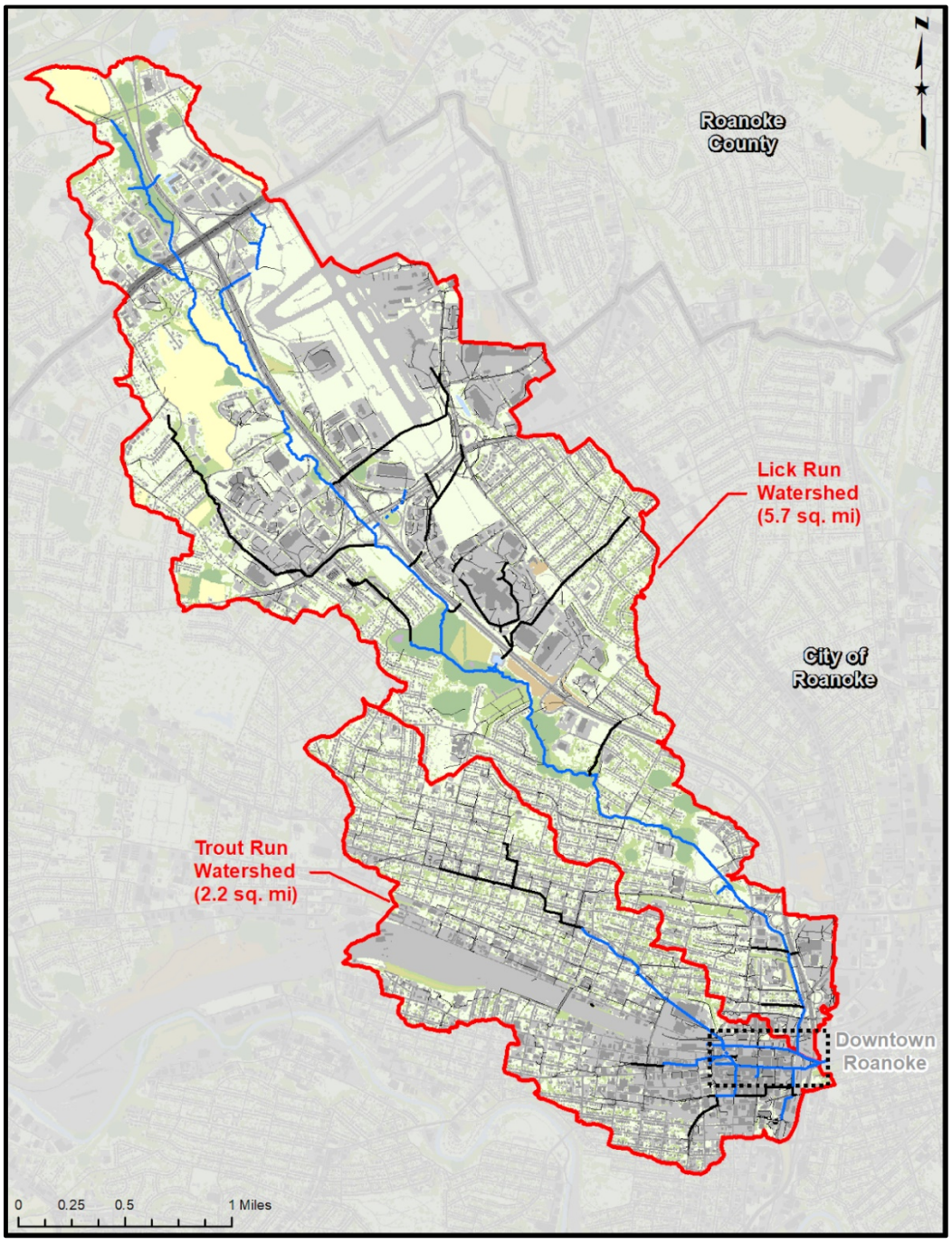
Watershed Size

The overall watershed draining through the Roanoke CBD is 7.9 Square Miles (see Figure 1-3). 5.7 Square Miles is from the Lick Run Watershed which is 44% impervious and enters the Norfolk Tunnel near the east end of the CBD (Williamson Road) where the tunnel then follows Norfolk Avenue to its outfall at Campbell Avenue. Being 72% of the entire watershed, the Lick Run watershed can create high tailwater conditions that slow drainage through the CBD tunnels, but

[1] Brendel, C. E., Dymond, R. L., and Aguilar, M. F. (2020). Modeling Storm Sewer Networks and Urban Flooding in Roanoke, Virginia with SWMM and GSSHA. Journal of Hydrologic Engineering, 26(1), 1–13. doi:10.1061/(ASCE)HE.1943-5584.0002021.

the actual runoff is far enough east (downstream) to avoid contributing directly to localized flooding in areas of most concern. 2.2 Square Miles collects from the Trout Run Watershed which mostly enters the Roanoke CBD in a drainage tunnel under the Coca Cola Bottling Company Facility at 235 Shenandoah Avenue NW, and then crosses the Norfolk Southern Railroad Yard near Centre Avenue going towards Warehouse Row. With 66% estimated imperviousness in the Trout Run Watershed, this runoff directly contributes to recurring flooding in the vicinity of 1st and Salem Avenue - which drains to a larger area of CBD flooding along Campbell Avenue.

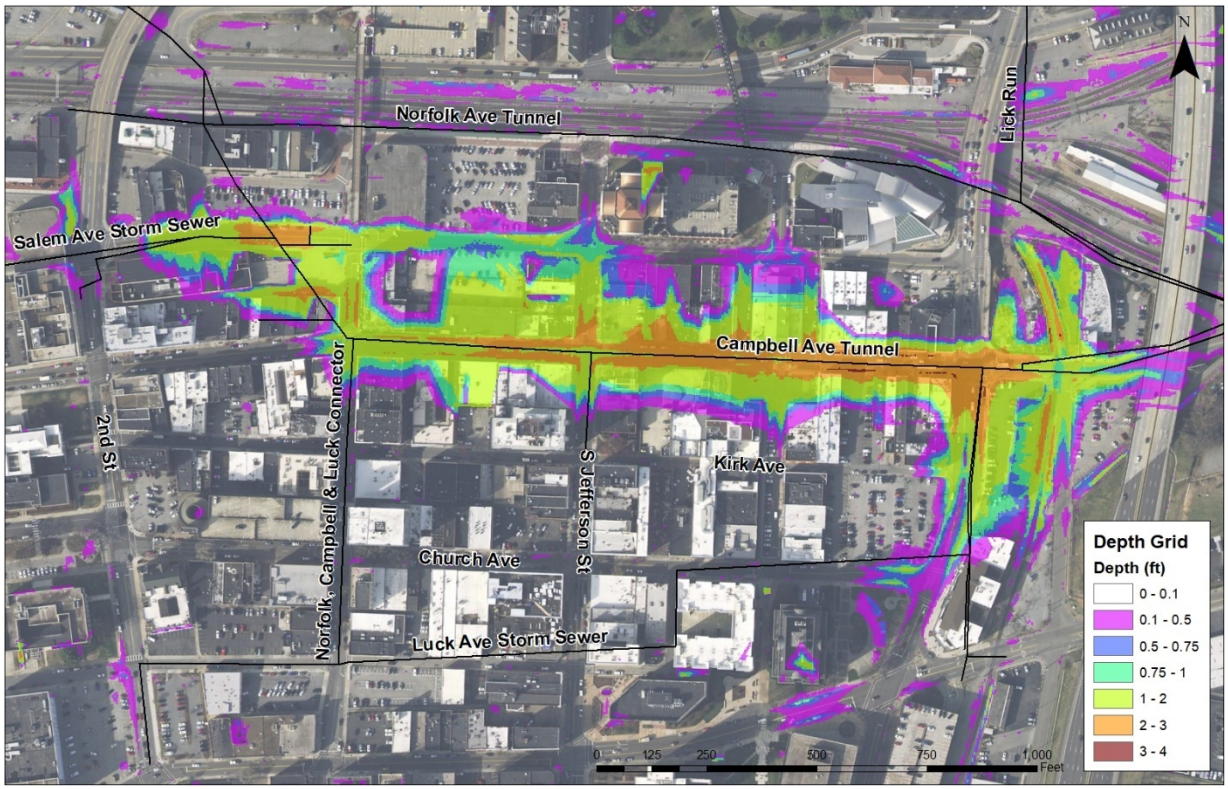
Figure 1-3 – Watershed Map



Topographic Low Points

Part of the reason for Roanoke CBD flooding is the lack of overland flow relief. The map below (Figure 1-4) shows localized topographic low points within the roadway network downtown that generally drain towards the lowest street elevations on Campbell Avenue which then traps standing water like a large detention pond on the road, until the floodwaters can recede and drain through drainage inlets and grates into the emptying tunnel system underneath.

Figure 1-4 – Topographic Low Points



Flooding occurs as a result of the tunnel systems being undersized for larger storm events, causing them to surcharge and overtop into the city streets above. As you can see, the topographic low point in Campbell Avenue can result in standing water up to 3' deep - with no overland flow relief, should the storm drain system become overtaxed or clogged. This lack of overland flow relief is a significant reason for the risk of flooding along Campbell Avenue.

Study Goals

The primary goals of this study are to make recommendations that reduce or eliminate street flooding for the 25-Year storm event using both a 1-hour "Flash Flood" and a larger 24-hour duration storm event to model proposed flood mitigation projects deployed in combination as a comprehensive flood mitigation plan. Secondly, we plan to promote water quality improvement in the solutions presented, where feasible. Thirdly, we plan to complement the growth and redevelopment planning goals for the Roanoke CBD in this plan to foster a shared vision.

CHAPTER 2 – ALTERNATIVES ANALYSIS

In finding engineering solutions this flood mitigation study has included an evaluation of existing resources, an evaluation of proposed alternatives, and preliminary hydrologic and hydraulic modeling as described below to help compare alternatives.

Evaluation of Existing Resources

Based on the collection and review of existing background resources at the start of this study, fifty (50) possible solutions were identified for reducing or eliminating flooding concerns. The table in the report appendices includes each of these project ideas, as well as resulting commentary and website references that were considered by the study team. These possible solutions were considered during early study coordination meetings and this resulted in thirty-one (31) ideas remaining to be considered further during the evaluation of proposed alternatives.

Evaluation of Proposed Alternatives

Based on initial coordination that resulted in thirty-one (31) ideas, possible solutions were then reduced to fifteen (15) of the most feasible alternatives to be compared and considered.

1. Salem Avenue & 1st Street "L-Tunnel" – Due to a localized low point in Salem Avenue and a diagonal tunnel to its south that crosses a private parking lot and goes under existing buildings, it was determined that a new culvert could be installed within the public right-of-way (Salem Avenue and 1st Street) to better convey runoff from this area. Due to shallow cover conditions, a low height box culvert or elliptical pipe may be required for portions of the new storm drain system. Also, there are low points in the existing 36" RCP that do not drain well into the 54"x96" box culvert that conveys runoff from this area.

2. Shenandoah Avenue Division Tunnel – This alternative is a diversion of runoff coming from the pipe under the Coca-Cola Bottling Company (CCBC) to a new culvert that would drain east under Shenandoah Avenue to an abandoned pedestrian tunnel at N. Jefferson Street. By generally matching the size of the 8'x10' abandoned pedestrian tunnel, the resulting drainage system would convey substantial amounts of runoff away from the drainage problems at Warehouse Row and then ultimately at Salem & 1st Street.

3. CCBC Large Detention Basin – This alternative suggests the relocation of the Coca-Cola Bottling Company (CCBC) facility to another location in the City to make room for a large lake that would impound runoff from the Trout Run Watershed to reduce peak discharges for a wide range of storm events. A 16-acre wet pond is envisioned with a loop trail and continued vehicular access along Shenandoah Avenue NW with approximately 4-acres residual lands adjacent to 5th Street NW unprogrammed for community input from the Gainsboro and Gilmer neighborhoods as to whether to enlarge the detention basin or provide other facility amenities related to the loop trails.

4. CCBC Small Detention Basin – This alternative reduces the detention basin size at the CCBC facility to co-exist onsite with the existing botting company. It includes deploying extensive underground detention and a possible reduction in the building footprints to provide enough stormwater detention for the planned flood reduction benefits. A portion of the Trout Run watershed might continue to drain unmitigated, downstream to make this feasible.

5. Continuous Monitoring and Control (CMAC) System – This alternative expands the CCBC detention basin options by providing real-time weather monitoring equipment for the advanced lowering of the wet pond prior to larger storm events. The larger the predicted rainfall amount, the more the normal pool elevation will be lowered creating additional stormwater storage capacity in the detention basin.

6. Transportation Museum Diversion – Much of the runoff into the upper end of the Norfolk Tunnel comes from the railroad yard behind the Transportation Museum which floods frequently. This area generally drains to existing drainage structures in the loading dock, and this alternative would divert that runoff to the Shenandoah Tunnel instead of the Norfolk Tunnel and provide additional flow relief to Warehouse Row.

7. Campbell Avenue Storm Drain Extension – This alternative provides enlarged pipes from the intersection of Campbell & 1st Street to Campbell and 6th Street SW which is an undersized culvert for the contributing watershed during larger storm events. Smaller and localized drainage issues within this neighborhood would be addressed by this project including older flooding concerns from the city's CIP at Rorer & 5th Street SW, and at Salem & 3rd Street SW.

8. Campbell Avenue Upper Watershed Improvements – This alternative uses stormwater detention basins and green streets (permeable pavement and bioretention) to detain 14.1 acre-feet of runoff for the 25-year storm event, reducing peak discharges at the intersection of Rorer and 6th Street SW to acceptable levels for the existing drainage systems downstream. The solution is similar to the 2015 Drainage Study recommendations (Lumsden) but it has been upgraded to include a 25-year detention volume and green infrastructure in the planned solution.

9. Luck / Church Avenue Storm Drain – This alternative involves plugging flow going to the Campbell Avenue tunnel by way of a 42" RCP under 1st Street, and then installing a missing pipe connection under Church Avenue, from Jefferson Street to the intersection with Luck Avenue near the Hampton Inn, to increase drainage system capacity.

10. Luck Avenue Watershed Improvements – This alternative includes addressing older, standing water concerns on 5th Street between Luck and Marshall Avenue (near the YMCA) and then adding other detention basins with underground vaults and permeable pavement for a total of 22.67 acre-feet for the contributing watershed to protect existing drainage systems downstream. One of the permeable pavement areas is also on Luck Avenue between 2nd and 1st Street which is an older flooding concern. The third is near Elmwood Park, another older flooding concern.

11. Trout Run Watershed Improvements – This alternative seeks to reduce peak discharges from the Trout Run Watershed through high percentage participation from existing residential and commercial properties throughout the upper watershed to retrofit detention of stormwater runoff into their individual properties. City incentive programs would be used to incentivize or support these projects which would incrementally reduce and control runoff.

12. Downtown Parking Lot Detention Regulations – This alternative considers a regulatory change to require additional detention with permeable pavement and/or underground vaults for private parking lots and street improvement projects downtown that are designated as a land disturbing activity with stormwater management requirements to help reduce flooding. In this case, the detention requirement discussed would require an onsite detention system that reduces the 25-year design storm event in the Roanoke CBD to the 10-year, pre-development peak discharge conditions.

13. Maintenance Access Upgrades – This alternative provides improved access to the existing tunnels for long-term inspection and maintenance needs. Steel grates on top would allow more natural light and ventilation into the tunnels in those areas, with steps and safety slabs added to lower equipment and personnel more safely. Also, sediment traps may be excavated into the tunnel floors to trap larger material in a location that can be more readily accessed for sediment and debris monitoring and removal. Nine (9) locations throughout the existing CBD tunnel system were studied for improved maintenance access.

14. NS Railroad Yard Diversion – This alternative improves the collection of excess runoff in the railroad yard between 14th Street and 5th Street using a new storm drain collection system in the railroad yard itself to then divert runoff away from the Norfolk Tunnel and into either a proposed CCBC detention basin or the proposed Shenandoah Avenue Diversion Tunnel. This project would be built almost entirely on railroad right-of-way in close partnership between Norfolk Southern (NS) and the City of Roanoke.

15. Luck Avenue Bypass Storm Drain – This alternative was based heavily on the 1991 Report entitled, “Preliminary Design Report Luck Avenue By-Pass Storm Drain Project (Lumsden) and included a new and parallel storm drain system to convey runoff from the upper watershed to the Campbell Tunnel more effectively.

It’s important to note that references to older flooding concerns and capital improvement projects (CIP projects) are typically based on the 2006 Downtown Drainage Study and other prior studies that are the basis for a majority of the prior recommendations and current CIP projects for flood mitigation in the CBD area. All current CIP plans and earmarked funds should be re-evaluated in relation to this flood mitigation plan to be sure funds are being spent towards a holistic solution for the downtown flooding concerns from here forward.

Comparison of Proposed Alternatives

In order to narrow the list of possible alternatives, scoring criteria and a ranking system was applied to each of the fifteen (15) alternatives along with further investigations of the details for each potential solution. Conclusions reached as a result of this comparison are noted below.

1. Preliminary PC-SWMM Modeling – Although this study did not include proposed SWMM modeling for alternatives in the scope of work, models were developed to a preliminary level to generally consider the options presented. In many cases, the detention of runoff from upper watershed areas was more effective than adding conveyance pipes since adding conveyance would drain runoff more quickly to areas of concern in the Campbell Tunnel further downstream. Better results were found by delivering less runoff to the Campbell Tunnel, to provide a longer watershed response time. Preliminary PC-SWMM model results for the 25-year storm event eliminated the following projects from further consideration in this study since they increased anticipated peak flood depths on Campbell Avenue.

    a. Campbell Avenue Storm Drain Extension (ID #7)

    b. Luck / Church Avenue Storm Drain (ID #9)

    c. Luck Avenue Bypass Storm Drain (ID #15)

    Pipe diversions that yielded excellent results for preliminary SWMM modeling and therefore remain in the plan, include:

    a. Salem Avenue and 1st Street “L-Tunnel (ID #1)

    b. Shenandoah Avenue Diversion Tunnel (ID #2)

    Also, the CCBC Small Detention Basin (ID #4) was eliminated from consideration based on preliminary PC-SWMM modeling because we could not feasibly provide enough detention volume for the Trout Run Watershed at this location without deploying the entire footprint of the proposed detention pond. Additionally, the CMAC system (ID #5) was added to the flood mitigation plan to increase the available detention volume for the CCBC large detention basin (ID #3) during more extreme flooding events. This operational control of the water level provides substantial, increased detention storage benefits for reducing peak discharges.

    Another project removed from consideration by comparison to preliminary SWMM modeling of other alternatives was the Transportation Museum Diversion (ID #6). It was eliminated since the NS Railroad Yard Diversion (ID #14) did a better job of conveying runoff to the CCBC large detention basin, whereas the transportation museum diversion worked better without the CCBC basin in the flood mitigation plan from a hydraulics standpoint.

2. Water Quality Benefits - Based on planning-level guidance available through the Chesapeake Bay Program and state standards for the established alternatives in this study, preferential rankings were established for projects that would help trap sediment and improve downstream water quality in their implementation. The most effective projects for trapping sediment that are being considered for this flood mitigation plan include:

a. The CCBC Large Detention Basin (ID #3) provides significant water quality benefits as a large, regional wet pond providing shoreline conservation plantings and aquatic vegetation in a combined shallow marsh / forebay area to trap sediment currently going into the CBD tunnel systems to trap 147 tons of sediment per year currently flowing into the CBD tunnel systems.

b. The Campbell Avenue Upper Watershed Improvements (ID #8) increase water quality benefits for a previously planned project in this area, by incorporate permeable pavement and bioretention into the planned detention basins for this area, along with increased levels of detention storage to trap 30 tons of sediment per year currently flowing into the CBD tunnel systems.

c. The Luck Avenue Upper Watershed Improvements (ID #10) provide significant water quality benefits in three areas with identified and localized flooding concerns, incorporating permeable pavement and bioretention into the planned solutions, along with underground vaults for increased detention storage to trap 29 tons of sediment per year currently flowing into the CBD tunnel systems.

