





FINAL

Upper West Neck Creek Drainage Basin
Stormwater Master Plan

December 2021











PREPARED FOR:

City of Virginia Beach

PREPARED BY:

Kimley»Horn

Table of Contents

1 Introduction 1

2 Methodology and Assumptions 5

2.1 Hydraulic Modeling and Design 5

2.2 Level of Service 6

2.3 Alternative and Project Scoring 8

2.4 Project Figures 8

2.5 Opinions of Probable Construction Cost (OPCC) 9

2.6 Benefit-Cost Ratio (BCR) and Benefit Ratio (BR) Calculations 10

3 Upper West Neck Creek Drainage Basin SFAs 11

3.1 Buckner Farms 12

3.1.1 ***Phase 1: Dam Neck Road at Holland Road*** 12

3.1.2 ***Phase 2A: Holland Road at Shipps Corner Road*** 14

3.1.3 ***Phase 2B: Light Horse Loop and Storm Bird Loop*** 15

3.1.4 ***Phase 3A: Criollo Drive*** 17

3.1.5 ***Phase 3B: Buckner Boulevard at Crofts Pride Drive*** 18

3.1.6 ***Phase 4A: Brigands Way at Dam Neck Road*** 19

3.1.7 ***Phase 4B: Grassland Farms*** 21

3.1.8 ***Phase 4C: Buckner Farms North*** 23

3.1.9 ***Buckner Farms Combined Summary*** 25

3.2 Buyrn Circle at Buyrn Court 26

3.3 Buyrn Farm 27

3.4 Castleton 29

3.5 Christopher Farms 31

3.5.1 ***Phase 1: Princess Anne Crossing*** 31

3.5.2 ***Phase 2: North Christopher Farms*** 33

3.5.3 ***Christopher Farms Combined Summary*** 35

3.6 Court House Forest 36

3.7 Courthouse Drive at James Madison Boulevard 38

3.8 Dam Neck Road and Harpers Road 41

3.8.1 ***Phase 1: London Bridge Road at Harpers Road*** 41

3.8.2 ***Phase 2: Dam Neck Road at Harpers Road*** 43

3.8.3 ***Dam Neck Road and Harpers Road Combined Summary*** 45

3.9 Dam Neck Road at Drakesmile Road 46

3.10 Dam Neck Road at Princess Anne Road 49

3.11 Dam Neck Road at Taylor Farm Road 52

3.12 Drakesmile Road at HRSD Shipps Corner Pressure Reducing Station (PRS) 55

3.13 Drakesmile Road at Shipps Corner Road 57
3.14 Eagles Nest 59
3.15 Foxfire 62
3.16 General Booth Boulevard at Corporate Landing 65
3.17 Heron Ridge Estates 67
3.18 Highgate Greens and Seaboard Forest 70
3.18.1 ***Phase 1: Live Oak Trail at Seaboard Road*** 70
3.18.2 ***Phase 2: Highgate Greens and Sawyer's Meadow*** 72
3.18.3 ***Highgate Greens and Seaboard Forest Combined Summary*** 73
3.19 Holland Oaks and Holland Pines North 75
3.20 Holland Woods 77
3.21 Indian River Road 79
3.22 Lake Placid 80
3.23 Landstown Meadows and Landstown Lakes 82
3.24 Laurel Oak Lane at Holland Road 85
3.25 Leroy Road at Farmers Court 88
3.26 Litchfield Manor, Highcourt and Princess Anne Quarter 91
3.27 London Bridge Road at Hunt Club Farm 94
3.28 Maple Shade Drive at Wild Cherry Court 96
3.29 Mayberry Drive at London Bridge Road 98
3.30 Mulberry Loop 101
3.31 Nestlebrook Trail 103
3.32 Nimmo Parkway at Seaboard Road 106
3.33 Penshurst Way 108
3.34 Pine Ridge and Middle Oaks Plantation 110
3.34.1 ***Phase 1: Pine View Avenue at London Bridge Road*** 110
3.34.2 ***Phase 2: Breezy Pines Lane at Bartholomews Crossing*** 112
3.34.3 ***Pine Ridge and Middle Oaks Plantation Combined Summary*** 113
3.35 Prince George Estates 115
3.36 Princess Anne Place 118
3.37 Princess Anne Road at Landstown Centre Way 120
3.38 Princess Anne Road at Mathews Green Road 122
3.39 Princess Anne Road at North Landing Road 125
3.40 Princess Anne Road at Seaboard Road 128
3.41 Princess Anne Woods 130
3.42 Rollingwood 133
3.43 Saville Garden Way at Holland Road 135