The Trout Run Upper Watershed Improvements (ID #11) and the Downtown Parking Lot Detention Regulations (ID #12) would also have provided significant water quality benefits, however both projects had flaws identified in the comparison of alternatives.

a. The Trout Run Upper Watershed Improvements (ID #11) relied on public-private partnerships and incentives to achieve a high enough level of participation to reduce peak discharges downstream. Like the CCBC Small Detention Basin (ID #4) it was determined that the required detention storage volume for the watershed was too high to be achieved with this type of decentralized approach.

b. The Downtown Parking Lot Detention Regulations (ID #12) relied on land disturbing and regulated activities in private parking lots to achieve a high enough level of participation to reduce peak discharges downstream. Not only was this considered unlikely, preliminary PC-SWMM modeling showed that time lags for the runoff in the CBD itself could actually cause increased peak discharges as compared to detaining runoff in the upper watershed as described for other projects in this study.

Maintenance Access Upgrades (ID #13) and the NS Railroad Yard Diversion (ID #14) both showed smaller water quality benefits by providing sediment trapping areas with improved accessibility for inspections and sediment/debris removal from the system.

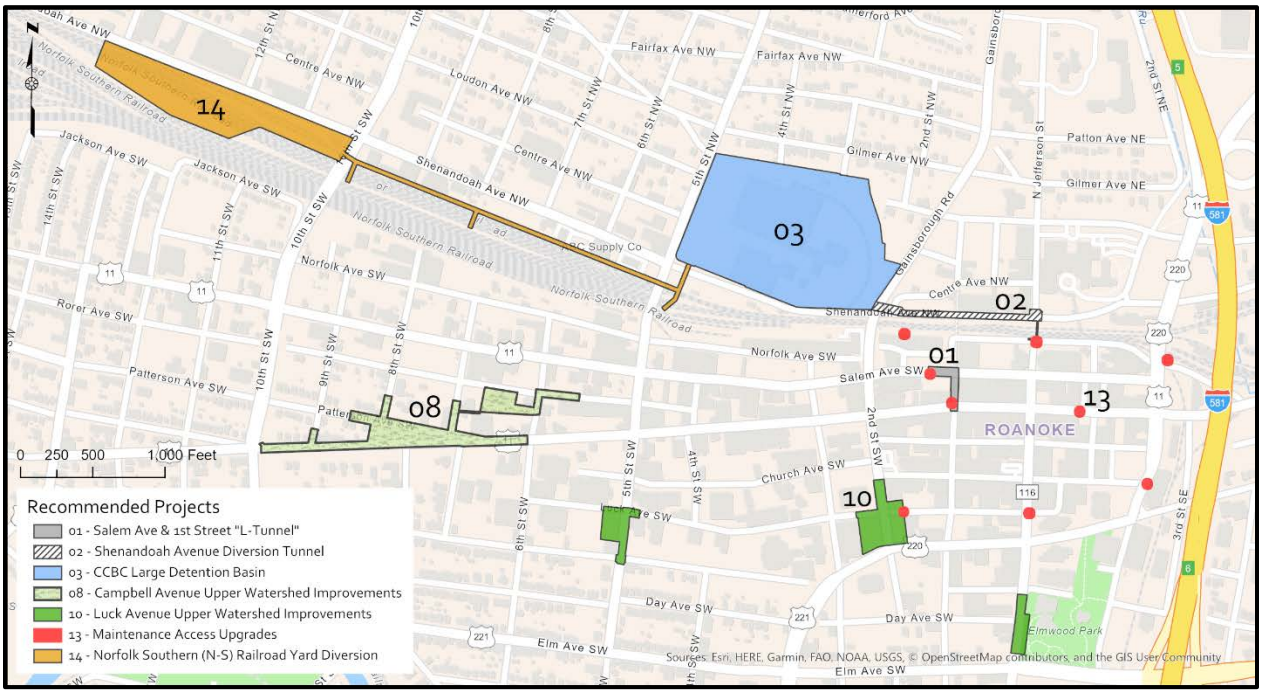
Water quality calculations for Total Phosphorus (TP), Total Nitrogen (TN) and Total Suspended Solids (TSS) based on guidance in the Chesapeake Bay Program are provided in the appendices to this report for the projects noted above.

3. Supporting Information - The tables in the report appendices summarize results for these fifteen (15) alternatives and help inform how the best projects were chosen for the recommended flood mitigation plan.

CHAPTER 3 – RECOMMENDED PLAN

The recommended plan for flood mitigation includes seven discrete projects that are described below, and further detailed in Appendix C of this report, including 30% concept plans and preliminary cost estimates for each flood mitigation solution. There was also a prioritization and ranking system applied to all seven projects to help establish the implementation recommendations for this study, as shown in Appendix C.

Figure 3-1 – Recommended Projects



Project 01 - Salem Avenue & 1st Street "L-Tunnel"

Summary

In this project, a diversion pipe or "L-Tunnel" is proposed that will tie into the existing Warehouse Row diagonal tunnel in Salem Avenue (54"x96" reinforced concrete box culvert) at node 104537, diverting runoff along Salem Avenue and 1st Street to its intersection with Campbell Avenue at node 607548 in 187 LF of 60" RCP and 214 LF of 48"x76" elliptical concrete pipe, where pipe cover or utility conflict avoidance become necessary along part of the project's length. Junction boxes are planned at the upstream and downstream ends of the new L-Tunnel for improved access, and lateral pipes and inlets along its length will be improved to better capture localized runoff in the topographically depressed area along Salem Avenue, just west of 1st Street SW.

Project Costs

The project budget is estimated at $1.5M as detailed in the report appendices for cost estimating, and project funding is anticipated to be local stormwater utility funds for capital projects during the engineering design and construction of this project. Private maintenance of a portion of existing diagonal tunnel that is planned to remain may also be required since it is not in a public right of way or easement, and since this flood mitigation project moves the city trunk line into the public rights of way for Salem Avenue and 1st Street.

Project Benefits

The primary benefit of this project is to divert flow from the diagonal tunnel at Warehouse Row into Salem Avenue and 1st Street, eliminating the diagonal tunnel downstream on private property with a public storm drain system by pipe plugging at the southerly right of way line for Salem Avenue. The new "L-shaped" tunnel will follow Salem Avenue and 1st Street, to tie into the Campbell Tunnel at approximately the same location as the diagonal tunnel (node 607548). This project also provides improved maintenance access into the Campbell Tunnel via a proposed junction box with natural light and ventilation from above, as well as a possible sediment trap in the bottom for water quality benefits.

Engineering Discussion

The total length of the new storm drain tunnel will be approximately 401 LF, including 214 LF of 48"x76" elliptical concrete pipe below Salem Avenue where there are concerns related to pipe cover and utility conflicts, and 187 LF of 60" RCP in 1st Street where it ties into the Campbell Tunnel. Average slope for the entirety of the 401 LF is basically flat with less than 1-inch of change in the pipe invert elevations at the upstream and downstream ends.

The upstream invert at the tie-in to the existing Warehouse Row diagonal tunnel is approximately elevation 909.74' and the street elevation of Salem Avenue is at 916.50 (6.76' depth). This would require the construction of a 12' x 12' poured in place junction box at the tie-in location, and inlets along Salem Avenue should also be upgraded and connected to the L-Tunnel.

The downstream invert at the tie-in to the existing Campbell Tunnel is approximately elevation 909.68' and the street elevation of Campbell Avenue is at 917.24' (7.56' depth). This would

require the construction of a 10’ x 20; poured in place junction box at the tie-in location, and inlets along 1st Street should also be upgraded and connected to the L-Tunnel.

For improved maintenance, proposed pipes for the new L-Shaped Tunnel and laterals should be designed with gravity flow capacity for the design flood events and self-cleansing velocities for smaller storm events, wherever possible. Proposed drainage inlets should be designed with good access through grates or manhole tops into the 48” x 76” elliptical pipe trunk line which is proposed for approximately 0.1% running slopes, which is extremely flat.

Water Quality Benefits

This project will not directly provide any measurable quality benefit to stormwater, but proposed sumps at junction boxes will decrease the maintenance effort required for removing built up sediment from the storm drain system.

Right-of-Way Acquisition

The project is anticipated to be built entirely within city rights of way (city streets) except beyond the downstream pipe plug which will become privately maintained in this design approach. Exact pipe, inlet and junction box sizes and locations should be designed to keep the required sheeting and shoring and any utility adjustments or temporary measures within the existing right-of-way.

Project 02 - Shenandoah Avenue Diversion Tunnel

Summary

In this project, a diversion tunnel is proposed that will tie into the existing Trout Run Tunnel (54"x156" reinforced concrete box culvert) at node 104308 near the intersection of Shenandoah Avenue NW and Gainsboro Road NW, to divert runoff below Shenandoah Avenue to the N. Jefferson Street intersection in 931 LF of 6'H x 12'W reinforced concrete box culvert. The diversion tunnel will then tie into the 8'H x 10'W tunnel that was previously used by the Hotel Roanoke to provide pedestrian access downtown, below the Norfolk Southern railroad tracks. Improved maintenance access will be established into the existing pedestrian tunnel near the corner of Shenandoah Avenue and N. Jefferson Street. The existing pedestrian tunnel will then be connected to the existing 6'H x 12'W corrugated aluminum arch tunnel on Norfolk Avenue by extending the existing tunnel south to build a connection over the arch pipe in a junction box at node 203764 on the Norfolk Tunnel. Laterals along Shenandoah Avenue will be connected to the new tunnel with improved drainage inlets.

As a second part of this project, a new 20' x 16' junction box is planned over the Norfolk Tunnel in the alley behind Warehouse Row for improved access to the existing Norfolk Tunnel. The work will include removing accumulated sediment and debris from the tunnels in that area and plugging a broken weir wall that previously restricted runoff into the diagonal tunnel going towards Salem Avenue. The weir will be rebuilt with a removable plate to plug flow entirely so that the resulting plug is removeable or adjustable later should the tunnel systems show a negative result to the planned pipe plug on the diagonal tunnel. Preliminary PC-SWMM modeling shows the plug to work better than a modified weir wall at this time.

Project Costs

The project budget is estimated at $4.6M as detailed in the report appendices for cost estimating, and project funding is anticipated to be a combination of local stormwater utility funds for capital projects and VDOT revenue sharing funds using a 50/50 cost share during the engineering design and construction of this project.

Project Benefits

The primary benefit of this project is to divert flow from the Trout Run watershed away from the Norfolk Tunnel at the Warehouse Row diagonal tunnel, and convey runoff further downstream in the new tunnel before tying back into the Norfolk Tunnel at N. Jefferson Street. This lowers the hydraulic grade line (HGL) in the Norfolk Tunnel from node 203685 (underground vault behind warehouse row) to node 203764 (N Jefferson St), allowing for additional conveyance and storage capacity in the existing pipes. This project provides improved maintenance access into the Norfolk Tunnel at both the warehouse row diagonal tunnel and the new tunnel connection at N. Jefferson Street. It also includes good maintenance access into the Shenandoah Tunnel at both Centre Avenue (upstream end) and into the existing pedestrian tunnel at Shenandoah Avenue and N. Jefferson Street. Each of the four (4) maintenance access points for this project should provide improved natural light and ventilation from above, as well as a sediment trap in the bottom of the structure. In fact, the existing tunnel has a 2.0' sump in the bottom for this design since the

existing invert is lower than the tie-in elevation at the Norfolk Tunnel, which further enhances water quality benefits through sediment trapping capabilities, but requires a sump pump system to dewater the tunnel entirely.

Engineering

The total length of the new storm drain tunnel will be approximately 1,070 LF, including 931 LF of 6'H x 12'W reinforced concrete box culvert below Shenandoah Avenue, 135 LF of renovated 8'H x 10'W pedestrian tunnel, and 4 LF of proposed 8'H x 10'W box culvert to tie into the Norfolk Tunnel downstream. Average slope for the entirety of the 1,070 LF would be 0.22% based on the most upstream and downstream tie-in invert elevations.

The invert of the existing reinforced concrete box (RCB) for the Trout Run tunnel at the upstream tie-in location is approximately elevation 912.55' and the street elevation of Shenandoah Avenue is at 920.75' (8.20' depth). The tie-in requires the construction of a 20' x 16' cast in place junction box at the tie-in location near Gainsboro Road NW, such that storm drain inlets and laterals can also be connected to the new Shenandoah Avenue Tunnel. In particular, it is important that the 24" RCP (node 104308) be re-routed into the new junction box so that drainage from this intersection flows into the proposed Shenandoah Avenue Tunnel and is not directed towards the NS railroad tracks and the Warehouse Row diagonal tunnel. Further study of the existing storm drainage pipes under the NS railroad yard is recommended to properly size this flow split as part of the final engineering design. Also, further study and sizing of the repaired weir wall and pipe plug in the Junction Box behind warehouse row (node 203685) should be part of the final engineering design.

The downstream tie-in to the Norfolk Tunnel (6'H x 12'W corrugated aluminum arch) would be in the Norfolk Avenue / N. Jefferson Street intersection, extending the abandoned pedestrian tunnel under the NS railroad tracks. This tunnel is maintained by the Western Virginia Water Authority (WVWA) and houses a 16" WVWA water main. At the tie-in location, the invert of the existing pedestrian tunnel is 908.16' (node 203764) and the ground elevation is 920.50' (12.34' depth) based on an estimate of tie-in elevation at Station 9+50 in the 2014 tunnel profile drawings by Crouch Engineering[2]. A new 20'x20' cast in place junction box will need to be constructed to connect the existing pedestrian tunnel to the existing corrugated aluminum arch tunnel in Norfolk Avenue with temporary sheeting and shoring.

A sump pump will be needed to dewater the existing subway tunnel after each storm event and as a result of daily groundwater inflows, since the tunnel invert is flat level at its lowest point under the NS railroad tracks, and since it has an invert that is 2.0' lower than the Norfolk Tunnel at the connection point. Final design of the tunnel connection will include improved access at the north end, waterproofing, structural repairs, and any required protection measures for the 16" WVWA water main and other existing or planned infrastructure in close coordination with the WVWA who

[2] The invert elevation of 909.94' deviates by -0.5' from the invert elevation of 910.44' shown in a profile view of the pedestrian tunnel in the 1953 plans; this deviation may be attributable to the use of NGVD29 in the older plans, as NGVD29 elevations are between 0 and 8 inches higher than NAVD88 elevations in the Roanoke area (NOAA VERTCON). Surveying should be planned for final engineering design.

owns and maintains the tunnel. This includes noted locations to avoid water and sewer conflicts at utility crossing locations inside the existing tunnel and nearby the planned construction work for this project in Shenandoah Avenue NW and Norfolk Avenue NW.

Water Quality Benefits

This project will not directly provide a water quality benefit to stormwater, but proposed sumps at junction boxes and in the existing subway tunnel will decrease the maintenance effort required for removing built up sediment from the storm drain system at a location with improved access.

Right-of-Way Acquisition

The project is anticipated to be built entirely within city rights of way (city streets) except where it crosses under the NS railroad yard. It is important to note however that the NS property line on the south side of Shenandoah Avenue is at or near the eastbound edge of pavement, and the proposed tunnel is envisioned to shift towards the westbound edge or pavement as necessary to keep temporary sheeting and shoring within the right of way limits.

In order to coordinate the shared use of the existing pedestrian tunnel at N. Jefferson Street to convey stormwater runoff, an access agreement will need to be acquired from the WVWA outlining construction modifications to the tunnel and long-term maintenance responsibilities for each party. WVWA should be engaged early in the scoping process to determine if it is acceptable to convert this tunnel into a conveyance tunnel for flood mitigation needs downtown. Related coordination with Norfolk Southern may also be required.

Project 03 – CCBC Large Detention Basin

Summary

In this project, a 16-acre wet pond with a 4-acre constructed wetland forebay is proposed on the existing Coca-Cola Bottling Company (CCBC) parcel. Upper Trout Run will inflow from a proposed headwall at the existing Trout Run tunnel (54"x156" box culvert) near node 104308. This large detention basin will also receive runoff from a 66" RCP runoff diversion project in the NS railroad yard (see Project ID #14 for diversion pipe details). All totaled the project provides an estimated 154 acre-feet of detention storage for the design storm event (25-year, 24-hour) and also serves as a regional stormwater management facility (Wet Pond, Level 2) for Trout Run.

A 12' wide bench at approximately elevation 926.0' is proposed to accommodate a looped pedestrian path or greenway around the pond. Treated runoff will discharge near the southeastern corner of the wet pond, with a 40' long concrete weir (inlet box) at elevation 924.00' which is also the normal water elevation for the wet pond. The weir then discharges into a proposed 54"x156" box culvert for 145 LF before its eventual tie in with the existing 72"x156" box culvert at invert 913.62' (node 608274).

A 16-acre wet pond is envisioned with a loop trail and continued vehicular access along Shenandoah Avenue NW with approximately 4-acres residual lands adjacent to 5th Street NW unprogrammed for community input from the Gainsboro and Gilmer neighborhoods as to whether to enlarge the detention basin or provide other facility amenities related to the loop trails.

The constructed wetlands and sediment forebay concept shown in the northwest quadrant of the wet pond will be across the street from the future George Washington Carver Environmental Education Center and may be integrated into the same environmental education goals. Community input from the Gainsboro and Gilmer neighborhoods as to environmental education, and other facility amenities related to the loop trails could be beneficial to the multi-objective benefits of this project for the neighborhoods.

To maximize detention volume, this project includes a 530 linear foot retaining wall to create an overlook where existing Shenandoah Avenue NW runs along the edge of the wet pond down into the vicinity of the Shenandoah Tunnel Division, downstream. It also includes a Continuous Monitoring and Control (CMAC) system at the project outfall. Normal water in the pond is proposed at elevation 924.0' with the walking path 2' higher to provide recreational access and environmental learning opportunities close to the water, however that water elevation can then be lowered as much as 10.0' for increasing detention capacity during larger storm events. The CMAC system can also be used to lower the water level for wetland and shoreline maintenance needs.

Project Costs

The project budget is estimated at $38.4M as detailed in the report appendices for cost estimating, and project funding is anticipated to be a combination of local stormwater utility funds for capital projects and Virginia DEQ Stormwater Local Assistance Funds using a 50/50 cost share during the engineering design and construction of this project. Due to the larger project size, this project

might also need to explore funding through FEMA's Building Resilient Infrastructure and Communities (BRIC) or other alternative funding sources.

Project Benefits

The primary benefit of this project is to detain runoff from the Trout Run watershed in a large detention pond that will delay and offset peak flows from the Trout Run watershed. This will result in smaller pipe sizes becoming adequate downstream as peak flows in the upper watershed are delayed. This project also provides recreational amenities in a new "green" city space across the railroad yard from the Roanoke CBD. It includes considerations for future park amenities and tie-ins to the planned George Washington Carver Environmental Education Center. Not only would this pond provide substantial benefits to reduced flooding, but it also generates large water quality benefits for the otherwise, untreated runoff from the Upper Trout Run watershed.

Engineering

The total area of the new wet pond will be approximately 19.3 acres, including 3.3 acres of constructed wetlands at the upstream end of the pond. The constructed wetland is proposed from elevation 924.0' to 922.0', providing pre-treatment before the stormwater makes it into the wet pond at a normal water elevation of 924.0'.

Nearly 1 million square feet of asphalt saw cutting and removal is proposed to begin construction on the pond, not including the removal of numerous existing buildings and other infrastructure from the site. A large percentage of the project costs are in the demolition and site preparation to create a "green space" prior to building the wet pond.

The existing 54"x156" box culvert running under the existing CCBC facility will now outfall into the constructed wetland portion of the detention basin at elevation 923.0' (Node 104308). A 66" RCP diversion from the railroad is also proposed to outfall into the constructed wetland at elevation 924.0' (New Node). These pipes will drain through a combination of constructed wetlands and forebays to the open water for the pond. Normal water of the wet pond is at 924.0' with a 10.38' maximum depth controlled by an outlet structure that includes a 2' deep micro-pool and a Continuous Monitoring and Control (CMAC) system at the project outfall that will respond to weather conditions by advanced lowering of the wet pond's normal water elevation. The pond outfalls to a 40' long weir at elevation 924.0' discharging into a proposed 54"x96" box (145 L.F.) which then ties into the existing 72"x156" at an invert of 913.62 (Node 608274).