3.44 Seaboard Road and Chloe Lane 138
3.45 Seaboard Road at County Place 141
3.46 Seaboard Road at Heron Ridge Lane 143
3.47 Signature Circle 146
3.48 South Rosemont Road at Buckner Boulevard 149
3.49 South Rosemont Road at Concert Drive 151
3.50 Springhaven Drive at Windy Pines Bend 153
3.51 Strawbridge Park 155
3.52 Strawbridge Park North 157
3.53 Taylor Farm Road at Aviator Drive 160
3.54 Three Oaks 163
3.55 Tower Bridge Loop North 165
3.56 Tower Bridge Loop at Seven Kings Road 167
3.57 Tree Garden Way at Kindling Hollow Road 169
3.58 Victoria Park 171
3.59 West Neck Road at North Landing Road 174
3.60 West Neck Road at Signature Drive 176
3.61 Windy Pines Bend at Piney Woods Lane 178
3.62 Windy Willow Court 180
3.63 Woodhouse Corner 182
3.63.1 ***Phase 1: Hunters Run Trail at Rockingchair Lane*** 182
3.63.2 ***Phase 2A: West Southgate*** 184
3.63.3 ***Phase 2B: Hunt Club Forest*** 185
3.63.4 ***Phase 3: East Southgate*** 187
3.63.5 ***Phase 4A: Nimmo Parkway Eastbound at Rockingchair Lane*** 189
3.63.6 ***Phase 4B: McComas Way at General Booth Boulevard*** 190
3.63.7 ***Phase 5A: McComas Way at Nimmo Parkway*** 191
3.63.8 ***Phase 5B: General Booth Boulevard at Strawbridge Marketplace*** 192
3.63.9 ***Woodhouse Corner Combined Summary*** 195
4 Conclusion.....196

Abbreviations

AACE – Association for the Advancement of Cost Engineering

AAL – Average Annual Loss

ASC – Alternative Selection Criteria

BCR – Benefit-Cost Ratio

BMP – Best Management Practice

BR – Benefit Ratio

CIP – Capital Improvement Program

DEQ – Department of Environmental Quality

DPU – Department of Public Utilities (City)

ENR – Engineering News-Record

ER – Easement Required (width available)

ER* - Easement Required (PWDSM width not available, but improvements can likely be constructed/maintained)

FEMA – Federal Emergency Management Agency

FSI – Formed Suction Intake

GIS – Geographic Information System

HAZUS – FEMA Flood Loss Estimate Software Hazards US

HGL – Hydraulic Grade Line

HOA – Homeowners' Association

LF – Linear Feet

LiDAR – Light Detection and Radar

LOS – Level of Service

MDM – Master Drainage Model

NAS – Naval Air Station

NAVD – North American Vertical Datum

NOAA – National Oceanic and Atmospheric Administration

NPV – Net Present Value

NWSE – Normal Water Surface Elevation

OPCC – Opinion of Probable Construction Cost

PA – Property Acquisition Required

PPC – Project Performance Criteria

PRS – Pressure Reducing Station

PSMS – Primary Stormwater Management System

PWDSM – Public Works Design Standards Manual (2020)