Water Quality Benefits

The proposed wet pond will provide the city with roughly 147 tons of sediment (TSS) reduction annually that can be trapped mostly in the pond forebay given frequent maintenance and removal activities. This will have related benefits for Total Phosphorus (TP) and Total Nitrogen (TN) reductions. The sediment reduction benefits will help decrease clogging in the storm drain network for the Roanoke CBD and then discharging downstream to Lick Run and the Roanoke River.

Property Acquisition

The project is anticipated to be built entirely within city rights of way (city streets) and the existing CCBC parcel. Recent tax assessments have the lot listed as worth $9.1 million, and $10 million was estimated for land costs associated with the future discussions about relocating the CCBC facility to the City Industrial Park. Costs for building a new CCBC facility are not itemized in the project costs, and further discussions with the property owner are recommended to ascertain the feasibility of this project plan.

Project 08 – Campbell Avenue Upper Watershed Improvements

Summary

In this project, “green streets” are proposed in this upper watershed neighborhood to detain runoff and then tie into an existing 36” RCP along Rorer Avenue SW (Node 201957). This includes a large detention basin (7.0 acre-feet) behind the old fire station at Rorer Avenue SW and 6th Street SW, and a smaller detention basin (2.6 acre-feet) at the intersection of Patterson Avenue NW and 8th Street SW. A combination of dry swales and piped runoff is shown near the intersection of Campbell Avenue SW and 10th Street SW, where an existing 48” RCP drains into a 15” RCP creating an underground detention basin in the 48” RCP, and the combination of “Green Streets” from 10th Street SW to 6th Street SW includes permeable pavement, curb extensions with bioretention, and street trees with check dams under the pavement to help facilitate a terraced detention system. The sum total of detention storage required for this project to reduce peak discharges is 14.1 acre-feet.

Project Costs

The project budget is estimated at $9.5M as detailed in the report appendices for cost estimating, and project funding is anticipated to be a combination of local stormwater utility funds for capital projects and Virginia DEQ Stormwater Local Assistance Funds using a 50/50 cost share during the engineering design and construction of this project.

Project Benefits

The primary benefit of this project is to detain peak discharges from the upper watershed for Campbell Avenue, thereby reducing peak discharges in the Roanoke CBD downstream. This project also provides substantial water quality and runoff reduction benefits as a demonstration project for Green Streets in the City of Roanoke, and it can be integrated into planned corridor enhancements for this neighborhood plan.

Engineering Discussion

The existing 48” RCP along 10th Street SW discharges into a 15” RCP that restricts runoff draining into roadside ditches. This detention in oversized pipes along the west side of 10th Street SW will be tied into a new 48” outlet pipe at Node 201948 which conveys runoff into dry swales on the east side of 10th Street SW. Excess runoff will be conveyed through a smaller diameter outlet pipe (18” RCP shown) to the detention basin at Patterson Avenue NW and 8th Street SW.

The detention basin at Patterson Avenue NW and 8th Street SW provides detention storage from 966.0’ to 970.0’ (4’ deep). It is contained on the back side by a 965 linear foot (L.F.) retaining wall ranging from 982’ to 966’ in elevation. In order to achieve the desired footprint for this basin the building at 801 Campbell Ave would also need to be removed. A 117 L.F. sidewalk with steps is shown along the western side of the basin to provide pedestrian connectivity from Campbell Avenue SW to Patterson Avenue SW. This upper basin provides 2.6-acre-foot detention storage.

The detention basin behind the old fire station at Rorer Avenue SW and 6th Street SW provides storage from 958.0’ to 951.0’ (7’ deep). It receives flow from a proposed 24” RCP (183 L.F.) in

the alley at invert 955.0' and includes a 1,029 linear foot (L.F.) retaining wall ranging from 976' to 951' in elevation. In order to achieve the desired footprint for this basin the building at 624 Rorer Ave would also need to be removed. This detention basin has a stormwater outlet structure with an invert at 951.0' tying into a nearby inlet at invert 950.77' (Node 107109) that creates a backwater into the rest of the green streets detention system with check dams used at different terraces in the subgrade elevations, generally estimated at a 4' depth of detention storage for each terrace. This lower basin provides 7.0-acre-foot detention storage.

The permeable pavement along Patterson Avenue SW, Campbell Avenue SW, and interconnecting streets account for 4.0 acre-feet of detention by using a series of check dams to keep water in 48" "reservoirs". This includes open graded reservoir stone under permeable wearing surfaces and bioretention media and stone layers in landscaped areas. Street trees will also be used in the Green Streets to intercept more runoff and uptake more runoff from the underlying soils to further enhance runoff reduction benefits of this project. A void ratio of 40% for the open graded stone, and an area ratio of 75% for the percentage of right of way using permeable pavement were used in the detention volume calculations.

For maintenance requirements, all pipes and laterals should be designed with gravity flow capacity for the design flood events and with self-cleansing velocities in the pipes for smaller storm events. Inlets should be designed with good access through grates or manhole tops. Also, the detention volume will be visible within the two basins and the dry swale for larger storm events allowing open access to the community in seeing the rapid rise and fall of the detained runoff as it infiltrates into the ground below. Grading of these open basins will also accommodate locations for oNStreet educational displays for this pilot project at three locations: (1) Intersection of Campbell Avenue SW and 10th Street SW; (1) intersection of Patterson Avenue SW and 8th Street SW looking south, and (3) at the old fire station on Rorer Avenue SW or 6th Street SW.

Water Quality Benefits

The combination of permeable pavers, bioretention, dry swales, and detention ponds will provide the city with roughly 30 tons of sediment (TSS) removal annually, with related benefits for Total Phosphorus (TP) and Total Nitrogen (TN) reductions. This will help reduce the likelihood of clogging in the existing storm drain network downstream.

Property Acquisition

The project calls for the removal of two existing buildings in order to build detention basins. 801 Campbell Ave had its most recent assessment come in at $215k; and 624 Rorer Ave came in at $259k.

Project 10 – Luck Avenue Upper Watershed Improvements

Summary

In this project, detention of stormwater runoff is proposed in three locations identified as flood prone areas within the upper watershed for Luck Avenue. This includes detention (5.6 acre-feet) centered on the city parking lot across the street from the YMCA and along 5th Street between Luck Avenue and Marshall Avenue, where detention is provided by permeable pavement with a series of concrete vaults underneath. It also includes detention in two private parking lots and 2nd Street, centered on Luck Avenue, where detention (13.25 acre-feet) is provided by permeable pavement with a series of concrete vaults underneath. It also includes detention near Elmwood Park on S. Jefferson Street, where storage is provided by underground vaults and by converting a turf grass plaza into a combination of bioretention basin and pervious concrete sidewalks (4.07 acre-feet). In each case, the permeable surfaces will help address flat terrain and standing water issues, with the underlying vaults sized to reduce peak discharges for the larger design storm events being considered by this flood mitigation study. The sum total of detention storage required for this project to reduce peak discharges is 22.67 acre-feet.

Project Costs

The project budget is estimated at $20.1M as detailed in the report appendices for cost estimating, and project funding is anticipated to be a combination of local stormwater utility funds for capital projects and Virginia DEQ Stormwater Local Assistance Funds using a 50/50 cost share during the engineering design and construction of this project.

Project Benefits

The primary benefit of this project is to detain peak discharges from the upper watershed for Luck Avenue, thereby reducing peak discharges in the Roanoke CBD downstream. This project also provides water quality and runoff reduction benefits through the use of permeable pavement and bioretention areas for treating local runoff.

Engineering Discussion

The existing 48” RCP along 10th Street SW discharges into a 15” RCP that restricts runoff draining into roadside ditches. This detention in oversized pipes along the west side of 10th Street SW will be tied into a new 48” outlet pipe at Node 201948 which conveys runoff into dry swales on the east side of 10th Street SW. Excess runoff will be conveyed through a smaller diameter outlet pipe (18” RCP shown) to the detention basin at Patterson Avenue NW and 8th Street SW.

The detention basin (5.6 acre-feet) across the street from the YMCA and along 5th Street between Luck Avenue and Marshall Avenue provides detention storage from 950.1’ to 962.1’ (12’ depth maximum) with control weirs between the three vaults to allow them to fill entirely during the design storm event. Permeable pavement will drain into the vaults having a filtering affect but minimal runoff reduction benefits. The system drains to Project Outfall #1 on Luck Avenue (Node 201490) at an existing 24” RCP.

The detention basin in two private parking lots and 2nd Street, centered on Luck Avenue (provides detention storage (13.25 acre-feet) from 926.0' to 934.0' (8' depth) in the vaults with 12: reservoir stone above the vaults allowing the permeable pavement to drain into the vaults below, having a filtering affect but minimal runoff reduction benefits. The system drains to Project Outfall #2 on Luck Avenue (Node 201875) at an existing 42" RCP.

The detention basin (4.07 acre-feet) near Elmwood Park on S. Jefferson Street provides detention storage from 938.0' to 948.0' (10' depth maximum) with a control weir between the two vaults to allow them to fill entirely during the design storm event. Bioretention and pervious concrete in the renovated plaza will drain into the vaults having a filtering affect but minimal runoff reduction benefits. The system drains to Project Outfall #3 on S. Jefferson Street (Node 201369) at an existing 15" RCP.

The combined benefits of all three detention systems is fully realized at the downstream confluence in the existing storm drain system, which is at the intersection of Luck Avenue and S. Jefferson Street where there is an existing 60" RCP, draining east towards Church Avenue, Williamson Road and then the Campbell Tunnel.

For maintenance requirements, all permeable pavement and bioretention areas should be kept clear and free draining, and the vaults routinely inspected with sediment removed and weirs cleared of any debris or clogging.

Water Quality Benefits

The combination of permeable pavers, bioretention, and underground detention ponds will provide the city with reduced benefits related to sediment (TSS), Total Phosphorus (TP) and Total Nitrogen (TN) reductions since runoff reduction by infiltration is not part of this proposed solution. Partial crediting of water quality benefits for these BMP's can be anticipated as the details of the design layout are further evaluated.

Property Acquisition

The project calls for the deployment of permeable pavement on city streets and several parking lots, including two privately owned parking lots. While the stormwater management benefits and new permeable pavement wearing surfaces will substantially improve these private parking lots, the city might prefer to own and operate the lots themselves. A budget of $1.4 million was established for land costs associated with private parking lots involved in this flood mitigation solution based on current assessed values, for further consideration.

Project 13 – Maintenance Access Upgrades

Summary

In this project, nine (9) new junction boxes are proposed to provide the city with better access to the existing tunnels for inspections and maintenance work. These junction boxes range in size from 8'x8' to 20'x20', and are proposed within city rights-of-way, where they were positioned initially to minimize potential utility conflicts. In some cases, associated traffic impacts might require the junction boxes to be offset into sidewalk areas, side streets or on-street parking spaces to allow to the city to best maintain traffic during construction.

Project Costs

The project budget is estimated at $4.2M which is an average of $420,000 per junction box, as detailed in the report appendices for cost estimating, and project funding is anticipated to be a combination of local stormwater utility funds for capital projects and VDOT revenue sharing funds using a 50/50 cost share during the engineering design and construction of this project. Some of these junction boxes are double counted as part of projects #1 and #2 above, to be built with whichever project comes first.

Project Benefits

The primary benefit of this project is to provide the city safer and easier access into their existing stormwater system. Each feasible location for an oversized junction box can provide safety slabs, steps or ladders, DI-7 double grates for natural light and ventilation above, a place to reinstall flow sensors, and possibly a sump to trap sediment and debris in a floor depression, making it more easily removable at improved access locations from the street above.

Engineering Discussion

Proposed junction boxes 1-3 will provide the city improved access into the Norfolk Tunnel, with Junction Boxes #1 and #2 also included as part of the Shenandoah Avenue Diversion Tunnel. Junction Box #4 is at the upstream end of the Salem & 1st Street "L-Tunnel" with Junction Box #5 at the downstream end of the project in Campbell Avenue. Junction Boxes 5-7 provide access to the Campbell Avenue Tunnel. Junction Boxes 8 and 9 will provide improved access to the Luck Avenue Storm Drain System, with Junction Box #8 also included in the Luck Avenue Upper Watershed Improvements Project at the downstream outfall from Detention #2. Lastly, Junction Box #10 provides access to the 42" and 48" pipes running along Williamson Road in the lower section of the Luck Avenue Storm Drain Outfall.

Water Quality Benefits

This project will not provide a direct water quality benefit to stormwater, but proposed sumps at the junction boxes will help collect sediment and debris in a location that reduces the maintenance effort required for accessing and removing these materials from the storm drain system, making it visible from above for frequent inspections of debris accumulation through double DI-7 type grates in the city streets above.

Right-of-Way Acquisition

The project is anticipated to be built entirely within city rights of way (city streets).

Project 14 – Norfolk Southern (NS) Railroad Yard Diversion

Summary

In this project, two sediment basins are proposed to be constructed on the NS railroad property to help collect runoff from the surrounding tracks in the railroad yard. These two basins will act as a sediment trap, as well as a catchment to direct runoff into a proposed 66" RCP trunk line running along the railroad right-of-way from 10th Street to 5th Street, and then up along 5th Street heading north towards the large CCBC detention basin (Project #3). Several DI-7 type grate inlets are proposed at low points in this section of the railroad yard with small diameter pipe laterals to help collect runoff that would otherwise drain directly to the Norfolk Tunnel downstream, entering the tunnel through drainage inlets in the loading dock area behind the Transportation Museum.

Project Costs

The project budget is estimated at $4.3M as detailed in the report appendices for cost estimating, and project funding is anticipated to be a combination of local stormwater utility funds for capital projects and by private agreement with the railroad for managing stormwater runoff in their railroad yard. Discussions with Norfolk Southern are recommended to consider the project benefits and costs, relative to an estimated 100-acres of railroad yard, tracks, and adjacent railroad properties in this area, draining to the Roanoke CBD.

Project Benefits

The primary benefit of this project is to divert flow from the railroad yard to the CCBC detention basin. The sediment traps in the railroad yard at the upstream end of the pipe diversion will help reduce downstream maintenance needs in the 66" RCP and the CCBC detention basin from the railroad runoff.

Engineering Discussion

The two sediment basins at the upstream end of the pipe diversion can detain an estimated 4.6 acre-feet of stormwater runoff at the peak stage. The upper basin includes cut excavation from 970' down to 962' (8' maximum depth) with a 24" RCP (361 L.F.) equalizer pipe shown between the two basins from 962.0' to 954.0' depending on the location, size and condition of existing culverts already in place under these tracks. The lower basin includes cut excavation from 964' down to 952' (12' maximum depth) with a basin outlet to the 66" diversion pipe to detain runoff. Both basins are anticipated to drain dry within 24-hours at full capacity.

The 66" diversion pipe was sized for no attenuation of peak discharges from the 4.6-acre-foot detention basins. It provides a 0.87% slope average through the system, with an upstream invert of 952.0' and a downstream invert (at the CCBC detention basin) of 923.0' and an overall length of 3,342 linear feet (L.F.). The diversion pipe includes an access manhole at the southern end of 8th Street for inspections and maintenance, and another manhole near 5th Street. The alignment along 5th Street was offset roughly 50' to the east in order to reduce the amount of cut excavation required to set the pipe. This also reduces the amount of bends in the pipe lateral behind the transportation museum yard, resulting in a more optimal conveyance of stormwater in that area.

This project will result in roughly 144 acres of runoff (a majority of which is coming from NS properties) being diverted away from the Norfolk Tunnel (6'x12') behind the transportation museum, and being added to the water quality treatment benefits of the CCBD detention basin solution (Project #3). Alternatively, this pipe diversion could continue east along Shenandoah Avenue tying to the Shenandoah Tunnel Diversion directly should the CCBC detention basin solution be delayed or eliminated from the flood mitigation plan.

At an average running slope of 0.87% in the 66" RCP, the diversion pipe has adequate gravity flow capacity for larger storm events with self-cleansing velocities anticipated in the pipes for reduced maintenance concerns. Inlets and pipe laterals should also be designed with good access through grates or manhole tops and running slopes with pipe crowns matched where possible to reduce surcharging in the smaller pipes.

Water Quality Benefits
The proposed sediment traps will act as pre-treatment for the planned CCBC detention basin downstream and will help remove sediment (TSS) with proper maintenance but their small size relative to the watershed will reduce pollutant removal efficiency.

Right-of-Way Acquisition
The project is anticipated to be built nearly entirely within the NS railroad's right of way by agreement with the City. Exact pipe, inlet and basin sizes should be designed to minimize track removals and changes, temporary sheeting, and shoring, and required utility adjustments within the existing NS right-of-way. Land costs are not included in the current estimate.

CHAPTER 4 – CONCLUSIONS

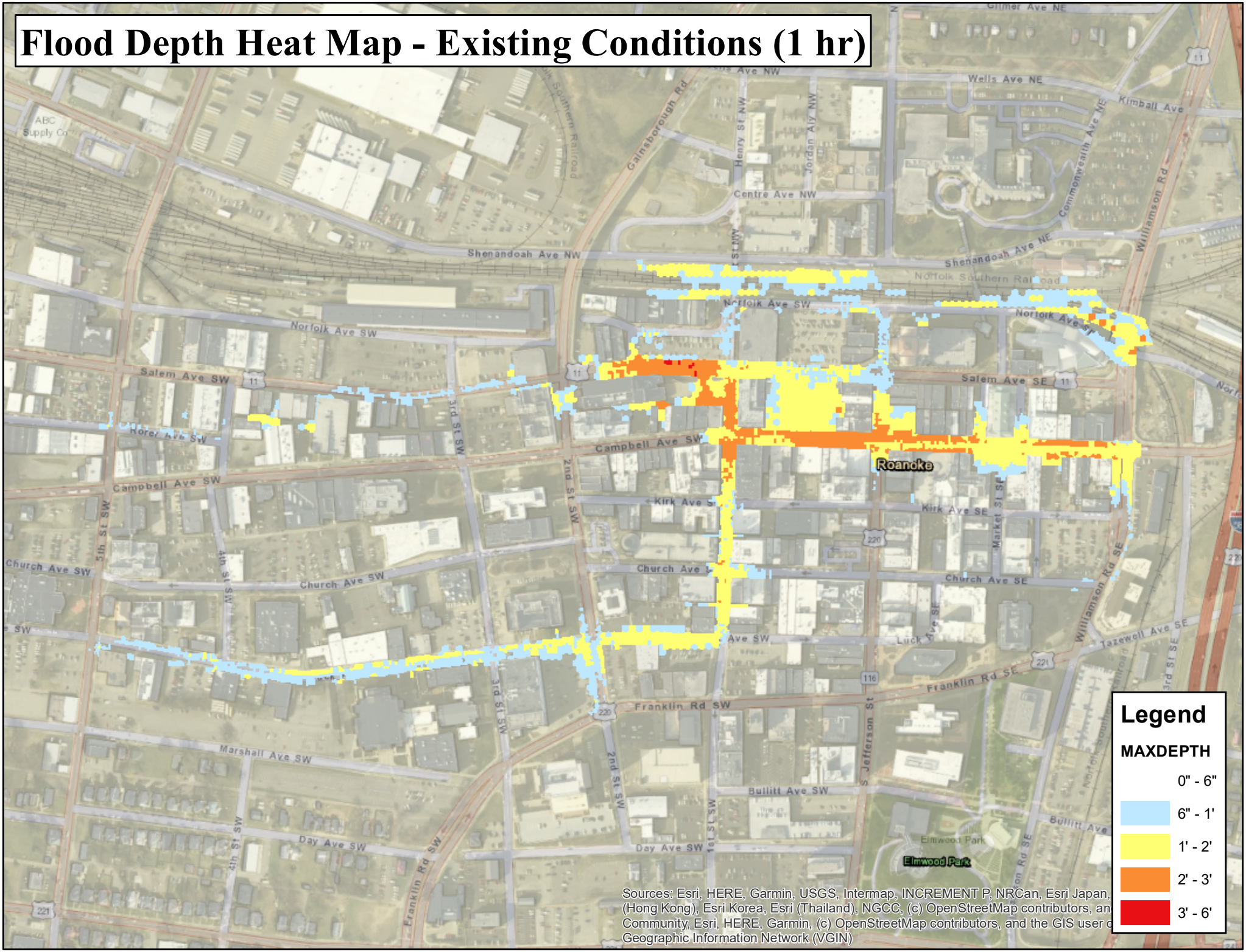
The six (6) flood mitigation projects described in Chapter 3 work in combination to reduce or eliminate flooding for the 25-Year design event in locations as described in this study, using both a 1-hour and 24-hour storm duration to evaluate project benefits. Heat maps showing existing and proposed conditions for both 25-Year design storm events are shown on the pages that follow. This will not entirely eliminate flooding for larger storm events, beyond the intensity and size established as the basis for these recommendations. Also, changing weather patterns and unknown magnitudes of future weather events, make it important to understand that this plan reduces but does not eliminate flood risk for the largest storm events.