PW-SWEC – Public Works Stormwater Engineering Center

ROW – Right-of-Way

SFA – Simulated Flooding Area

SLR – Sea Level Rise

SLW – Sea Level Wise

SWMF – Stormwater Management Facility

SWMM – Stormwater Management Model

SWMP – Stormwater Master Plan

TMDL – Total Maximum Daily Load

USGS – United States Geological Survey

VCRIS – Virginia Cultural Resource Information Systems

VGIN – Virginia Geographic Information Network

VSMP – Virginia Stormwater Management Program

List of Figures

Figure 1. City Drainage Basin Location Map 2
Figure 2. Upper West Neck Creek Basin Overall Map 3
Figure 3. Stormwater Master Plan Process Flowchart 4
Figure 4. Upper West Neck Creek Basin Detailed SFA Map 11
Figure 5. Location Map of Dam Neck Road at Holland Road, Holland Road at Shipps Corner Road, Light Horse Loop and Storm Bird Loop, Criollo Drive, Buckner Boulevard at Crofts Pride Drive, Brigands Way at Dam Neck Road, Grassland Farms, and Buckner Farms North SFAs 12
Figure 6: Location Map of Buyrn Circle at Buyrn Court SFA 26
Figure 7. Location Map of Buyrn Farm SFA 27
Figure 8. Location Map of Castleton SFA 29
Figure 9. Location Map of Princess Anne Crossing, Princess Anne Road at Tournament Drive, Christopher Farms Drive, Pleasant Acres Drive, and Princess Anne Road at Seagrass Way SFAs 31
Figure 10. Location Map of Court House Forest SFA 36
Figure 11 Location Map of Courthouse Drive at Mattaponi Road and George Mason Drive at James Madison Boulevard SFAs 38
Figure 12. Location Map of Dam Neck Road at London Bridge Road, Dam Neck Road at Taylor Farms, Harpers Road at Castleton Commerce Way, and Colony Drive at London Bridge Road SFAs 41
Figure 13. Location Map of Dam Neck Road at Drakesmile Road SFA 46
Figure 14. Location Map of Dam Neck Road at Princess Anne Road, Landstown Court, and Dam Neck Road at Public Utilities Operations SFAs 49
Figure 15. Location Map of Horse Pasture Road at Taylor Farm Road and Dam Neck Road at Horse Pasture Road SFAs 52
Figure 16. Location Map of Drakesmile Road at HRSD Shipps Corner PRS SFA 55
Figure 17. Location Map of Drakesmile Road at Shipps Corner Road SFA 57
Figure 18. Location Map of Eagles Nest at Coopers Arch and Eagles Nest at Kestrel Lane SFAs 59
Figure 19. Location Map of Foxfire SFA 62
Figure 20. Location Map of General Booth Boulevard at Corporate Landing SFA 65
Figure 21. Location Map of Heron Ridge Estates SFA 67
Figure 22. Location Map of Live Oak Trail at Seaboard Road, Highgate Greens, and Bodnar Lane SFAs 70
Figure 23. Location Map of Holland Oaks and Holland Pines North SFA 75
Figure 24. Location Map of Holland Woods SFA 77
Figure 25. Location Map of Indian River Road 1-3 SFAs 79
Figure 26. Location Map of Lake Placid SFA 80
Figure 27. Location Map of Barberry Lane at Bloomfield Drive, Glastonberry Drive at Monet Drive, and Winterberry Lane at Holland Road SFAs 82
Figure 28. Location Map of Laurel Oak Lane at Holland Road SFA 85
Figure 29. Location Map of Leroy Road at Farmers Court SFA 88
Figure 30. Location Map of Highcourt and Princess Anne Quarter, Holland Road at Litchfield Way, and Litchfield Manor SFAs 91
Figure 31. Location Map of London Bridge Road at Hunt Club Farm SFA 94
Figure 32. Location Map of Maple Shade Drive at Wild Cherry Court SFA 96
Figure 33. Location Map of Mayberry Drive at London Bridge Road SFA 98
Figure 34. Location Map of Mulberry Loop SFA 101
Figure 35. Location Map of Nestlebrook Trail at Indian River Road, Stonewood Drive at Nestlebrook Trail, and Stonewood Drive at West Neck Road SFAs 103