The estimated cost for implementing this flood mitigation plan is **$81.9 million dollars** as presented in the cost estimates provided in the report appendices, and these projects will require additional funding beyond that amount for the long-term maintenance and operation of the improved and expanded storm drainage system for the Roanoke CBD. Required funding makes this multi-generational plan something to utilize and adopt over an anticipated 20-year life span with significant community outreach and support required.

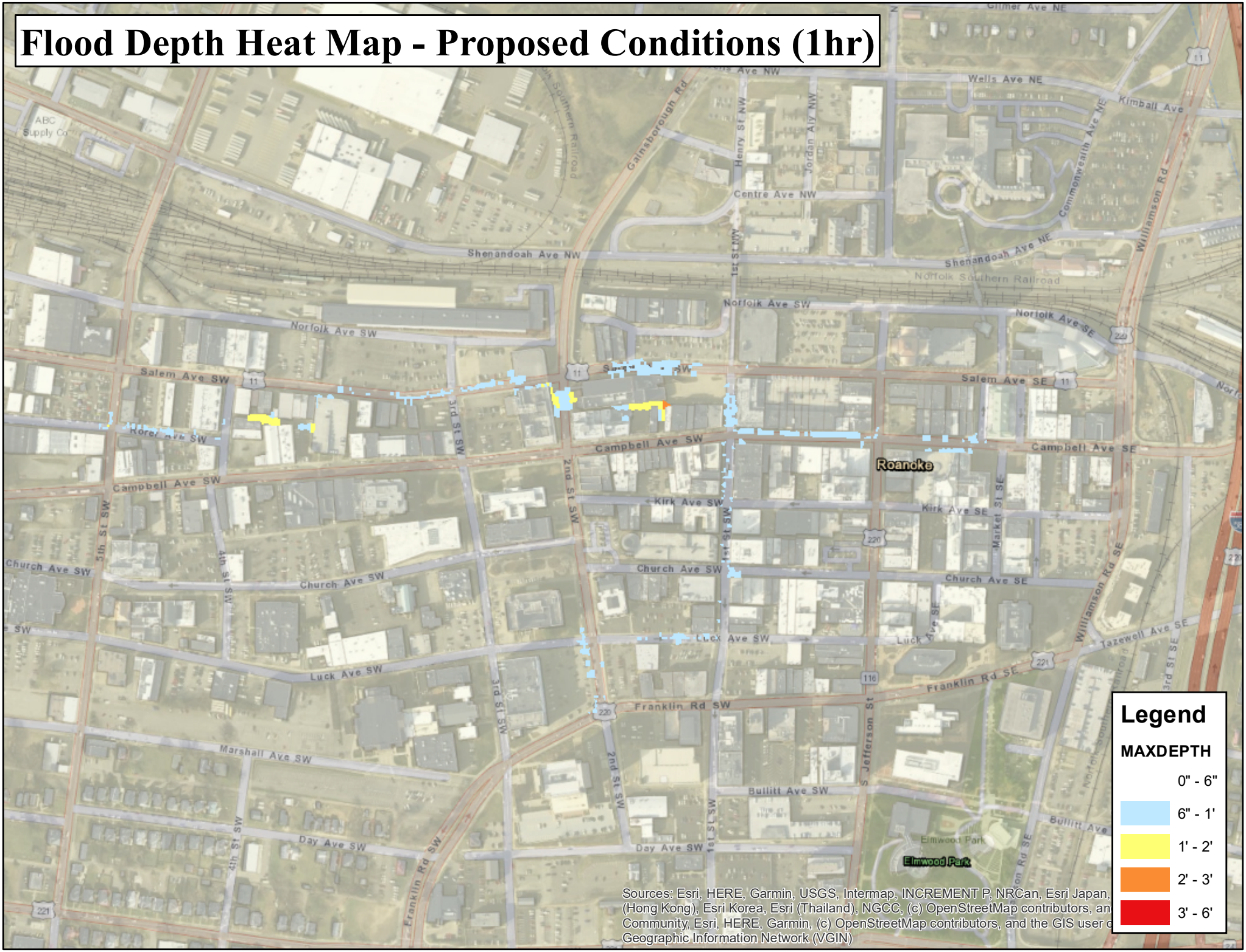
Funding will be very difficult for a plan of this magnitude, and it is anticipated to be pursued primarily through a combination of local stormwater utility funds for capital projects, Virginia DEQ Stormwater Local Assistance Funds, VDOT Revenue Sharing Funds, and FEMA Flood Mitigation Assistance (FMA) funds including Building Resilient Infrastructure and Communities (BRIC) and other federal funding opportunities.

Partnerships are also necessary with impacted business owners and partners for this flood mitigation effort to be successful, most notably with the Norfolk Southern Railroad Company, the Western Virginia Water Authority, the Coca-Cola Bottling Company, and directly impacted buildings and parking lots as shown on the concept plans.

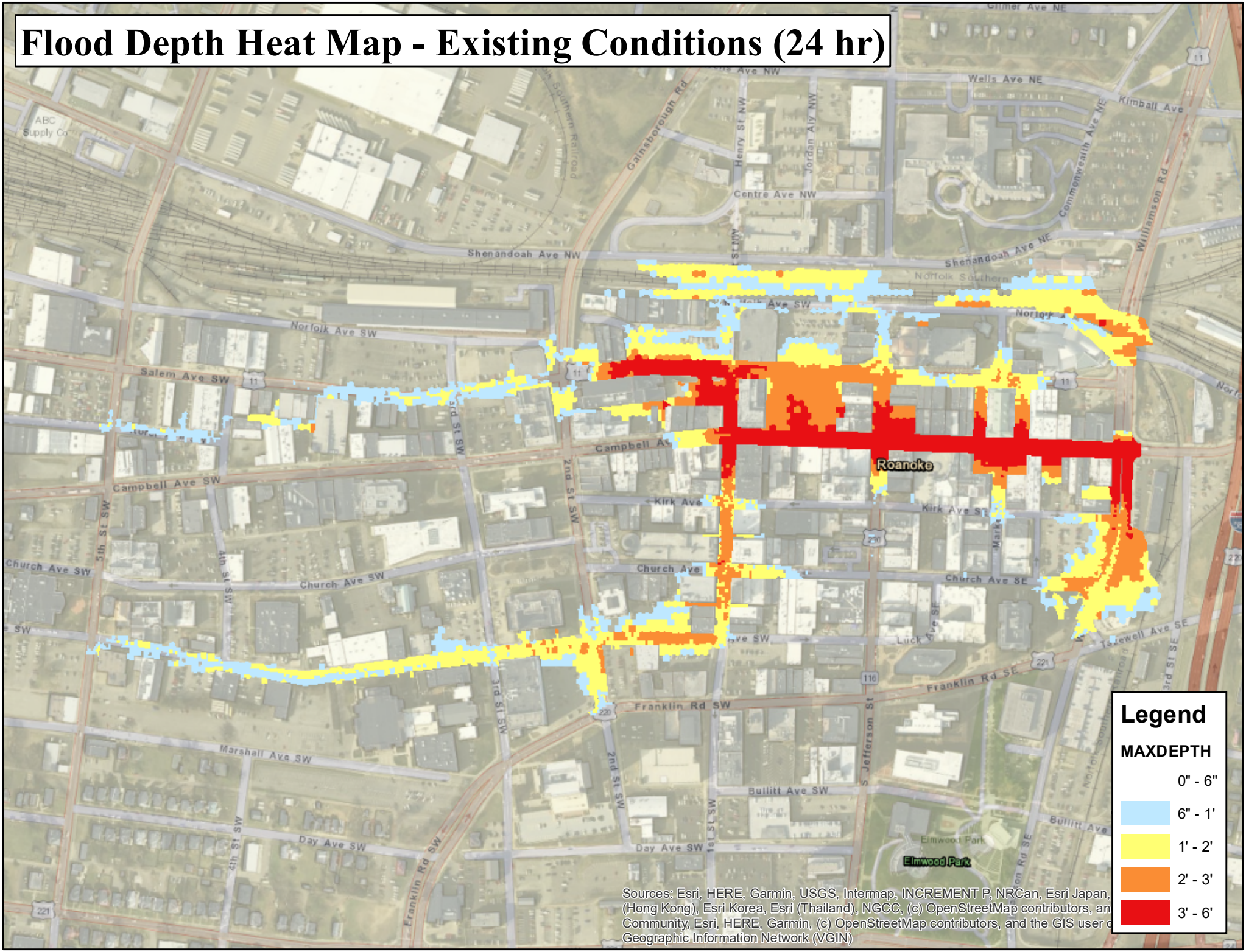
Flood Depth Heat Map - Existing Conditions (1 hr)



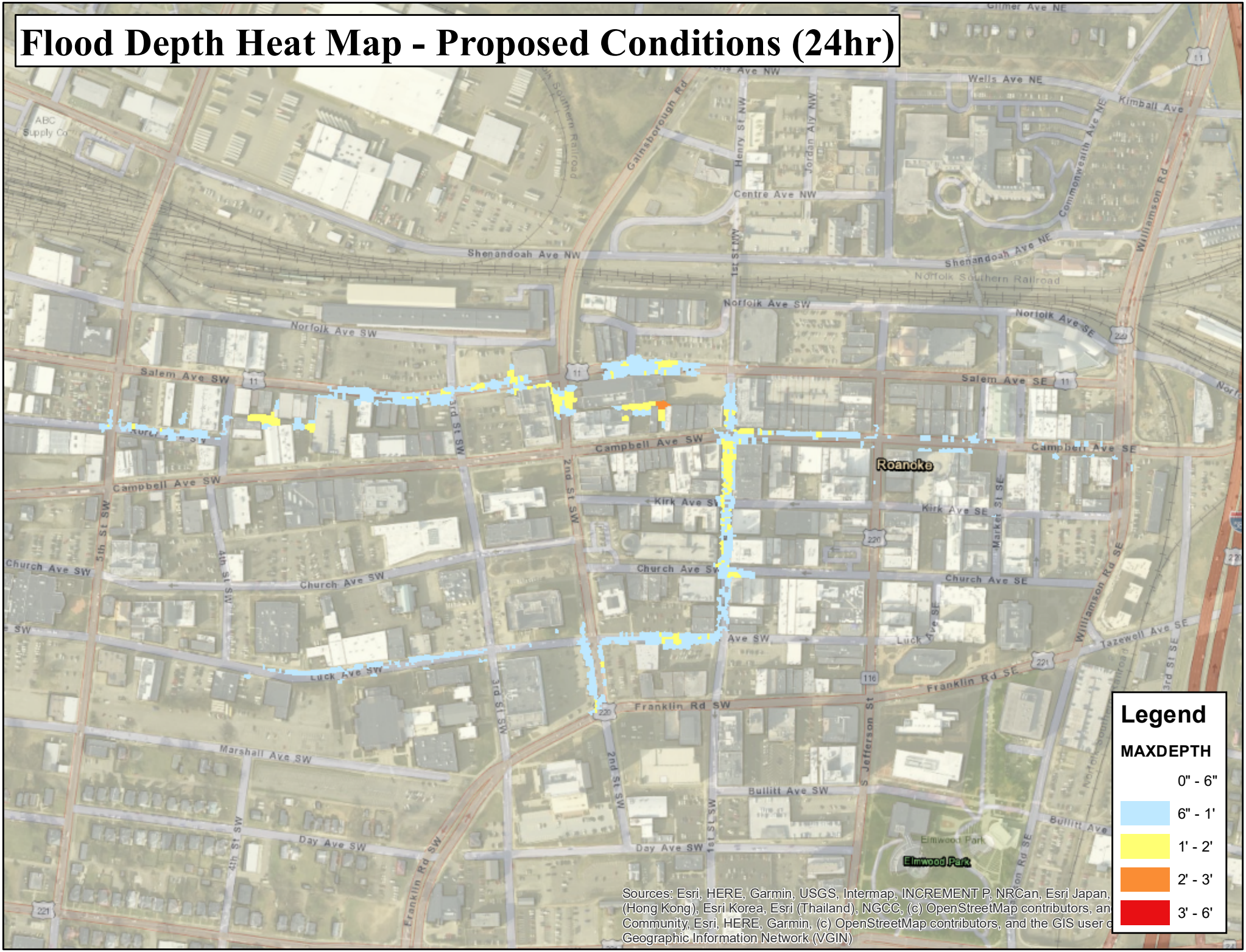
Flood Depth Heat Map - Proposed Conditions (1hr)



Flood Depth Heat Map - Existing Conditions (24 hr)



Flood Depth Heat Map - Proposed Conditions (24hr)



City of Roanoke - Downtown Flood Mitigation Study
Summary of Preliminary Cost Estimates

ID	Project Name	Cost	Project Description
1	Salem Avenue & 1st Street "L-Tunnel"	$1,400,000	This is a proposed, L-Shaped 60" RCP (48"x76" elliptical equivalent) diverts runoff away from the diagonal pipe that may be plugged and abandoned as part of a future private development project. We plan to include large junction boxes at both ends for improved access.
2	Shenandoah Avenue Diversion Tunnel	$4,500,000	This is a proposed, L-Shaped box culvert that uses an abandoned subway tunnel under the N-S railroad tracks to reduce costs. Preliminary SWMM modeling shows that a pipe plug in the junction box at Warehouse road would also be beneficial to diverting flow away from Salem and Campbell Avenue with this project.
3	CCBC Large Detention Basin	$38,400,000	This is envisioned as a 20-acre lake (wet pond) with 154 acre-feet of detention storage with a perimeter trail, linear park or greenway around it. The exact size and depth will be optimized through SWMM modeling and combined with a CMAC system (ID #5) to lower the lake level for larger storm events. This project will provide substantial water quality and recreational benefits to the City, but the CCBC facility will need to be relocated to the city's industrial park. Might be called the new "Roanoke Unity Park" and tied to the future George Washington Carver Environmental Education Center across the street.
4	CCBC Small Detention Basin		This is envisioned as a reduced pond size that alows CCBC to stay in it's current location, and could require underground detention or permeable pavement as part of therequired storage volume . It only works offiline in preliminary SWMM modeling, meaning a portion of the Trout Run Watershed would continue to flow downstream, untreated. It also means other projects like the Shenandoah Tunnel might need to be larger, to make this work hydraulically.
5	Continuous Monitoring and Control (CMAC) System		This is not likely to remain a separate project, but will be used in combination with the CCBC wet pond for advanced lowering of the new lake to maximize flood detention capacity prior to a larger storm event such as the 25-year, 24-hour design storm.
6	Transportation Museum Diversion		Preliminary SWMM modeling shows this increases flooding to Trout Run, so we would need to use this type of diversion in combination with the CCBC pond and/or the Shenandoah Tunnel. Need to figure out which combination works best, if any. Also, this wouldn't be needed if we do the N-S detention basins.
7	Campbell Avenue Storm Drain Extension		Preliminary SWMM modeling shows that this pipe extension would increase flooding in the Campbell Tunnel so it might be necessary to also enlarge the existing Cambell Tunnel as far east as Williamson Road. MIght be able to incporate detention into the parking lots near the Transportation Mueseum. Need to map the watershed and see what works best in comparison to previously planned CIP projects nein this neighborhood as part of the overall flood miitgation plan.
8	Campbell Avenue Upper Watershed Improvements	$9,500,000	This is a Green Street Pilot Project that re-imagines three (3) detention basins that were previously planned and an additional, larger detention basin behind Twists & Turns as necessary, along with green streets and green alleys for a combination of 14 acre-feet of detention storage that reduces peak discharges for the 25-year storm to fit within the existing 36" RCP just downstream. This will also have significant environmental benefits.
9	Luck / Church Avenue Storm Drain		Preliminary SWMM modeling shows that plugging flow to Campbell causes increased flooding on Luck / Church so this might not work. Need to review the Lumsden Study posted by Marcus and possibly talk to Luke Pugh to be sure we are modeling this correctly, before drawing any final conclusions.
10	Luck Avenue Upper Watershed Improvements	$20,100,000	Combine detention storage in three locations in the Luck Avenue Upper Watershed with long standing drainage concerns, through a combiation of underground vaults, permeable pavement and a bioretention area near Elmwood Park.
11	Trout Run Watershed Improvements		This project would require a high level of particpation in the contributing watershed of Upper Trout Run, and it is unlikely to result in the required detention volume to miigate flooding in the Roanoke CBD downstream. Enouraging LID in the watershed is still possible for pre-treatment and water quality benefits to the planned CCBC regoinal detention basin.
12	Downtown Parking Lot Detention Regulations		Preliminary SWMM results have shown that a decentralized plan to require 25/10 detention in parking lots downtown may have a negative affect on the time to peak, potentially increasing flood potential by delaying/detaining downtown runoff until the upper watershed peak becomes more conincidental.
13	Maintenance Access Upgrades	$3,700,000	There is a need for improved access to the downtown tunnels for long-term inspections and maintenance needs. We might also retrofit sediment traps at the improved access points for easier sediment removal and could install steps in some of the manholes at other locations as secondary access points. Up to ten (10) primary access locations are recommended for further consideration in this study.
14	N-S Railroad Yard Diversion	$4,300,000	To help address untreated stormwater runoff from the railroad yard (which constitutes 10% (or 144 acres) of the total watershed area) sediment forebays are planned on railroad lands near the 10th Street Bridge, diverted to the CCBC Detention Basin or the Shenandoah Tunnel in a 66" RCP. This provides primarily flood control benefits but could be eligible for a SWU fee reduction through a partnership with Norfolk Southern (N-S) on project costs.
15	Luck / Church Avenue Storm Drain Replacement		Preliminary investigations show that larger pipes could cause flooding to increase in the Campbell Tunnel, downstream, and therefore Project ID#10 is preferred.
	Recommended Budget for Flood Mitigation Plan =	**$81,900,000**	

1. SALEM AVENUE & 1ST STREET "L-TUNNEL"

CONCEPTUAL COST ESTIMATE

8-Dec-20

ITEM NO.	DESCRIPTION	UNIT PRICE	QUANTITY	UNIT	COST
	SOFT COSTS				
1	Surveying & SUE Services	$25,000.00	1	LS	$25,000.00
2	Engineering Design & Permitting	$50,000.00	1	LS	$50,000.00
3	Construction Engineering and Inspection	$35,000.00	1	LS	$35,000.00
	SUBTOTAL =				**$110,000.00**
	GENERAL CONDITIONS				
4	Mobilization & Temporary Facilities	$50,000.00	1	LS	$50,000.00
5	Bonds, Taxes, Permits, and Insurance	$20,000.00	1	LS	$20,000.00
6	Traffic Control Measures / TMP	$100,000.00	1	LS	$100,000.00
	SUBTOTAL =				**$170,000.00**
	DEMOLTION & SITE PREPARATION				
7	Erosion and Sediment Control (ESC)	$25,000.00	1	LS	$25,000.00
8	Removal of Pipe and Structures / Plugs	$50,000.00	1	LS	$50,000.00
9	Asphalt Sawcut / Removal / Disposal	$35.00	500	SY	$17,500.00
10	Excavation / Grading / Disposal	$35.00	1,500	CY	$52,500.00
	SUBTOTAL =				**$145,000.00**
	STORMWATER INFRASTRUCTURE				
11	Large Manhole (VDOT Std.)	$10,000.00	3	EA	$30,000.00
12	JB-1 Junction Box (VDOT Std.)	$50,000.00	1	EA	$50,000.00
13	Special Design Junction Box w/ Sump	$100,000.00	1	LS	$100,000.00
14	76" x 48" Elliptical Storm Drain Pipe	$500.00	137	LF	$68,500.00
15	60" RCP Storm Drain Pipe	$350.00	206	LF	$72,100.00
16	Storm Drain Laterals (30" to 42" Size)	$200.00	40	LF	$8,000.00
17	Storm Drain Laterals (12" to 24" Size)	$100.00	80	LF	$8,000.00
	SUBTOTAL =				**$336,600.00**
	SITE IMPROVEMENTS				
18	ROW Asphalt Replacement	$100.00	500	SY	$50,000.00
19	Utility Relocation Budget	$80,000.00	1	LS	$80,000.00
20	Pavement Markings / Misc. Restoration	$40,000.00	1	LS	$40,000.00
	SUBTOTAL =				**$170,000.00**
	TOTAL ESTIMATED COST =				**$1,041,600**
	CONTINGENCY = 30%				$312,480
	PRELIMINARY BUDGET =				**$1,400,000**

Cost Estimate Notes:

1) Surveying, SUE designation & Test Pits are recommended to minimize utility conflicts
2) Eight (8) possible locations of water main conflicts are shown on the concept plan
3) Two (2) oversized junction boxes are shown on the plans
4) No Right of Way Acquisition is anticipated for this project
5) Present Value O&M Costs are not included

2. SHENANDOAH AVENUE DIVERSION TUNNEL

CONCEPTUAL COST ESTIMATE

8-Dec-20

ITEM NO.	DESCRIPTION	UNIT PRICE	QUANTITY	UNIT	COST
	SOFT COSTS				
1	Surveying & SUE Services	$40,000.00	1	LS	$40,000.00
2	Engineering Design & Permitting	$180,000.00	1	LS	$180,000.00
3	Construction Engineering and Inspection	$100,000.00	1	LS	$100,000.00
	SUBTOTAL =				**$320,000.00**
	GENERAL CONDITIONS				
4	Mobilization & Temporary Facilities	$200,000.00	1	LS	$200,000.00
5	Bonds, Taxes, Permits, and Insurance	$100,000.00	1	LS	$100,000.00
6	Traffic Control Measures / TMP	$100,000.00	1	LS	$100,000.00
	SUBTOTAL =				**$400,000.00**
	DEMOLTION & SITE PREPARATION				
7	Erosion and Sediment Control (ESC)	$50,000.00	1	LS	$50,000.00
8	Sheeting & Shoring (Norfolk Ave.)	$100,000.00	1	LS	$100,000.00
9	Sheeting & Shoring (Shenandoah Ave.)	$100,000.00	1	LS	$100,000.00
10	Removal of Pipe and Structures / Plugs	$100,000.00	1	LS	$100,000.00
11	Asphalt Sawcut / Removal / Disposal	$35.00	1,736	SY	$60,760.00
12	Excavation / Grading / Disposal of Excess	$35.00	6,000	CY	$210,000.00
	SUBTOTAL =				**$620,760.00**
	STORMWATER INFRASTRUCTURE				
13	Manhole / Inlet (VDOT Std.)	$8,000.00	1	EA	$8,000.00
14	JB-1 Junction Box (VDOT Std.)	$50,000.00	2	EA	$100,000.00
15	Special Design Junction Box w/ Sump Pump	$150,000.00	2	LS	$300,000.00
16	12'x6' Box Culvert	$900.00	931	LF	$837,900.00
17	10'X8' Box Culvert	$1,000.00	4	LF	$4,000.00
18	Storm Drain Laterals (12" to 24" Size)	$100.00	40	LF	$4,000.00
	SUBTOTAL =				**$1,253,900.00**
	SITE IMPROVEMENTS				
19	ROW Asphalt Replacement	$100.00	1,736	SY	$173,600.00
20	Sidewalk / Curb Ramp Replacement	$80.00	70	SY	$5,600.00
21	Curb and Gutter / Curb Replacement	$50.00	20	LF	$1,000.00
22	Utility Relocation Budget	$200,000.00	1	LS	$200,000.00
23	Pavement Markings / Misc. Restoration	$150,000.00	1	LS	$150,000.00
	SUBTOTAL =				**$530,200.00**
	TOTAL ESTIMATED COST =				**$3,444,860**
	CONTINGENCY = 30%				$1,033,458
	PRELIMINARY BUDGET =				**$4,500,000**

Cost Estimate Notes:

1) Surveying, SUE designation & Test Pits are recommended to minimize utility conflicts
2) Two (2) possible locations of water and sewer main conflicts are shown on the concept plan
3) Two (2) oversized junction boxes are shown on the plans
4) WVWA Permission will be required to use subway tunnels for drainage (they fill with water)
5) Present Value O&M Costs are not included

3. CCBC LARGE DETENTION BASIN

CONCEPTUAL COST ESTIMATE

8-Dec-20

ITEM NO.	DESCRIPTION	UNIT PRICE	QUANTITY	UNIT	COST
	SOFT COSTS				
1	Surveying & SUE Services	$50,000.00	1	LS	$50,000.00
2	Engineering Design & Permitting	$300,000.00	1	LS	$300,000.00
3	Construction Engineering and Inspection	$200,000.00	1	LS	$200,000.00
	SUBTOTAL =				**$550,000.00**
	GENERAL CONDITIONS				
4	Mobilization & Temporary Facilities	$500,000.00	1	LS	$500,000.00
5	Bonds, Taxes, Permits, and Insurance	$250,000.00	1	LS	$250,000.00
6	Traffic Control Measures / TMP	$100,000.00	1	LS	$100,000.00
	SUBTOTAL =				**$850,000.00**
	DEMOLTION & SITE PREPARATION				
7	Erosion and Sediment Control (ESC)	$100,000	1	LS	$100,000.00
8	Removal of Pipe and Structures / Plugs	$100,000	1	LS	$100,000.00
9	Building and Spur Rail Demolition Work	$3,000,000	1	LS	$3,000,000.00
10	Asphalt Sawcut / Removal / Disposal	$30.00	106,480	SY	$3,194,400.00
11	Utility Demolition Work / Adjustments	$750,000	1	LS	$750,000.00
	SUBTOTAL =				**$7,144,400.00**
	STORMWATER INFRASTRUCTURE				
12	Basin Outlet Structure (40' Weir)	$25,000.00	1	EA	$25,000.00
13	Manhole on 54"x156" Box Downstream	$15,000.00	1	LS	$15,000.00
14	54"x96" Box Culvert Outlet	$850.00	145	LF	$123,250.00
15	Storm Drain Laterals (30" to 42" Size)	$200.00	50	LF	$10,000.00
16	CMAC Control System to Lower Lake	$200,000.00	1	LS	$200,000.00
17	Excavation / Disposal of Excess Material	$30.00	367,723	CY	$11,031,690.00
18	Wetland Forebay & Weir Outlet	$100,000.00	3.3	AC	$330,000.00
	SUBTOTAL =				**$11,734,940.00**
	SITE IMPROVEMENTS				
19	ROW Asphalt Restoration	$100.00	500	SY	$50,000.00
20	Retaining Wall	$1,000.00	530	LF	$530,000.00
21	Sidewalk / Curb Ramp Restoration	$80.00	200	SY	$16,000.00
22	Curb and Gutter / Curb Restoration	$50.00	300	LF	$15,000.00
23	Utility Relocation Budget	$250,000.00	1	LS	$250,000.00
24	Pavement Markings / Misc. Restoration	$100,000.00	1	LS	$100,000.00
	SUBTOTAL =				**$961,000.00**
	TOTAL ESTIMATED COST =				**$21,790,340**
	CONTINGENCY = 30%				$6,537,102
	LAND COSTS =				$10,000,000
	PRELIMINARY BUDGET =				**$38,400,000**

Cost Estimate Notes:

1) Site Surveying, SUE utility markings and test pits are recommended to minimize conflicts
2) Costs for relocating the CCBC to an adequately sized parcel at the City industrial Park is not included in the current estimate.
3) A park master plan and budget for recreational amenities, parking and access is not included
4) Present Value O&M Costs are not included

8. CAMPBELL AVENUE UPPER WATERSHED IMPROVEMENTS

CONCEPTUAL COST ESTIMATE

8-Dec-20

ITEM NO.	DESCRIPTION	UNIT PRICE	QUANTITY	UNIT	COST
	SOFT COSTS				
1	Surveying & SUE Services	$50,000.00	1	LS	$50,000.00
2	Engineering Design & Permitting	$200,000.00	1	LS	$200,000.00
3	Construction Engineering and Inspection	$150,000.00	1	LS	$150,000.00
	SUBTOTAL =				**$400,000.00**
	GENERAL CONDITIONS				
4	Mobilization & Temporary Facilities	$250,000.00	1	LS	$250,000.00
5	Bonds, Taxes, Permits, and Insurance	$100,000.00	1	LS	$100,000.00
6	Traffic Control Measures / TMP	$150,000.00	1	LS	$150,000.00
	SUBTOTAL =				**$500,000.00**
	DEMOLTION & SITE PREPARATION				
7	Erosion and Sediment Control (ESC)	$100,000	1	LS	$100,000.00
8	Removal of Pipe and Structures / Plugs	$200,000	1	LS	$200,000.00
9	Building Demolition Work	$300,000	1	LS	$300,000.00
10	Asphalt Sawcut / Removal / Disposal	$30.00	9,000	SY	$270,000.00
11	Utility Demolition Work / Adjustments	$100,000	1	LS	$100,000.00
	SUBTOTAL =				**$970,000.00**
	STORMWATER INFRASTRUCTURE				
12	Basin Outlet Structures	$10,000.00	2	EA	$20,000.00
13	Basin Retaining Walls	$400.00	1,994	LF	$797,600.00
14	Storm Drain (15" to 48" Size)	$240.00	1,698	LF	$407,520.00
15	Excavation / Disposal of Excess Material	$30.00	30,000	CY	$900,000.00
16	#3 Reservoir Stone under PICP	$60.00	8,000	CY	$480,000.00
17	HDPE or PVC Check Dam	$3,000.00	28	EA	$84,000.00
18	Permeable Pavement Underdrains	$200,000	1	LS	$200,000.00
19	Stablization & Conservation Plantings	$50,000	2.0	AC	$100,000.00
20	Bioretention Basins / Dry Swales	$200,000	1.00	AC-FT	$200,000.00
	SUBTOTAL =				**$3,189,120.00**
	SITE IMPROVEMENTS				
21	Permeable Pavement (PICP & PC)	$80.00	9,000	SY	$720,000.00
22	Sidewalk / Curb Ramp Replacement	$80.00	3000	SY	$240,000.00
23	Curb and Gutter / Curb Replacement	$50.00	4000	LF	$200,000.00
24	Utility Relocation Budget	$150,000.00	1	LS	$150,000.00
25	Pavement Markings / Misc. Restoration	$150,000.00	1	LS	$150,000.00
	SUBTOTAL =				**$1,460,000.00**
	TOTAL ESTIMATED COST =				**$6,919,120**
	CONTINGENCY = 30%				$2,075,736
	LAND COSTS =				$474,000
	PRELIMINARY BUDGET =				**$9,500,000**

Cost Estimate Notes:

1) Surveying, SUE designation & Test Pits are recommended to minimize utility conflicts
2) Costs for relocating the impacted businesses and residences are not included.
3) An additional streetscaping and landscaping budget may be required including street trees.
4) Present Value O&M Costs are not included

10. LUCK AVENUE UPPER WATERSHED IMPROVEMENTS

CONCEPTUAL COST ESTIMATE

8-Dec-20

ITEM NO.	DESCRIPTION	UNIT PRICE	QUANTITY	UNIT	COST
	SOFT COSTS				
1	Surveying & SUE Services	$60,000.00	1	LS	$60,000.00
2	Engineering Design & Permitting	$240,000.00	1	LS	$240,000.00
3	Construction Engineering and Inspection	$180,000.00	1	LS	$180,000.00
	SUBTOTAL =				**$480,000.00**
	GENERAL CONDITIONS				
4	Mobilization & Temporary Facilities	$400,000.00	1	LS	$400,000.00
5	Bonds, Taxes, Permits, and Insurance	$150,000.00	1	LS	$150,000.00
6	Traffic Control Measures / TMP	$300,000.00	1	LS	$300,000.00
	SUBTOTAL =				**$850,000.00**
	DEMOLTION & SITE PREPARATION				
7	Erosion and Sediment Control (ESC)	$100,000	1	LS	$100,000.00
8	Removal of Pipe and Structures / Plugs	$250,000	1	LS	$250,000.00
9	Asphalt Sawcut / Removal / Disposal	$30.00	19,000	SY	$570,000.00
10	Utility Demolition Work / Adjustments	$250,000	1	LS	$250,000.00
	SUBTOTAL =				**$1,170,000.00**
	STORMWATER INFRASTRUCTURE				
11	Storm Drain (18" to 42" Size)	$200.00	250	LF	$50,000.00
12	Underground Concrete Vault (Depth Varies)	$50.00	129,188	SF	$6,459,400.00
13	Excavation / Disposal of Excess Material	$35.00	50,000	CY	$1,750,000.00
14	#3 Reservoir Stone under PICP	$70.00	5,500	CY	$385,000.00
15	Bioretention Basins	$200,000	0.25	AC-FT	$50,000.00
	SUBTOTAL =				**$8,694,400.00**
	SITE IMPROVEMENTS				
16	Permeable Pavement (PICP & PC)	$125.00	16,360	SY	$2,045,000.00
17	Sidewalk / Curb Ramp Replacement	$80.00	2000	SY	$160,000.00
18	Curb and Gutter / Curb Replacement	$50.00	3000	LF	$150,000.00
19	Utility Relocation Budget	$200,000.00	1	LS	$200,000.00
20	Pavement Markings / Misc. Restoration	$100,000.00	1	LS	$100,000.00
	SUBTOTAL =				**$2,655,000.00**
	TOTAL ESTIMATED COST =				**$14,329,400**
	CONTINGENCY = 30%				$4,298,820
	LAND COSTS =				$1,400,000
	PRELIMINARY BUDGET =				**$20,100,000**

Cost Estimate Notes:

1) Surveying, SUE designation & Test Pits are recommended to minimize utility conflicts
2) Costs for easements and private parking lot impacts need to be refined in the design
3) Corrugated Plastic Pipe may be used for underground detention to reduce overall costs
4) Present Value O&M Costs are not included

13. MAINTENANCE ACCESS UPGRADES (9 LOCATIONS)

CONCEPTUAL COST ESTIMATE

8-Dec-20

ITEM NO.	DESCRIPTION	UNIT PRICE	QUANTITY	UNIT	COST
	SOFT COSTS				
1	Surveying & SUE Services	$45,000.00	1	LS	$45,000.00
2	Engineering Design & Permitting	$270,000.00	1	LS	$270,000.00
3	Construction Engineering and Inspection	$135,000.00	1	LS	$135,000.00
	SUBTOTAL =				**$450,000.00**
	GENERAL CONDITIONS				
4	Mobilization & Temporary Facilities	$135,000.00	1	LS	$135,000.00
5	Bonds, Taxes, Permits, and Insurance	$135,000.00	1	LS	$135,000.00
6	Traffic Control Measures / TMP	$270,000.00	1	LS	$270,000.00
	SUBTOTAL =				**$540,000.00**
	DEMOLTION & SITE PREPARATION				
7	Erosion and Sediment Control (ESC)	$45,000.00	1	LS	$45,000.00
8	Removal of Pipe and Structures / Plugs	$135,000.00	1	LS	$135,000.00
9	Asphalt Sawcut & Removal / Excavation / Disposal	$135,000.00	1	LS	$135,000.00
	SUBTOTAL =				**$315,000.00**
	SPECIAL DESIGN JUNCTION BOXES				
10	15'x15' Junction Box: Norfolk Tunnel 1 (1)	$125,000.00	1	LS	$125,000.00
11	16'x18' Junction Box: Norfolk Tunnel 2 (2)	$150,000.00	1	LS	$150,000.00
12	Repairs & New Top: Norfolk Tunnel 3 (3)	$50,000.00	1	LS	$50,000.00
13	12'x12' Junction Box: Salem Avenue 1 (4)	$50,000.00	1	LS	$50,000.00
14	10'x15' Junction Box: Campbell Tunnel 1 (5)	$100,000.00	1	LS	$100,000.00
15	10'x15' Junction Box: Cambell Tunnel 2 (6)	$100,000.00	1	LS	$100,000.00
16	8'x8' Junction Box: Luck Avenue 1 (7)	$40,000.00	1	LS	$40,000.00
17	10'x10' Junction Box: Luck Avenue 2 (8)	$50,000.00	1	LS	$50,000.00
18	10'x15' Junction Box: Church Avenue 1 (9)	$100,000.00	1	LS	$100,000.00
	SUBTOTAL =				**$765,000.00**
	RESTORATION WORK				
19	ROW Asphalt Replacement	$135,000.00	1	LS	$135,000.00
20	Sidewalk, Curb, and Curb Ramp Replacements	$45,000.00	1	LS	$45,000.00
21	Utility Relocation Budget	$90,000.00	1	LS	$90,000.00
22	Pavement Markings / Misc. Restoration	$45,000.00	1	LS	$45,000.00
	SUBTOTAL =				**$315,000.00**
	TOTAL ESTIMATED COST =				**$2,835,000**
	CONTINGENCY (includes MH step retrofits) =	30%			$850,500
	PRELIMINARY BUDGET =				**$3,700,000**

Cost Estimate Notes:

1) Surveying, SUE designation & Test Pits are recommended to minimize utility conflicts
2) Includes or "double counts" junction boxes also included in Project ID #1 and ID #2
3) Oversized junction boxes are planned with grate tops (air & light) and sumps to trap sediment
4) No RW acquisition is anticpated for this project
4) Present Value O&M Costs are not included

14. N-S RAILROAD YARD DIVERSION

CONCEPTUAL COST ESTIMATE

8-Dec-20

ITEM NO.	DESCRIPTION	UNIT PRICE	QUANTITY	UNIT	COST
	SOFT COSTS				
1	Surveying & SUE Services	$30,000.00	1	LS	$30,000.00
2	Engineering Design & Permitting	$80,000.00	1	LS	$80,000.00
3	Construction Engineering and Inspection	$80,000.00	1	LS	$80,000.00
	SUBTOTAL =				**$190,000.00**
	GENERAL CONDITIONS				
4	Mobilization & Temporary Facilities	$200,000.00	1	LS	$200,000.00
5	Bonds, Taxes, Permits, and Insurance	$50,000.00	1	LS	$50,000.00
6	Traffic Control Measures / TMP	$50,000.00	1	LS	$50,000.00
	SUBTOTAL =				**$300,000.00**
	DEMOLTION & SITE PREPARATION				
7	Erosion and Sediment Control (ESC)	$25,000.00	1	LS	$25,000.00
8	Removal of Pipe and Structures / Plugs	$25,000.00	1	LS	$25,000.00
9	Removal of Railroad Tracks	$25,000.00	2	LS	$50,000.00
10	Asphalt Sawcut / Removal / Disposal	$35.00	400	SY	$14,000.00
	SUBTOTAL =				**$114,000.00**
	STORMWATER INFRASTRUCTURE				
11	Basin Outlet Structure (SWM-1)	$15,000.00	1	EA	$15,000.00
12	Excavation / Disposal of Excess Material	$35.00	3,500	CY	$122,500.00
13	Stablization of Basin Sites	$25,000.00	1.5	AC	$37,500.00
14	Manholes for 66" Pipe	$10,000.00	4	EA	$40,000.00
15	66" RCP Storm Drain Pipe	$500.00	3342	LF	$1,671,000.00
16	66" Headwall	$10,000.00	4	EA	$40,000.00
17	DI-7 Grate Inlets for Laterals	$5,000.00	4	EA	$20,000.00
18	Storm Laterals (18" to 36" Size) - BORE	$500.00	818	LF	$409,000.00
	SUBTOTAL =				**$2,355,000.00**
	SITE IMPROVEMENTS				
19	ROW Asphalt Replacement	$100.00	400	SY	$40,000.00
20	Sidewalk / Curb Ramp Replacement	$80.00	100	SY	$8,000.00
21	Curb and Gutter / Curb Replacement	$50.00	100	LF	$5,000.00
22	Utility Relocation Budget	$25,000.00	1	LS	$25,000.00
23	Pavement Markings / Misc. Restoration	$10,000.00	1	LS	$10,000.00
	SUBTOTAL =				**$88,000.00**
	TOTAL ESTIMATED COST =				**$3,237,000**
	CONTINGENCY = 30%				$971,100
	PRELIMINARY BUDGET =				**$4,300,000**