Figure 36. Location Map of Nimmo Parkway at Seaboard Road and Seaboard Road at Smokehouse Road SFAs 106
Figure 37. Location Map of Penshurst Way SFA 108
Figure 38. Location Map of Pine View Avenue at London Bridge Road and Breezy Pines Lane at Bartholomews Crossing SFAs 110
Figure 39. Location Map of London Bridge Road at Castleton Commerce Way and Prince George Estates SFAs 115
Figure 40. Location Map of Princess Anne Place SFA 118
Figure 41. Location Map of Princess Anne Road at Landstown Centre Way SFA 120
Figure 42. Location Map of Princess Anne Road at General Booth Boulevard and Mathews Green Road at Princess Anne Road SFAs 122
Figure 43. Location Map of Princess Anne Road at North Landing Road SFA 125
Figure 44. Location Map of Princess Anne Road at Seaboard Road SFA 128
Figure 45. Location Map of Princess Anne Woods SFA 130
Figure 46. Location Map of Rollingwood SFA 133
Figure 47. Location Map of Bernard Farms and Greenwood SFAs 135
Figure 48. Location Map of Chloe Lane at Childeric Road and Seaboard Road at Huckleberry Trail SFAs 138
Figure 49. Location Map of Seaboard Road at County Place SFA 141
Figure 50. Location Map of Seaboard Road at Heron Ridge Golf Club and Seaboard Road at Golfwatch Lane SFAs 143
Figure 51. Location Map of Einstein Drive and Willowlawn Way and Signature Drive at Wilderness Lane SFAs 146
Figure 52. Location Map of South Rosemont Road at Buckner Boulevard SFA 149
Figure 53. Location Map of South Rosemont Road at Concert Drive SFA 151
Figure 54. Location Map of Springhaven Drive at Windy Pines Bend SFA 153
Figure 55. Location Map of Strawbridge Park SFA 155
Figure 56. Location Map of Strawbridge Park North SFA 157
Figure 57. Location Map of Taylor Farm Road at Encounter Court and Taylor Farm Road at Engagement Court SFAs 160
Figure 58. Location Map of Three Oaks SFA 163
Figure 59. Location Map of Tower Bridge Loop North SFA 165
Figure 60. Location Map of Tower Bridge Loop at Seven Kings Road SFA 167
Figure 61. Location Map of Tree Garden Way at Kindling Hollow Road SFA 169
Figure 62. Location Map of Bombay Landing at Wilhelm Drive and West Neck Road at Kellam High School SFA 171
Figure 63. Location Map of West Neck Road at North Landing Road SFA 174
Figure 64. Location Map of West Neck Road at Signature Drive SFA 176
Figure 65. Location Map of Windy Pines Bend at Piney Woods Lane SFA 178
Figure 66. Location Map of Windy Willow Court SFA 180
Figure 67. Location Map of Hunters Run Trail at Rockingchair Lane, West Southgate, Grey Fox Lane at Piney Bark Drive, Hunting Horn Way at Hunters Run Trail, Hunts Neck Trail at Grey Fox Lane, Nimmo Parkway Westbound at Hunters Run Trail, East Southgate, Nimmo Parkway Eastbound at Rockingchair Lane, McComas Way at General Booth Boulevard, McComas Way at Nimmo Parkway, and General Booth Boulevard at Strawbridge Marketplace SFAs 182
Figure 68. Upper West Neck Creek Tier 1 and 2 Projects 198

List of Tables

Table 1. Dam Neck Road at Holland Road Project Summary 14
Table 2. Holland Road at Shipps Corner Road Project Summary 15
Table 3. Light Horse Loop and Storm Bird Loop Project Summary 17
Table 4. Criollo Drive Project Summary 18
Table 5. Buckner Boulevard at Crofts Pride Drive Project Summary 19
Table 6. Brigands Way at Dam Neck Road Project Summary 21
Table 7. Grassland Farms Project Summary 23
Table 8. Buckner Farms North Project Summary 24
Table 9. Buckner Farms Project Summary 25
Table 10. Buyrn Farm Project Summary 28
Table 11. Castleton Project Summary 30
Table 12. Princess Anne Crossing Project Summary 33
Table 13. North Christopher Farms Project Summary 34
Table 14. Christopher Farms Summary 35
Table 15. Court House Forest Project Summary 37
Table 16. Courthouse Drive at James Madison Boulevard Project Summary 40
Table 17. London Bridge Road at Harpers Road Project Summary 43
Table 18. Dam Neck Road at Harpers Road Project Summary 45
Table 19. Dam Neck and Harpers Road Project Summary 45
Table 20. Dam Neck Road at Drakesmile Road Project Summary 48
Table 21. Dam Neck Road at Princess Anne Road Project Summary 51
Table 22. Dam Neck Road at Taylor Farm Road Project Summary 54
Table 23. Drakesmile Road at HRSD Shipps Corner PRS Project Summary 56
Table 24. Drakesmile Road at Shipps Corner Road Project Summary 58
Table 25. Eagles Nest Project Summary 61
Table 26. Foxfire Project Summary 64
Table 27. General Booth Boulevard at Corporate Landing Project Summary 66
Table 28. Heron Ridge Estates Project Summary 69
Table 29. Live Oak Trail at Seaboard Road Project Summary 72
Table 30. Highgate Greens and Sawyer's Meadow Project Summary 73
Table 31. Highgate Greens and Seaboard Forest Project Summary 74
Table 32. Holland Woods Project Summary 78
Table 33. Landstown Meadows and Landstown Lakes Project Summary 84
Table 34. Laurel Oak Lane at Holland Road Project Summary 87
Table 35. Leroy Road at Farmers Court Project Summary 90
Table 36. Litchfield Manor, Highcourt and Princess Anne Quarter Project Summary 93
Table 37. London Bridge Road at Hunt Club Farm Project Summary 95
Table 38. Maple Shade Drive at Wild Cherry Court Project Summary 97
Table 39. Mayberry Drive at London Bridge Road Project Summary 100
Table 40. Nestlebrook Trail Project Summary 105
Table 41. Nimmo Parkway at Seaboard Project Summary 107
Table 42. Penshurst Way Project Summary 109
Table 43. Pine View Avenue at London Bridge Road Project Summary 112
Table 44. Breezy Pines Lane at Bartholomews Crossing Project Summary 113
Table 45. Pine Ridge and Middle Oaks Plantation Summary 114
Table 46. Prince George Estates Project Summary 117
Table 47. Princess Anne Road at Landstown Centre Way Project Summary 121

Table 48. Princess Anne Road at Mathews Green Road Project Summary 124
Table 49. Princess Anne Road at North Landing Road Project Summary 127
Table 50. Princess Anne Woods Project Summary 132
Table 51. Rollingwood Project Summary 134
Table 52. Saville Garden Way at Holland Road Project Summary 137
Table 53. Seaboard Road and Chloe Lane Project Summary 140
Table 54. Seaboard Road at County Place Project Summary 142
Table 55. Seaboard Road at Heron Ridge Lane Project Summary 145
Table 56. Signature Circle Project Summary 148
Table 57. South Rosemont Road at Buckner Boulevard Project Summary 150
Table 58. South Rosemont Road at Concert Drive Project Summary 152
Table 59. Strawbridge Park Project Summary 156
Table 60. Strawbridge Park North Project Summary 159
Table 61. Taylor Farm Road at Aviator Drive Project Summary 162
Table 62. Three Oaks Project Summary 164
Table 63. Tower Bridge Loop North Project Summary 166
Table 64. Tree Garden Way at Kindling Hollow Road Project Summary 170
Table 65. Victoria Park Project Summary 173
Table 66. West Neck Road at North Landing Road Project Summary 175
Table 67. West Neck Road at Signature Drive Project Summary 177
Table 68. Windy Willow Court Project Summary 181
Table 69. Hunters Run Trail at Rockingchair Lane Project Summary 184
Table 70. West Southgate Project Summary 185
Table 71. Hunt Club Forest Project Summary 187
Table 72. East Southgate Project Summary 189
Table 73. Nimmo Parkway Eastbound at Rockingchair Lane Project Summary 190
Table 74. McComas Way at General Booth Boulevard Project Summary 191
Table 75. McComas Way at Nimmo Parkway Project Summary 192
Table 76. General Booth Boulevard at Strawbridge Marketplace Project Summary 194
Table 77. Woodhouse Corner Combined Project Summary 195
Table 78. Upper West Neck Creek Tier 1 Projects 199
Table 79. Upper West Neck Creek Tier 2 Projects 201
Table 80. Upper West Neck Creek Tier 3 Projects 203