Cost Estimate Notes:

1) Surveying, SUE designation & Test Pits are recommended to minimize utility conflicts
2) Norfolk Southern Railroad Participation may be required to do work in their rail yard
3) This project drains to the large CCBC basin as shown or could be revised to run along Shenandoah Avenue to drain into the proposed Shenandoah Tunnel (ID #2)
4) Present Value O&M Costs are not included

(14) N-S RAILROAD YARD DIVERSION

(3) CCBC LARGE DETENTION BASIN

(2) SHENANDOAH AVE DIVERSION TUNNEL

(1) SALEM AVE "L" TUNNEL

(8) CAMPBELL AVENUE UPPER WATERSHED IMPROVEMENTS

(10) LUCK AVE UPPER WATERSHED IMPROVEMENTS

(10) LUCK AVE UPPER WATERSHED IMPROVEMENTS

(13) MAINTENANCE ACCESS UPGRADES (TYP. OF 9)

SHENANDOAH AVE
JACKSON AVE
NORFOLK-SOUTHERN RAILROAD YARD
NORFOLK AVE
SALEM AVE
RORER AVE
PATTERSON AVE
CHAPMAN AVE
CAMPBELL AVE
FERDINAND AVE
MARSHALL AVE
DAY AVE
ELM AVE
LUCK AVE
CHURCH AVE
KIRK AVE
BULLITT AVE
GAINSBORO RD
JEFFERSON ST
WILLIAMSON RD
FRANKLIN RD
ELMWOOD PARK
ROANOKE RIVER

Date	D. RISSMEYER	D. PAPA	B. FELTON	J. ARTHUR
	11/20	11/20	11/20	02/17/21

Designed
Drawn
Checked
Approved

COMMONWEALTH OF VIRGINIA
DONALD J. RISSMEYER
No. 26104
PROFESSIONAL ENGINEER

Flood Mitigation Plan for Roanoke CBD

Overall Flood Mitigation Plan

Conceptual Design Plans

City of Roanoke, VA

A. Morton Thomas and Associates, Inc.
Consulting Engineers

AMT Project No.
18-1108.004

Drawing Name
C1-1

Sheet 1 of 11

Flood Mitigation in Roanoke's Central Business District (CBD)
Evaluation of Existing Resources

AMT
Completed on June 12, 2020

ID	Project Ideas	AMT Preliminary Comments	City Meeting on 5/28/2020	Website Reference / Other Notes	Recommendation	
					Yes	No
AMT Data Review and Suppemental Surveying Task Results / Initial Ideas for Kickoff Meeting						
1	New Pipe Outfall for Salem Avenue at 1st Street, tying into the Norfolk Tunnel, Campbell Tunnel, or both tunnels	Pick the best option hydraulically using SWMM modeling and new results at flooded nodes. Look for negative impacts downstream in the system.	This is a possible solution for flooding at Salem and 1st Street but may only provide localized flood reduction and could move the problems downstream. Also a lower cost option versus many others. HSMM Salem Avenue 2 project.	See Video of pipe inspection under Warehouse Row for conditions nearby	X	
2	New Tunnel under Salem Avenue from the diagonal tunnel at Warehouse Row to Market Street, then tie into the Norfolk and/or Campbell Tunnels	Due to higher cost than #1 above, we need to see a better hydraulic performance at flooded nodes.	The City felt it was cost prohibitive to try building a tunnel east of Jefferson Street due to heavy traffic on Salem Avneue in the CBD for that area.	Removed from consideration..		X
3	New Tunnel under Shenandoah Avenue to divert runoff from the Coke Plant away from the Salem / 1st Street Intersection. Cross the railroad tracks at the old pedestrian tunnel (Jefferson Street) and tie into the Norfolk and/or Campbell Avenue Tunnels.	Due to higher cost than #1 above, we need to see a better hydraulic performance at flooded nodes.	Due to lower traffic on Shenandoah than Salem Avenue, this was considered more feasible than #2 above, especially if it ties into the Norfolk Tunnel only.	See the record drawings for the old pedestrian tunnel under the railroad tracks at Jefferson Street, to re-purpose the abandoned tunnel. WVWA water main inside the tunnel will need to be maintained in the plan	X	
4	Provide improved maintnenace access, including a Junction Box behind Warehouse Row. Also provide improved maintenance access at other locations with debris or clogging issues (see Trout Run Tunnel Inspection)	At each location selected by the City, improvements to permanent access can include ladders, steps or safety slabs. Also, remove sediment and make repairs.	The City felt this should not be one of the five SWMM modeled alternatives in the study, but AMT feels it needs to be included in the 10 to 15 high level options.	See Trout Run Tunnel Inspection Report below and coordiante with the City for other known locations of maintenance and repair concerns.	X	
5	New Storm Drain on Campbell Avenue from 2nd Street to 1st Street, to divert coming from City Hall directly to the intersection of Campbell/1st Street instead of going north to Salem Avenue.	Not a standalone option, but might help other more impactful parts of this study.	Due to the small drainage area and location in relation to the flooding problems at 1st and Salem, it was decided this would not likely help much.	A larger option derived from the HSMM study is shown in #45 below.		X
6	23-Acre detention basin on the entire parcel for the Coca Cola Bottling Company (CCBC) Facility	This requires the relocation of the Coke Plant and was previously estimated at $30M in sitework, not including costs for relcation of CCBC or doing recreational amenities around the new lake. See previous whilte paper for more details.	Work on options involving the CCBC are highly confidential at this time, to avoid causing concerns about economic and other impacts before this is even considered a viable alternative.	https://www.alexandriava.gov/tes/stormwater/info/default.aspx?id=94755#LakeCookStormwaterManagementRetrofitProject	X	
7	Detention in the parking lots and loading dock areas at the CCBC Facility (might require parking decks or permeable pavement areas)	Need to see enough of a reduction in flooding to avoid the more extensive option of relocating the CCBC facility entirely.	If a smaller detention pond works at the CCBC than it could significantly reduce impacts to avoid using the entire parcel for stormwater management. This would also allow CCBC to maintian operations as a bottling company on the site.	Need to study if a significant reducation in detention benefits would still address downstream flooding concerns. Not sure?	X	
8	Upper Watershed LID above the CCBC Facility	Not sure how realistic LID watershed-wide is for this area. Would be like Montgomery County Rainscapes, so I've started coordination with Anne English who runs their program to see if they have had flood reduction benefits from LID.	This will be part of the 10 to 15 alternatives for further coordination of the feasibility and level of participation required n the watershed to be effective.	https://www.montgomerycountymd.gov/water/rainscapes/index.html	X	
9	Detention under the parking lots at Campbell and 3rd Street SW, near the Future Transit Center.	Could reduce peak discharges just upstream of the Salem/1st drainage problems. Need to look at time to peak for detention on this smaller subwatershed versus the larger subwatershed of Trout Run at the CCBC Facility Lake.	Might be able to divert runoff currently going into a 54-inch pipe behind the Transpotation Museum to the CCBC Basin. Might be able to detain runoff in the front parking lots.	We should discuss more details about the development for the Transit Center with the City and the detention planned fo rregulatory compliance veruss the detention required to reduce or eliminate downtown flooding.	X	
10	Detention in the three parking lots near Salem Ave. and 1st Street SW (possible development project is planned here)	We should get information from the City about the development project and their stormwater management requirements, and see if this could be used in combination with other options to improve results by combining detention with tunnel/pipe upgrades.	Review speciifc project identified in the Stormwater Master Plan as background for this option and consider how it fits into the overall plan.	Could be combined with #1 above to be an effective and low cost option.	X	
11	Replace downtown parking lots or roadways with Permeable Pavement and Underground Storage Options.	Might not be enough strorage volume to help with larger storms, and might be cost prohibitive as a public works project since most of the lots are privately owned, but many have aspahlt that is in bad shape. Might want to create a local requiement to provide stormwater management for these parking lots with 25/10 detention through permeable pavement or parking decks with storarge vaults.	This could be developed as a regulatory requirement for the CBD flood prone areas. County be combined with #16 below.	https://cip.h2o4atl.com/wp-southeast-atlanta-green-infrastructure-initiative-sagii-permeable-pavers/	X	
12	Plug existing outfall for drainage at Church/Jefferson to divert runoff into the Church Tunnel with a new pipe under Church Avenue, and to reduce runoff into the Campbell Tunnel at Node 20290.	Quick comparison of flooded nodes to see if this helps. Not a standalone option, but might help other more impactful parts of this study.	Might work well in combination with other options to divert pipe and surface water overflows to Campbell Avenue which is the toopgraphic low point.	Study this in combination with other small pipe diversions downtown for an overall affect on downtown flooding. Would be a low cost option, if it works.	X	
13	Modify the cross connected tunnels near 1st Street SW with weir walls, pipe plugs to disconnect entirely, or other hydraulic controls for split flow.	Quick comparison of flooded nodes to see if this helps slightly. Not a standalone option, but might help other more impactful parts of this study.	Plugging of otherwise restricting flow might not help due to flooding in the vicinity of all the tunnels downtown. Consider moveable gates.	https://www.mdpi.com/2073-4441/7/3/1291/pdf		X
14	Continuous Monitoring and Control (CMAC) systems, flood alert and warning systems, to better manage split flow, looped systems, etc.	Not sure how many of these systems to monitor flooding make sense to study. One option might be trying to open and close cross connects for larger storm events to model inflatable dams in your tunnels. Another option might be OPTI in the new lake at the CCBC facility. [ALSO POSSIBLE FUTURE VT COLLABORATION TO INTEGRATE THIS TO PUFFIN AND SHARKS]	OPTI or similar might help optimize the size of the pond at the CCBC or elsewhere. Could be combined with the narrative for #7 above.	https://nam04.safelinks.protection.outlook.com/?url=https%3A%2F%2Fmoney.cnn.com%2F2017%2F10%2F06%2Ftechnology%2Fopti-anti-flooding-system-hurricane%2Findex.html&data=02%7C01%7Cdrissmeyer%40amtengineering.com%7Cc52ee096e0ce490889aa08d7f65da01d%7C84e6bb5c2b2a40eaaf0d6be59b35ed17%7C0%7C0%7C637248754286564914&sdata=vrb2Yidc8mOqKMgQVQJS2TJAtMunQ26NzCtcNx%2FCvto%3D&reserved=0	X	
15	Reduce Head Loss in the Campbell Tunnel by removing of modifying the 24" sewer main and pipe foundations.	This is too expensive with little benefit, most likely.	Not a feasible option.	Removed from consideration.		X
16	Map the 100-year floodplain downtown or otherwise setup regulatory restrictions to help manage the impacts of future development in the CBD as floodplains.	Could secure DCR 50% funding support for mapping the floodplain with a FEMA LOMR through the Dam Safety, Flood Protection and Prevention Assistance Fund	The City does not want to restrict development by mapping this portion of the floodplain downtown at this time	Removed from consideration.		X
17	Setup higher regulatory requirements for stormwater management on development projects downtown, due to the flood prone areas and to reduce the impacts of future development plans.	This could be accomplished by requiring higher detention requirements, such as having the 25-year post-developllment discharge get reduced to the 10-year pre-development levels for a project site.	Milling pavement is not currently considerd a land disturbing activity however the City has the authority to enfore stricter requirements in the CBD due to the flooding concerns, so this can be a part of the solution. See pages 3-4 of the attached stormwater regulations from Henrico County for an example of where this has been done already.	https://henrico.us/assets/totaldocchapter4.pdf	X	
18	Stream Daylighting opportunities above CCBC in Trout Run Watershed	There does not appear to be opportunities for a greenway or stream daylighting downtown, except by closing lesser traveled roadways to vehicular traffic. Possible greenway integration near the CCBC Facilliity at Shenandoah Avenue.	We discussed using stream daylighting in the neighborhood above the CCBC facility but not sure of the flood reduction benefits to this.	Thish could be considered along with the Trout Run Watershed LID in #8.	X	

Conrad's Final Report with latest SWMM modeling and detention consideration for 25-year, 24-hour storm event.						
19	The Trout Run watershed is larger than Salem Avenue and could provide larger benefits from detention as a result.	See earlier discussions about the CCBC facility, and upper watershed LID options in the Trout Run Watershed. Larger watershed may mean more benefits downstream if we can get enough storage volume and delay peaks.	Combines with #6, #7, #8 and #18 above.	Include in multiple preliminary alternatives as needed	X	
20	The Salem Avenue watershed is smaller than Trout Run, so lesser detention volumes could still provide flood reduction benefits	One SWMM modeling option could study detention on the Salem Avenue reach. Need to look at time to peak for detention for this smaller subwatershed versus the larger subwatershed of Trout Run at the CCBC Facility Lake.	Look at Lumsden Study (10th and Campbell, etc.) - Consider Green Streets and Alleys apporach with outparcels to create enough detention volume to reduce downtown flooding. Total volume of runoff for 25-yr, 24-hr is 46 acre-feet.	https://www-nola-com.cdn.ampproject.org/c/s/www.nola.com/news/politics/article_0f047728-9bbb-11ea-91ea-5f1f267d28bf.amp.html	X	
21	Detention at the Future Transit Center seems to have merit.	Could be less expensive than the Green Streets (#20) but would have a larger watershed due to being closer to downtown	See option #9 above.	Combine with #9 above.	X	
22	Luck Avenue Tunnel / Church Avenue Tunnel were not reported on.	No additional alternatives are derived from Conrad's Study on these reaches	None are planned.	None are planned.		X
23	The Lick Run tunnel enters downtown near Willamson Road and does not seem to have flood reduction benefits since its entering the drainage system downstream of the flooded nodes.	No additional alternatives are derived from Conrad's Study on this reach	None are planned.	None are planned.		X
24	Any upstream detention redistributes looped flows between the downtown tunnels, and may cause downstream flooding (202901) but most seem to reduce flood potential at the downtown market.	Check Node 202901 (Campbell/Jefferson) and 201315 (market) for downstream flooding in each alternative. Also check flooded nodes at Salem/1st and Campbell/1st Street for flood reduction benefits of each option modeled	None are planned.	None are planned.		X
Tunnel Inspection Report, Trout Run Culvert under Norfolk Avenue						
25	Heavy sediment, trash, ballast and brick at short section EF, west of section C. It is a 6'x12' brick arch with a center invert in the brick floor. Point and tuck repairs could be needed in some areas per this study.	This section of tunnel needs to be cleaned out and repaired, possibly with improved access through a new junction box at this location for the work involved.	No flood reduction projects are planned thiis far downstream in the tunnels, so this should be programmed and addressed as a maintenance project, like other access improvements, sediment removal areas, and stuctural repair needs.	Combine with #4 above.		X
26	Reduce Head Loss in the Norfolk tunnel related to steel plate metal liners (5.7' x 11' tunnel size)	This is too expensive with lesser benefits, most likely	Might not help.	Not a feasible option.		X
Joseph Arthur Email on 5-14-2020						
27	Use the entire parcel of the Coca-Cola facility for detention combined with recreational amenities. It is a 27-acre site, per the 1990 plat. Depending on how well the 25-year storm events are detained and the size of the lake, what recreational amenities can be added to this parcel?	Detention for the ascending limb of the hydrograph won't affect peak discharges so we need to capture that volume in the pond at a minimum. Unless we store the entire storm event volume, it would not have the entire benefit of Conrad's quick and dirty estimate for the benefits to flooded nodes.	Also #6 above.	https://www.roanoke.com/news/local/heavy-rains-this-weekend-may-be-another-test-for-roanoke/article_deda1a00-9c74-55db-9f33-4dbae2d17474.html	X	
28	Would a new tunnel under Shenandoah help? There is the abandoned underground pedestrian crossing for the railroad tracks at the intersection of Jefferson and Shenandoah. The City has more details on this.	An exisitng tunnel would help reduce costs for the Shenandoah Tunnel alternative, assuming the required pipe size fits inside the existing tunnel.	Also #3 above.	Also #3 above.	X	
29	Could the City use a vast majority of the parcel for stormwater along with a new building (offices for City staff) with a green roof.	It is likely we could fit a small building on the site but this is a future design decision that won't affect SWMM models	Combine with #6 and #7 above.	New buildings and green roofs are not part of this initial flood study.		X
30	Could the new building be large enough to have a soccer field on top. The property could be partially for recreational use (above the new building only). This is where ENVISON would come in. The City may be able to leverage Parks and Recreation funding (facility would need adequate parking per the zoning ordinance requirements).	Since Marcus sent a prior study of a 23-acre detention pond (lake) then it is unlikely that we have enough room for a new building that could have a soccer field on top, unless we reduce the provided detnetion volume from the City's prior study.	Combine with #7 above.	Soccer fields and larger buidings are not part of this intiail flood study.		X
31	Could the new CCBC site have pervious paving or underground storage?	Yes, parking areas and access roads could offer detention benefits in the SWMM model along with the lake that is planned	Also #7 above.	Also #7 above.	X	
32	Could we have perimeter landscaping along Shenandoah & 5th Street?	This is a future design consideration that won't affect SWMM models	https://www.denvergov.org/content/dam/denvergov/Portals/705/documents/guidelines/PWES-008.0-Aesthetically_Enhanced_Detention_and_Water_Quality_Ponds.pdf	Landscaping details are not part of the initial flood study.		X
33	As of now, the intent is to leave all existing roads in place. The City has no issues temporarily shutting down Shenandoah for construction of a tunnel if need be.	Shenandoah between Gainsboro and 5th Street was suggested as worth considering but we can move on without that option since it just affects the allowable size of the CCBC lake and detention faiclities that are modeled in SWMM	Green Streets are being considered for detention in some areas, where the roadway can be maintained over the top. See other optinos for details on Green Streets.	Not a feasible option.		X
34	**Modeling** - Can the inlets (nodes) that flood downtown be lowered in elevation and pipe sizes increased (wider as in rectangular shaped) to prevent HGL's from popping out?	These ideas depend on the pipe sizes required and would need to be studied in the alternatives. Our best ideas for new pipe routes to be studied in the 10 to 15 alternatives, prior to SWMM modeling, are noted above.	Some of the tunnels have earthen bottoms or could be retrofit with sediment traps or micro pools at key junction boxes or access points, to then remove the sediment as it accumulates. Part of an overall maintenance strategy more than flood reduction options.	Combine with other options above.		X
35	**Modeling** - the SWU is open to re-routing the storm drain network in certain locations if it alleviates flooding and causes less stress on the existing system underground.	Need to study HSMM Study (2005) for planned CIP projects downtown.	Salem Avenue and 1st Street (3' tall x 18' wide box culvert) - Low cover conditions	Combine with Option #1 above.	X	
36	The SWU has a few other ideas that we can discuss when AMT is ready. Other long term possible land acquisitions or underground storage facilities in/around downtown (Norfolk Southern).	AMT is ready for all other ideas by the City before determininng the proposed 10 to 15 initial alternatives to evaluate in this study. Especially if the detention storage ideas involve the Salem Avenue or Transportation Museum watersheds which were recommended for further study by Conrad withtout clear direction on locations	The city wants a road map to solve downtown flooding.	All ideas are included in this spreadsheeet as Background Research		X
37	**Rainfall #1** - City Administration, residents, etc. all will ask - How would this facility handle the flood of 1985. That was 6.61" in 24-hrs, with a peak intensity of 4.25" within 3-hrs.	Since the 5.74" of rainfall in 24-hours (25-year storm event) is similar to the 1985 total rainfall amount in 24-hours (6.61") we could add this as a check storm for the 5 alternatives in the SWMM modeling to come?	DESIGN STORM #1 - The City will setup a design rainfall event based on the 1985 storm (we also discussed checking backwater in the Roanoke River at 23.35' elevation with HEC-RAS models downstream (downtown got flooded twice in 1985). This is the longer duration, highest volume of runoff event.	See new design rainfall for the 25-year, 24-hour event which is the contorlling storm for larger and longer duration flooding types. NRCS Type II distribution.	X	
38	**Rainfall #2** - I believe the SWU's goal is what can we do to successfully to pass the 25-year, 24-hour event (5.74") and the 25 year, 30-minute event (1.72"). However, we'll want to keep an eye to the future for other options for larger storm events.	The 1985 flood of 4.25" in 3-hours is less intense than the suggested 25-year, 30-minute event (1.72" rainfall) so one of these (or both) could also be added as a check storm to the 5 alternatives in the SWMM modeling to come?	DESIGN STORM #2 - The City will review 2016 rainfall and flooding to setup a design rainfall event with a 30-minute or 1-hour duration for a shorter, higher intenstify storm than #36 above.	See new design rainfall for the 25-year, 1-hour event which is the contorlling storm for short duration and flashy, high intensity storms. NRCS Type II distribution.	X	
39	**Tailwater Concerns** - he Roanoke River rose to 23.35' during the flood of 1985 causing a second wave of flooding downtown as water backed up, along the railroad tracks near Williamson Road.	The Roanoke River Flood Reduction Project was designed to reduce flood stages in the Roanoke River for all communities inlcuding the City of Roanoke.	Recent storms which have caused flooding did not rise to anywere near 23.35' flood stage, and it is very unlikely that this would happen again due to the Roanoke River Flood Reduction Project.	Per the City we do not need to add a higher tailwater assumption to the existing conditions SWMM model.		X