List of Appendices

A	Benefit-Cost Analysis (BCA) Methodology
B-1	Buckner Farms
B-1-1	Phase 1: Dam Neck Road at Holland Road
B-1-2	Phase 2A: Holland Road at Shipps Corner Road
B-1-3	Phase 2B Light Horse Loop and Storm Bird Loop
B-1-4	Phase 3A: Criollo Drive
B-1-5	Phase 3B: Buckner Boulevard at Crofts Pride Drive
B-1-6	Phase 4A: Brigands Way at Dam Neck Road
B-1-7	Phase 4B: Grassland Farms
B-1-8	Phase 4C: Buckner Farms North
B-2	Buyrn Circle at Buyrn Court
B-3	Buryn Farm
B-4	Castleton
B-5	Christopher Farms
B-5-1	Phase 1: Princess Anne Crossing
B-5-2	Phase 2: North Christopher Farms
B-6	Court House Forest
B-7	Courthouse Drive at James Madison Boulevard
B-8	Dam Neck Road and Harpers Road
B-8-1	Phase 1: London Bridge Road at Harpers Road
B-8-2	Phase 2: Dam Neck Road at Harpers Road
B-9	Dam Neck Road at Drakesmile Road
B-10	Dam Neck Road at Princess Anne Road
B-11	Dam Neck Road at Taylor Farm Road
B-12	Drakesmile Road at HRSD Shipps Corner Pressure Reducing Station (PRS)
B-13	Drakesmile Road at Shipps Corner Road
B-14	Eagles Nest
B-15	Foxfire
B-16	General Booth Boulevard at Corporate Landing
B-17	Heron Ridge Estates
B-18	Highgate Greens and Seaboard Forest
B-18-1	Phase 1: Live Oak Trail at Seaboard Forest
B-18-2	Phase 2: Highgate Greens at Bodnar Lane
B-19	Holland Oaks and Holland Pines North
B-20	Holland Woods
B-21	Indian River Road
B-22	Lake Placid
B-23	Landstown Meadows and Landstown Lakes
B-24	Laurel Oak Lane at Holland Road
B-25	Leroy Road at Farmers Court
B-26	Litchfield Manor, Highcourt, and Princess Anne Quarter
B-27	London Bridge Road at Hunt Club Farm
B-28	Maple Shade Drive at Wild Cherry Court
B-29	Mayberry Drive at London Bridge Road
B-30	Mulberry Loop
B-31	Nestlebrook Trail
B-32	Nimmo Parkway at Seaboard Road