Marcus Aguilar Email on 5-13-2020						
40	**Project Organization** - It's clear to me that we will need some sort of file repository for this effort, where we can quickly post, review, edit files. Do you all use Google Drive, Dropbox, OneDrive, etc.? We used an FTP for the survey effort, but I'm not sure that will be flexible enough for the PER.	We can use Google Drive	We will use Google Drive for this study.	Google Drive is now setup with all background research noted here.	X	
41	**Status of SWMM Model** - As far as I'm concerned, the SWMM model (version F30) does not need any further updates before we begin using it for scenario modeling, as Conrad incorporated the final changes we requested during our phone call on 4/27 and succesfully recalibrated to our sensor data. Three different design storms (10 yr 24 hr, 25 yr 6 hr, 25 yr 24 hr) were modeled.	Our plan was to use the 25-yr, 24-hr results to map flooded nodes initially as part of the existing conditions base mapping for our study	See #37 and #38 above for the new design storm events requested by the City.	See the latest SWMM model for the new design storm events.	X	
42	**Stream Daylighting Concept Study** - The City had previously explored the possibility of daylighting Trout Run around the northern part of the CCBC plant, although the effort was found to be infeasible due to invert issues. There is also a decent bit of survey data associated with this effort, that I can share once file repository is set up.	It was not feasbile to daylight Trout Run around the northern side of the CCBC plant (see M&C and WSSI study for details of the $1.5M project for stream daylighting) but the City might be able to incoroprate some stream daylighting into the upper watershed for Trout Run.	Combine with #8 above.	We are combining Upper Watershed LID with Stream Daylighting for Trout Run to see if either strategy is likely to reduce flooding downtown.	X	
43	**Downtown Surface Lots** - Agreed that surface lots are an inefficient use of high-value CBD land, and that if/when they are converted we need to take advantage of this. This is currently happening with the parking lot at 3rd and Salem, and we are pushing to get some underground detention/GI incorporated into the proposed site plan.	Let's review more details on how these parking lot detention options might fit into a downtown flood mitigation strategy for public and private development projects and retroift opportuniities.	Coordinate with City Plan Review	Combine with #17 above.	X	
44	**Redevelopment Rules** - Joseph shared with us this week that our VSMP administrator (Adrian Gilbert) has the ability to require additional quantity capture beyond VSMP reqs in flood prone areas, so long as we define this clearly. I believe that this is a path we should pursue, as there is likely to be redevelopment in the watershed draining to the Trout Run tunnels.	Let's discuss including some type of 50/10 or 25/10 watershed requirement for development projects in the flood prone areas downtown, and possibly for development projects in the upper watershed, too (See Henrico Example)	Coordinate with City Plan Review	Combine with #17 above.	X	
AMT Review of the old HSMM Study and Lumsden Study						
45	**Lumsden Study** - Three small detention basins, underground storage and pipe size upgrades along Cambell and Patterson between 10th and 5th Street primarily. Ties an upstream 36" RCP into a downstream 36" RCP at 5th Street, and addresses missing pipes and drainge issues in between.	Consider adding a Green Streets Concept to increase detention volumes and further reduce peak discharges. At least 2.5 acre-feet of detention is possible but it might be cost prohibite to detain closer to the 46 acre-feet volume for the 25-yr, 24-hr storm.	Refer to #20 above for more information. Conrad's report had 46 acre-feet	Green Street Pilot Project Downtown. Could lead to others if successful.	X	
46	**HSMM Study 1** - To reduce flooding on Campbell Avenue due to overland flow and pipe flows on 1st Street, we need more inlets at 1st/Church and 1st/Kirk. Also improve inlet capacity on Jefferson Street draining to the Luck Avenue storm drain system (not Campbell). Campbell has the lowest elevations downtown on the east-west street network (see topographic low point map or GEISHA modeling results for mapping of high risk areas in the CBD)	HSMM Market Street 1 (built already per GIS), Campbell Avenue 3, Campbell Avenue 4, and Williamson Road 1 will all help direct local runoff away from Campbell Ave. First Street 1 addresses overland flow concerns on 1st Street, and Kirk Avenue 1 and Jefferson Street 1 are both nearby. The 7 CIP projects were budgeted at $665,880 in 2005 and costs would be higher nowadays.	Jefferson from Day to Luck Avenue - inlets and larger pipes in a current CIP project. If we do more pipe interceiption and eliminate overland flow reflief to Campbell, does it help the Campbell Tunnel	If we do more inlet interception projects (add larger inlets) and eliminate overland flow reflief draning to Campbell, does it help the Campbell Tunnel. Need to study this group of projects for diverions of flow based on subwatershed size with preliminary SWMM modells ot deicde if these older HSMM CIP projects are helpful to reduce CBD flooding. If not, they can sitll be done for localized gutter spread and standing water issues.		X
47	**HSMM Study 2** - New storm drains from 5th/Rorer to the dual 36" near Campbell/3rd Street to Salem/1st and Campbell/1st Street.	p5 of the HSMM describes how the runoff from Rorer to Campbell diverts north to Salem over a longer flow path. Several projects result in this area	HSMM Campbell Avenue 1, Campbell Avenue 2, Rorer Avenue 1, and Rorer Avenue 2, Salem Avenue 1, and Salem Avenue 2 are all in this vicinity to increase inlet and pipe capacity. These 6 CIP projects were budgeted at $3,591,660 in 2005.	Not sure if a larger pipe along Campbell, Salem and/or Rorer between 5th and 1st Street would help downtown flooding, but we discused studying a new pipe along Campbell Avenue since it's the most direct route and shortest length of pipe required for this.	X	
48	**HSMM Study 3** - Flooding Problems on 5th Street at Day Avenue and Luck Avenue, have been reported.	Need more inlets and pipes at 5th Street, to reduce overland flow in Luck Avenue giong towards downtown. Older project on Luck Avenue between 2nd and 1st Street is mentioned but HSMM proposed a 66" pipe (currently 42" per GIS). Might be another Green Street opportunity like the Patterson/Campbell pilot project (#20 above).	HSMM Luck Avenue 1 was budgeted at $2,218,980 in 2005. FY 2026 budget has $3.5M allocated to this new storm drain system along 5th Street and Luck Avenue.	Since the City owns the parking lots across from the YMCA we believe that a project combining permeable pavement parking lots with Green Streets as needed to reduce peak discharges to the point where the existing 36" pipe outfall is adequate could be a very good project in this subwatershed. Should cost less than $3.5 million.	X	
49	**HSMM Study 4** - Other Projects in the 2005 Study	Franklin Road 1 requires an upgrade from 36" to 54" for the pipe into the Luck Avenue Storm Drain. This could support upstream detention in this storm drain system rather than increasing capacity to the undersized Luck Avenue system downtown. Maybe at the Intersection of Franklin and Elm Street.	HSMM Franklin Road 1 was budgeted at $989,520 in 2005. FY 2024 budget has $2.25M allocated to tthis project.	If the property at Franklin and Elm Street is already poised for redevelopment by the new property owner, then we could look at a combination of underground detention and permeable pavement (Green Street) here to reduce runoff to the point where the downstream storm drain system is adqeuate. We also disucssed the development review requirements for this proepty to demonstrate an adeuate outfall.	X	
50	**HSMM Study 5** - Other Projects in the 2005 Study	Jefferson Street 2 increases pipe capacity and size from 24" to 36" for a lateral on Jefferson Street from Day Avenue to Luck Avenue into the Luck Avenue Storm Drain system for $851,880 and is adjacent to Elmwood Park 1 at $1,222,760. This could support detention retrofits at Elmwood Park, instead.	F2021 $1.44 M for Jeffrson Street 2 is currently being designed. It ties into the downtown tunnel system at Jeffersion and Luck Avenue whiich is generally considered downstream of the areas of known flooding concerns for this study.	At some point, we might want to put the design by others into the SWMM model to see how it impacts downtown floooding and/or consider adding detenion at Elmwood Park to decrease the required pipe size increase from 24" to 36". The City might also want to utilize our new design rainfall events in this engineering design, by others.		X

ID	Project Ideas	AMT Comments	Other Notes	City Comment Resolution
1	**Salem Avenue & 1st Street "L-Tunnel"**- New Pipe Outfall for Salem Avenue at 1st Street addressing ponding in a localized depressional area without overland flow relief, by tying into the Norfolk Tunnel, Campbell Tunnel, or both tunnels.	Might include parking lot detention in 2 or 3 parking lots near the Salem/1st Street intersection in this option if it helps reduce flooding in combination with the new storm drain system. Also due to shallow inverts it is anticipated that this might require an 18' span x 3' rise box culvert. Should also include a junction box for improved access and safety in this part of the downtown tunnel system.	Pick the best combination of pipes and parking lot detention using preliminary SWMM model results at flooded nodes. Look for both positive and negative impacts at flooded nodes. Look for reductions in peak discharges due to the parking lot detention part of this alternative.	Based on City Comments this is envisioned as an L-Shaped 18' span x 3' rise box culvert (or similar) that diverts runoff away from the diagaonal pipe that would be abandoned or removed as part of the future private development project. We would also include a large junction box for improved access at the upstream and downstream ends of this planned drainage improvement. We would not connect to the Norfolk Tunnel since the inverts don't work. We would not include detention in parking lots since preliminary SWMM modeling shows this has a negative affect on the time to peak, potentially increasing flood potential. One remaining option discussed was the private redevelopment of the old transit center on Salem Avenue, where a varation of this alternative could inlcude a drainage easement along a new north-south pedestrian alley to connect further down Campbell Avenue if it works better, hydraulically.
2	**Shenandoah Avenue Diversion Tunnel**- New Tunnel to divert runoff from Trout Run (at the CCBC) away from the Salem / 1st Street Intersection. Cross the railroad tracks at an old pedestrian tunnel (Jefferson Street) and tie into the Norfolk Tunnel, or tie into both the Campbell and Norfolk Tunnels with this alternative.	Due to higher cost that #1 above, we need to see a better hydraulic performance at flooded nodes. Also, by re-using the pedestrian tunnel we can establish a very good access point for long-term maintenance. We would need to accommodate the existing water main inside the tunnel with our design approach (WVWA water main).	Pick the terminus at the Norfolk Tunnel or the Campbell Tunnel, based on preliminary SWMM model results at flooded nodes. Look for negative impacts at downstream nodes, and whether this should be used in combination with any of the upper watershed LID, stream daylighting or CCBC detention ideas.	This seems to work best as an L-Shaped Tunnel that uses the abandoned pedestrian tunnel under the railroad tracks to reduce costs. It may include overiszing the tunnel for additoinal storage volume benefits and/or using permeable pavement on the streets above. Preliminary SWMM modeling shows that a weir wall or similar diversion will need to be built in the Warehouse Row diagonal pipe upstream, where a new junction box is planned or that diagonal connection under the railroad tracks might be abandoned entirely in favor of this new tunnel.
3	**CCBC Large Detention Basin** - 22-Acre detention basin on the entire parcel for the Coca Cola Bottling Company (CCBC) Facility which could include recreational amenities around the lake as a downtown city park amenity.	This requires the relocation of the Coke Plant and was previously estimated at $30.5M not including costs for relocation of the CCBC. Work on this alternative is highly confidential at this time until it's considered a highly ranked option that is shortlisted down to five (5) options or even a recommended plan.	Due to the high cost and impacts to CCBC we would need to see substantial reductions in peak discharges in preliminary SWMM modeling.	This is envisioned as a 20+ acre lake (wet pond) with 132 acre-feet of detention volume, with a permiter walking trail linear park or greenway around it. The exact size and depth will be refined through SWMM modeling. This should also provide substantial water qualty and enviornmental benefits to the City, and could be combined with the CMAC system described in ID #5 below. Downside is that the CCBC facility would need to be relocated to a simiarly sized parcel at the city industrial park with associated coordination needs and project costs. MIght be called "Roanoke Unity Park" concept.
4	**CCBC Small Detention Basin** - Smaller detention basin using supplemental parking lot detention (might require parking decks, permeable pavement and/or underground storage) to maintain functionality of the CCBC plant on this site, while still providing stormwater detention benefits.	Need to see enough of a reduction in flooding to avoid the more extensive option of relocating the CCBC facility entirely. Might need to combine this smaller detention pond option with the construction of a new Shenandoah Avenue Tunnel or with other, smaller options for detention in parking lots.	This alternative needs preliminary SWMM modeling that shows enough of a reduction in peak discharges to make it feasible without sacrificing the viability of the CCBC functions.	This is envisioned as a reduced pond size that alows CCBC to stay in business, and could require underground detention or permeable pavement . It only works offiline in preliminary SWMM modeling, meaning a portion of the Trout Run Watershed would conitinue to flow downstream, untreated. It also means other projects lke the Shenandoah Tunnel will be needed in combination to make this work hydraulically.
5	**Continuous Monitoring and Control (CMAC) System**- This is a flood warning and monitoring system to inform lowering wet pool volumes in advance of storm events to optimize detention benefits.	OPTI or similar might help optimize the size of the pond at the CCBC or elsewhere. Could be combined into any detention pond option with a wet pool volume.	Likely to be combined with the larger wet pond at the CCBC Facility instead of being a stand-alone alternative but was setup separately to apply more generally to any detention option that advances of the 5 alternatives next.	This is not likely to remain a separate alternative, but can be used in combination with the CCBC wet pond alternative for advanced lowering of the lake to maximize flood detention capacity prior to a large storm event. Should work well in cobmination.
6	**Transportation Museum Diversion**- Divert runoff currently going into the 54-inch pipe behind the Transportation Museum to go under the RR tracks and into the CCBC Basin or divert this runoff to the Shenandoah Avenue Tunnel.	This could be part of the strategy for other alternatives to put more runoff into the planned CCBC detention basin and/or the Shenandoah Tunnel.	Likely to be combined with other alternatives if preliminary SWMM model results show a reduction in flooded nodes.	Preliminary SWMM modeling shows this increases flooding to Trout Run, so we would need to use this type of diversion in combination with the CCBC pond and/or the Shenandoah Tunnel. Need to figure out which combination works best, if any. Also, we need to map the watershed to be sure it's modeled correctly in SWMM.
7	**Campbell Avenue Storm Drain Extension -**New Pipe along Campbell Avenue, from 5th Street to 1st Street, also considering flooding concerns for CIP Projects from the 2005 Study: Rorer Avenue 1, Rorer Avenue 2, Campbell Avenue 1, Campbell Avenue 2, and Salem Avenue 1, as currently programmed in the stormwater CIP.	Might include parking lot detention at the Future Transit Center near the Salem / 3rd Street intersection. Might also include a separate project for a Green Street Pilot at Campbell / Patterson upstream.	Pick the best combination of pipes and detention using preliminary SWMM model results at flooded nodes. Look for negative impacts at downstream nodes, and whether detention in parking lots and Green Streets would significantly reduce peak discharges at this location.	Preliminary SWMM modeling shows that this pipe extension would increase flooding in the Campbell Tunnel so it might be necessary to also enlarge the existing Cambell Avenue Tunnel as far east as Williamson Road. MIght also be able to incporate detention into the parking lots near the TRansportation Mueseum. Need to map the watershed and see what works best. MIght just do the previously planned CIP projects near the Transportation Museum to increase inlet capacity and address localized flooding concerns in that area, without doing major tunnel upgrades, larger pipes and/or detention if other alternatives work better.
8	**Campbell Avenue Upper Watershed Improvements -**This watershed is smaller than Trout Run, so reductions in peak discharges may be achievable by retrofitting Green Streets and Green Alleys with permeable pavement from 10th and Campbell / Patterson to Campbell / 6th Street. Interconnected streets and alleys would be included as permeable pavement, with street tree additions and possible city property acquisition of three parcels for detention basins as noted in the Lumsden Study. The neighborhood has a 36" inflow pipe and 36" discharge pipe (at 5th / Rorer).	We would anticipate at least 4,000 linear feet of Green Streets and Alleys with 3 small detention basins and street trees, working on combination to provide at least 3 acre-feet of detention storage. Given the estimated 70-acres of contributing drainage area, this might work better for the 25-hr, 1-hr storm event than the 25-yr, 24-hr storm event due to the higher volumetric requirements for larger and longer duration storms. Need to look at both design storms.	Might become the basis for other highly ranked alternatives for Green Streets and Parking Lots downtown as detention storage if the preliminary SWMM model shows a substantial reduction in peak discharges, and the cost is reasonable for this Green Streets pilot project.	This seems to work as a Green Streets Project in combination with three detention basins that were previously planned with the primary goal of addressing loalized flooding issues and reducing peak dsicharges to avoid installing larger pipes downstreamt (36" RCP currently). To address downstream flooding additional detnetion toalling 14 acre feet was modeled in SWMM and would likely require a fourth (larger) detention basin behind Twists 'N' Turns. Also, we need to map the watershed to be sure it's modeled correctly in SWMM. LIke the CCBC lake, this will have signfiicant environmental benefits. It would also enhance the transporation corridors. Might want to use pervious concrete (no PICP) for bike lanes.
9	**Luck / Church Avenue Storm Drain**- Plug existing outfall or divert runoff at Church/Jefferson into the 48" pipe one block east on Church Avenue. Also, add inlet capacity per HSMM 'Jefferson St. 1' and 'First St. 1' projects to reduce overland flow to Campbell Avenue.	Collectively diverts runoff away from the Campbell Tunnel at Node 20290 and other areas upstream of it from Luck and Church Avenue. Could add parking lot detention areas along Luck Avenue and/or a Green Street option from 2nd Street to Jefferson Avenue to reduce peak discharges and intercept more runoff that would otherwise reach Campbell Avenue via pipes and overland flow.	Preliminary SWMM modeling would need to show a reduction in peak discharges and a reduction in flooded nodes along Campbell Avenue.	Preliminary SWMM modeling shows that plugging flow to Campbell causes increased flooding on Luck / Church so this might not work. Need to review the Lumsden Study posted by Marcus and possibly talk to Luke Pugh to be sure we are modeling this correctly, before drawing any final conclusions.
10	**Luck Avenue Watershed Improvements**- Luck Avenue 1 and Franklin Road 1 are currently budgeted at $5.75M in the CIP. Both would provide larger pipes and inlets to better convey runoff from these upper watershed areas with localized flooding problems towards the Luck Avenue storm drain system, downtown.	Larger pipes and inlets in these areas could increase runoff to the Luck Avenue storm drain system downstream, causing flooding problems downtown. A new option would be to provide underground detention or permeable pavement instead, especially in the city-owned parking lots across from the YMCA. 50/10 detention at Franklin / Elm could be part of a future development project or provided in the vacant lot by the City. Might require a land swap with the developer.	Preliminary SWMM modeling would need to show a reduction in peak discharges and at least a 10-year capacity in the downstream storm drain systems as a replacement for the currently planned CIP projects. A better understanding of the impacts on downstream flooding to larger pipes versus detention storage would also be helpful.	Possible detention in the City-owned parking lot near the YMCA, First Baptist Church (Franklin / 3rd / Marshall) and the vacant lot at Franklin / Elm as well as increased detention at Elmwood Park to reduce peak discharges instead o installing larger pipes downstream. Could also deploy some Green Streets if increased detention volumes are needed beyond these detention basin ideas.
11	**Trout Run Watershed Improvements -**Upper Watershed LID and/or Stream Daylighting above the CCBC Facility in the Trout Run Watershed	Not sure how realistic LID watershed-wide implementation is for this solution or if a realistic level of participation could be met with the right incentives. Would be like Montgomery County Rainscapes, so I've started coordination with them to see if they have had flood reduction benefits from LID. The previous stream daylighting study at the CCBC site can also be referenced into this alternative for upper watershed options involving stream daylighting.	Preliminary SWMM modeling would need to show a reduction in peak discharges for smaller detention nodes throughout the upper watershed, to demonstrate the feasibility of this alternative to reduce downtown flooding.	Need to refine preliminary SWMM modeling to better gage if this might work based on a percentage of watershed participation, and if it might work better in the other, smaller watersheds contributing to downtown. Also, if there are any demonstrable success stories in reducing Q25-type flooding with this type of approach and the level of partiicpation that may be required. There are also vacant lots that could be converted to small detention basins, and local streets that could be converted into Green Streets as part of a public-private watershed parntership.
12	**Downtown Parking Lot Detention Regulations**- Considering that surface parking lots created excessive runoff in CBD flood prone areas, the City should require parking lot detention (underground storage/permeable pavement) in any development plans. We also discussed including some type of 25/10 detention requirement in flood prone areas downtown	Might not be enough storage volume to help with larger storms, and might be cost prohibitive as a public works project since most of the lots are privately owned, but many have asphalt in bad shape. This could be promoted as a regulatory requirement for redevelopment projects, however and the city could provide other incentives for public participation	Preliminary SWMM modeling would need to show a reduction in peak discharges for smaller detention nodes throughout the downtown area, to demonstrate the feasibility of this alternative to reduce downtown flooding.	Preliminary SWMM results have shown that a decentralized plan to require 25/10 detention in parking lots downtown may have a negative affect on the time to peak, potentially increasing flood potential by delaying and detaining the downtown runoff until the upper watershed comes. Need to verify this.
13	**Maintenance Access Upgrades**- Provide improved maintenance access, including a Junction Box behind Warehouse Row. Also provide improved maintenance access at other locations with debris or clogging issues (see Trout Run Tunnel Inspection) and other areas of planned construction work.	At each location required, improvements to permanent access should be made including ladders, steps and/or safety slabs. Also, remove sediment and make structural repairs. See the Trout Run Inspection Report for notes about heavy sediment, trash, ballast and brick at short section EF, west of Section C.	Likely to be combined with other alternatives in its implementation as part of the flood reduction strategy downtown, and not a separate alternative.	There is a definite need for improved maintianance access to the downtown tunnels. This would likely be part of other alternatives being considered and also part of an overall master plan to gain access to the downtown system a regular intervals while also inspecting and repairing for long-term performance. We might also retrofit sediment traps at the access points for easier sediment removal. 5 locations for improved access have already been identified.
14	**N-S Railroad Yard Diversion** - The only place near downtown where there might be residual lands for a larger detention alternative, is the unused N-S railroad rights of way. This alternative studies the collection of excess runoff in the railroad yard to then divert away from the Norfolk Tunnel or treat in detention basins to reduce peak discharges.	The biggest scenario that is not on our 10 - 15 list currently is concerning the runoff generated from railroad land in Trout Run. In the WMP, I noted that the railroad's staging areas and ballasted tracks constitute 10% (144 ac) of the total WS area....all impervious and susceptible to sediment transport. Is the entirety of the staging area still used? Does N-S have plans for this area for the future? Can it be repurporposed with GI for SWU Fee Credit (land conversion?) and an improved relationship between N-S and Roanoke City. Need to do some preliminary SWMM modeling to see if it helps with flooding or just improves water quality (Marcus).	see Marcus' comments.	The biggest scenario that is not on our 10 - 15 list currently is concerning the runoff generated from railroad land in Trout Run. In the WMP, I noted that the railroad's staging areas and ballasted tracks constitute 10% (144 ac) of the total WS area....all impervious and susceptible to sediment transport. Is the entirety of the staging area still used? Does N-S have plans for this area for the future? Can it be repurporposed with GI for SWU Fee Credit (land conversion?) and an improved relationship between N-S and Roanoke City. Need to do some preliminary SWMM modeling to see if it helps with downtown flooding or just improves water quality.
15	**Luck Avenue Bypass Storm Drain**- Provide improved maintenance access, including a Junction Box behind Warehouse Row. Also provide improved maintenance access at other locations with debris or clogging issues (see Trout Run Tunnel Inspection) and other areas of planned construction work.	This alternative was based heavily on the 1991 Report entitled, "Preliminary Design Report Luck Avenue By-Pass Storm Drain Project" by Lumsden, and included a new and parallel storm drain system to convey runoff from the upper watershed to the Campbell Tunnel more effectively.	Likely to be combined with other alternatives in its implementation as part of the flood reduction strategy downtown, and not a separate alternative.	There is a definite need for improved maintianance access to the downtown tunnels. This would likely be part of other alternatives being considered and also part of an overall master plan to gain access to the downtown system a regular intervals while also inspecting and repairing for long-term performance. We might also retrofit sediment traps at the access points for easier sediment removal. 5 locations for improved access have already been identified.

Flood Mitigation in Roanoke's Central Business District (CBD)

Preliminary Water Quality Calculations

AMT

Completed on October 19, 2020

BMP ID	BMP Type	Drainage Area (acres)					Reduction Efficiencies				
		Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	TN	TP	TSS	Upstream BMP ID
Option 3	Wet Pond	338.050	366.820			0.000	704.870	20%	45%	60%	

TP Load Pretreatment (lb/yr)						TP Load Reduction (lb/yr)						Remaining Untreated TP Load (lbs/yr)					
Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total
138.60	594.25	0.00	0.00	0.00	732.85	62.37	267.41	0.00	0.00	0.00	329.78	76.23	326.84	0.00	0.00	0.00	403.07

TN Load Pretreatment (lb/yr)						TN Load Reduction (lb/yr)						Remaining Untreated TN Load (lbs/yr)					
Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total
3404.16	6184.59	0.00	0.00	0.00	9588.75	680.83	1236.92	0.00	0.00	0.00	1917.75	2723.33	4947.67	0.00	0.00	0.00	7671.00

TSS Load Pretreatment (lb/yr)						TSS Load Reduction (lb/yr)						Remaining Untreated TSS Load (lbs/yr)					
Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total
59429.19	429663.60	0.00	0.00	0.00	489092.79	35657.51	257798.16	0.00	0.00	0.00	293455.68	23771.68	171865.44	0.00	0.00	0.00	195637.12

BMP type	TN %	TP %	TSS %
Bioretention	80	85	90
Shallow Marsh	20	45	60
Wet Pond	20	45	60
Veg Filter Strip	70	75	80
Detention Basin	5	10	10
Sand Filter	40	60	80
Extended Detention	60	38	76
Enhanced Extended Detention	20	45	60
Wet Swale	40	60	80
Dry Swale	40	60	80
Constructed Wetland	55	75	80

Land Use Loading	TN	TP	TSS
Reg Perv	10.07	0.41	175.8
Reg Imp	16.86	1.62	1171.32
Forest	5.29	0.13	79.91

Baseline	TN	TP	TSS
Ratio to TP	6.9	1	469.2
Baseline Loading Rate	2.83	0.41	192.37

Flood Mitigation in Roanoke's Central Business District (CBD) **AMT**

Preliminary Water Quality Calculations *Completed on October 19, 2020*

BMP ID	BMP Type	Drainage Area (acres)					Reduction Efficiencies				
		Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	TN	TP	TSS	Upstream BMP ID
Option 8	Permeable Train	23.400	50.200			0.000	73.600	76%	75%	95%	

TP Load Pretreatment (lb/yr)						TP Load Reduction (lb/yr)						Remaining Untreated TP Load (lbs/yr)					
Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total
9.59	81.32	0.00	0.00	0.00	90.92	7.20	60.99	0.00	0.00	0.00	68.19	2.40	20.33	0.00	0.00	0.00	22.73

TN Load Pretreatment (lb/yr)						TN Load Reduction (lb/yr)						Remaining Untreated TN Load (lbs/yr)					
Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total
235.64	846.37	0.00	0.00	0.00	1082.01	179.08	643.24	0.00	0.00	0.00	822.33	56.55	203.13	0.00	0.00	0.00	259.68

TSS Load Pretreatment (lb/yr)						TSS Load Reduction (lb/yr)						Remaining Untreated TSS Load (lbs/yr)					
Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total
4113.72	58800.26	0.00	0.00	0.00	62913.98	3908.03	55860.25	0.00	0.00	0.00	59768.28	205.69	2940.01	0.00	0.00	0.00	3145.70

BMP type	TN %	TP %	TSS %
Bioretention	80	85	90
Shallow Marsh	20	45	60
Wet Pond	20	45	60
Veg Filter Strip	70	75	80
Detention Basin	5	10	10
Sand Filter	40	60	80
Extended Detention	60	38	76
Enhanced Extended Detention	20	45	60
Wet Swale	40	60	80
Dry Swale	40	60	80
Constructed Wetland	55	75	80

Land Use Loading	TN	TP	TSS
Reg Perv	10.07	0.41	175.8
Reg Imp	16.86	1.62	1171.32
Forest	5.29	0.13	79.91

Baseline	TN	TP	TSS
Ratio to TP	6.9	1	469.2
Baseline Loading Rate	2.83	0.41	192.37

Flood Mitigation in Roanoke's Central Business District (CBD)

Preliminary Water Quality Calculations

AMT

Completed on October 19, 2020

BMP ID	BMP Type	Drainage Area (acres)					Reduction Efficiencies				
		Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	TN	TP	TSS	Upstream BMP ID
Option 10	Permeable Train	17.050	48.980			0.000	66.030	76%	75%	95%	

TP Load Pretreatment (lb/yr)						TP Load Reduction (lb/yr)						Remaining Untreated TP Load (lbs/yr)					
Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total
6.99	79.35	0.00	0.00	0.00	86.34	5.24	59.51	0.00	0.00	0.00	64.75	1.75	19.84	0.00	0.00	0.00	21.58

TN Load Pretreatment (lb/yr)						TN Load Reduction (lb/yr)						Remaining Untreated TN Load (lbs/yr)					
Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total
171.69	825.80	0.00	0.00	0.00	997.50	130.49	627.61	0.00	0.00	0.00	758.10	41.21	198.19	0.00	0.00	0.00	239.40

TSS Load Pretreatment (lb/yr)						TSS Load Reduction (lb/yr)						Remaining Untreated TSS Load (lbs/yr)					
Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total	Reg Perv	Reg Imp	UnR Perv	UnR Imp	Forest	Total
2997.39	57371.25	0.00	0.00	0.00	60368.64	2847.52	54502.69	0.00	0.00	0.00	57350.21	149.87	2868.56	0.00	0.00	0.00	3018.43

BMP type	TN %	TP %	TSS %
Bioretention	80	85	90
Shallow Marsh	20	45	60
Wet Pond	20	45	60
Veg Filter Strip	70	75	80
Detention Basin	5	10	10
Sand Filter	40	60	80
Extended Detention	60	38	76
Enhanced Extended Detention	20	45	60
Wet Swale	40	60	80
Dry Swale	40	60	80
Constructed Wetland	55	75	80

Land Use Loading	TN	TP	TSS
Reg Perv	10.07	0.41	175.8
Reg Imp	16.86	1.62	1171.32
Forest	5.29	0.13	79.91

Baseline	TN	TP	TSS
Ratio to TP	6.9	1	469.2
Baseline Loading Rate	2.83	0.41	192.37

WebGrants Portal -> Scope of Work Document Crosswalk

Table provides a crosswalk between the WebGrants portal and the City's submitted Scope of Work narrative document

Tab 5 - Scope of Work - Projects

Order on Grants Portal	Item	Scope of Work Narrative Sections
1	Budget Narrative	5, Appendix B

Tab 6 - Scope of Work Supporting Information - Projects

Order on Grants Portal	Item	Scope of Work Narrative Sections
1	Population	4.1.a.
2	Historic Flooding data and Hydrologic Studies	4.1.b.
3	No Adverse Impact	4.1.c.
4	Ability to Provide Share of Cost	4.1.d.
5	Benefit-Cost Analysis	4.1.e
6	Repetitive Loss and or Severe Repetitive Loss Properties	4.1.g.i.
7	Residential and/or Commercial Structures	3.1, 4.1.e, 4.1.g.ii.
8	Critical Facilities/Infrastructure	4.1.g.iii.
9	Financial and Staff Resources	4.1.d, 4.2.a
10	Goals and Objectives	3.2
11	Approach Milestones and Deliverables	3.3
12	Relationship to Other Projects	4.6
13	Maintenance Plan	4.7
14	Criteria	4.8, Table 4

Tab 10 - Supporting Documentation

Order on Grants Portal	Item	Scope of Work Narrative Sections
1	Detailed map of the project area(s) (Projects/Studies)	Appendix C.1
2	FIRMette of the project area(s) (Projects/Studies)	Appendix C.2
3	Historic flood damage data and/or images (Projects/Studies)	Appendix D, Section 4.1.b.
4	A link to or a copy of the current floodplain ordinance	Appendix C.4
5	Maintenance and management plan for project	Section 4.7
6	A link to or a copy of the current hazard mitigation plan	Appendix C.6
7	A link to or a copy of the current comprehensive plan	Appendix C.7
8	Social vulnerability index score(s) for the project area	Section 4.2.b
9	Authorization to request funding from the Fund from governing body or chief executive of the local government	Appendix C.13
10	Signed pledge agreement from each contributing organization	Appendix A
11	Maintenance Plan	Section 4.7
12	Benefit Cost Analysis	Section 4.1.e.
13	Other Relevant Attachments	Appendix D-G

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5	Benefit-Cost Analysis	4.1.e
6	Repetitive Loss and or Severe Repetitive Loss Properties	4.1.g.i.
7	Residential and/or Commercial Structures	3.1, 4.1.e, 4.1.g.ii.
8	Critical Facilities/Infrastructure	4.1.g.iii.
9	Financial and Staff Resources	4.1.d, 4.2.a
10	Goals and Objectives	3.2
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12	Relationship to Other Projects	4.6
13	Maintenance Plan	4.7
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Tab 10 - Supporting Documentation

Order on Grants Portal	Item	Scope of Work Narrative Sections
1	Detailed map of the project area(s) (Projects/Studies)	Appendix C.1
2	FIRMette of the project area(s) (Projects/Studies)	Appendix C.2
3	Historic flood damage data and/or images (Projects/Studies)	Appendix D, Section 4.1.b.
4	A link to or a copy of the current floodplain ordinance	Appendix C.4
5	Maintenance and management plan for project	Section 4.7
6	A link to or a copy of the current hazard mitigation plan	Appendix C.6
7	A link to or a copy of the current comprehensive plan	Appendix C.7
8	Social vulnerability index score(s) for the project area	Section 4.2.b
9	Authorization to request funding from the Fund from governing body or chief executive of the local government	Appendix C.13
10	Signed pledge agreement from each contributing organization	Appendix A
11	Maintenance Plan	Section 4.7
12	Benefit Cost Analysis	Section 4.1.e.
13	Other Relevant Attachments	Appendix D-G

WebGrants Portal -> Scope of Work Document Crosswalk

Table provides a crosswalk between the WebGrants portal and the City's submitted Scope of Work narrative document

Tab 5 - Scope of Work - Projects

Order on Grants Portal	Item	Scope of Work Narrative Sections
1	Budget Narrative	5, Appendix B

Tab 6 - Scope of Work Supporting Information - Projects

Order on Grants Portal	Item	Scope of Work Narrative Sections
1	Population	4.1.a.
2	Historic Flooding data and Hydrologic Studies	4.1.b.
3	No Adverse Impact	4.1.c.
4	Ability to Provide Share of Cost	4.1.d.
5	Benefit-Cost Analysis	4.1.e
6	Repetitive Loss and or Severe Repetitive Loss Properties	4.1.g.i.
7	Residential and/or Commercial Structures	3.1, 4.1.e, 4.1.g.ii.
8	Critical Facilities/Infrastructure	4.1.g.iii.
9	Financial and Staff Resources	4.1.d, 4.2.a
10	Goals and Objectives	3.2
11	Approach Milestones and Deliverables	3.3
12	Relationship to Other Projects	4.6
13	Maintenance Plan	4.7
14	Criteria	4.8, Table 4

Tab 10 - Supporting Documentation

Order on Grants Portal	Item	Scope of Work Narrative Sections
1	Detailed map of the project area(s) (Projects/Studies)	Appendix C.1
2	FIRMette of the project area(s) (Projects/Studies)	Appendix C.2
3	Historic flood damage data and/or images (Projects/Studies)	Appendix D, Section 4.1.b.
4	A link to or a copy of the current floodplain ordinance	Appendix C.4
5	Maintenance and management plan for project	Section 4.7
6	A link to or a copy of the current hazard mitigation plan	Appendix C.6
7	A link to or a copy of the current comprehensive plan	Appendix C.7
8	Social vulnerability index score(s) for the project area	Section 4.2.b
9	Authorization to request funding from the Fund from governing body or chief executive of the local government	Appendix C.13
10	Signed pledge agreement from each contributing organization	Appendix A
11	Maintenance Plan	Section 4.7
12	Benefit Cost Analysis	Section 4.1.e.
13	Other Relevant Attachments	Appendix D-G

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4	Ability to Provide Share of Cost	4.1.d.
5	Benefit-Cost Analysis	4.1.e
6	Repetitive Loss and or Severe Repetitive Loss Properties	4.1.g.i.
7	Residential and/or Commercial Structures	3.1, 4.1.e, 4.1.g.ii.
8	Critical Facilities/Infrastructure	4.1.g.iii.
9	Financial and Staff Resources	4.1.d, 4.2.a
10	Goals and Objectives	3.2
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4	A link to or a copy of the current floodplain ordinance	Appendix C.4
5	Maintenance and management plan for project	Section 4.7
6	A link to or a copy of the current hazard mitigation plan	Appendix C.6
7	A link to or a copy of the current comprehensive plan	Appendix C.7
8	Social vulnerability index score(s) for the project area	Section 4.2.b
9	Authorization to request funding from the Fund from governing body or chief executive of the local government	Appendix C.13
10	Signed pledge agreement from each contributing organization	Appendix A
11	Maintenance Plan	Section 4.7
12	Benefit Cost Analysis	Section 4.1.e.
13	Other Relevant Attachments	Appendix D-G

WebGrants Portal -> Scope of Work Document Crosswalk

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4	A link to or a copy of the current floodplain ordinance	Appendix C.4
5	Maintenance and management plan for project	Section 4.7
6	A link to or a copy of the current hazard mitigation plan	Appendix C.6
7	A link to or a copy of the current comprehensive plan	Appendix C.7
8	Social vulnerability index score(s) for the project area	Section 4.2.b
9	Authorization to request funding from the Fund from governing body or chief executive of the local government	Appendix C.13
10	Signed pledge agreement from each contributing organization	Appendix A
11	Maintenance Plan	Section 4.7
12	Benefit Cost Analysis	Section 4.1.e.
13	Other Relevant Attachments	Appendix D-G

WebGrants Portal -> Scope of Work Document Crosswalk

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7	A link to or a copy of the current comprehensive plan	Appendix C.7
8	Social vulnerability index score(s) for the project area	Section 4.2.b
9	Authorization to request funding from the Fund from governing body or chief executive of the local government	Appendix C.13
10	Signed pledge agreement from each contributing organization	Appendix A
11	Maintenance Plan	Section 4.7
12	Benefit Cost Analysis	Section 4.1.e.
13	Other Relevant Attachments	Appendix D-G

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10	Signed pledge agreement from each contributing organization	Appendix A
11	Maintenance Plan	Section 4.7
12	Benefit Cost Analysis	Section 4.1.e.
13	Other Relevant Attachments	Appendix D-G