B-33	Penshurst Way
B-34	Pine Ridge and Middle Oaks Plantation
B-34-1	Phase 1: Pine View Avenue at London Bridge Road
B-34-2	Phase 2: Breezy Pines Lane at Bartholomews Crossing
B-35	Prince George Estates
B-36	Princess Anne Place
B-37	Princess Anne Road at Landstown Centre Way
B-38	Princess Anne Road at Mathews Green Road
B-39	Princess Anne Road at North Landing Road
B-40	Princess Anne Road at Seaboard Road
B-41	Princess Anne Woods
B-42	Rollingwood
B-43	Saville Garden Way at Holland Road
B-44	Seaboard Road and Chloe Lane
B-45	Seaboard Road at County Place
B-46	Seaboard Road at Heron Ridge Lane
B-47	Signature Circle
B-48	South Rosemont Road at Buckner Boulevard
B-49	South Rosemont Road at Concert Drive
B-50	Springhaven Drive at Windy Pines Bend
B-51	Strawbridge Park
B-52	Strawbridge Park North
B-53	Taylor Farm at Aviator Drive
B-54	Three Oaks
B-55	Tower Bridge Loop North
B-56	Tower Bridge Loop at Seven Kings Road
B-57	Tree Garden Way at Kindling Hollow Road
B-58	Victoria Park
B-59	West Neck Road at North Landing Road
B-60	West Neck Road at Signature Drive
B-61	Windy Pines Bend at Piney Woods Lane
B-62	Windy Willow Court
B-63	Woodhouse Corner
B-63-1	Phase 1: Hunters Run Trail at Rockingchair Lane
B-63-2	Phase 2A: West Southgate
B-63-3	Phase 2B: Hunt Club Forest
B-63-4	Phase 3: East Southgate
B-63-5	Phase 4A: Nimmo Parkway Eastbound at Rockingchair Lane
B-63-6	Phase 4B: McComas Way at General Booth Boulevard
B-63-7	Phase 5A: McComas Way at Nimmo Parkway
B-63-8	Phase 5B: General Booth Boulevard at Strawbridge Marketplace

Introduction



1 Introduction

The City of Virginia Beach (City) is located in a low-lying coastal area bordered by the Chesapeake Bay and the Atlantic Ocean. Over the years, flooding from relatively minor storm events has been a challenge to many areas of the City. Rain events can flood roadways—causing them to become impassable—and even damage homes and businesses.

In an effort to combat this challenge, the City of Virginia Beach Public Works Stormwater Engineering Center (PW-SWEC) is updating the Comprehensive Stormwater Management Plan (CDM 1990) to address the growing stormwater challenges within the City. The process is comprised of two components: a Master Drainage Model (MDM) and a Comprehensive Stormwater Master Plan (SWMP). The MDM is several City-wide stormwater models that contain all the major drainage networks in the City. The City uses these models to identify the areas where flooding occurs, known as Simulated Flooding Areas (SFAs). The focus of the SWMP is to develop and prioritize projects to improve the SFAs that are identified in the MDM.

SFAs are categorized by the rainstorm that begins to cause flooding, such as 1-, 2-, 10-, and 100-year. These categories tell how often a storm event, and its associated flooding, are likely to happen. A 1-year storm event has a 100 percent chance of occurring each year, whereas a 100-year storm event has a 1 percent chance (or 1 in 100 chance) of occurring in any given year. The City has five major outfalls: Elizabeth River, Little Creek, Lynnhaven River, the Oceanfront, and the Southern Rivers. These five outfalls are subdivided into 15 drainage basins. Consequently, stormwater runoff from the rainfall drains into one of the 15 drainage basins and ultimately into one of the five major outfalls, no matter where it falls in the City. Figure 1 presents the 15 drainage basins and identifies the location of the Upper West Neck Creek Drainage Basin. Figure 2 gives an overview of the extent of the Upper West Neck Creek Drainage Basin.

The first step in the SWMP was to develop a standardized set of criteria based on consensus from key stakeholders. The Alternative Selection Criteria (ASC) and the Project Performance Criteria (PPC) will be used to identify and prioritize improvements for each SFA. Refer to the Virginia Beach Stormwater Master Plan Criteria Technical Memorandum (October 2019) for further detail on how the City developed those criteria.

To ensure the applicability and soundness of the criteria, they had to be tested on a sample of proposed stormwater projects. Multiple alternatives were created for each SFA, and the ASC was applied to determine the highest ranked alternative. The highest-ranked alternative then became a project. A cost estimate, Benefit-Cost Ratio (BCR), and Benefit Ratio (BR) was determined for each project, and the projects were evaluated using the PPC. The last step was to calculate a combined ranking score for each project, which is the product of the selected ASC, PPC, BCR, and BR. The combined ranking score is used to separate the projects into three tiers. Upon confirming the criteria and the SWMP process as summarized above, the same process is being deployed to the other 14 drainage basins and is illustrated in Figure 3 below.

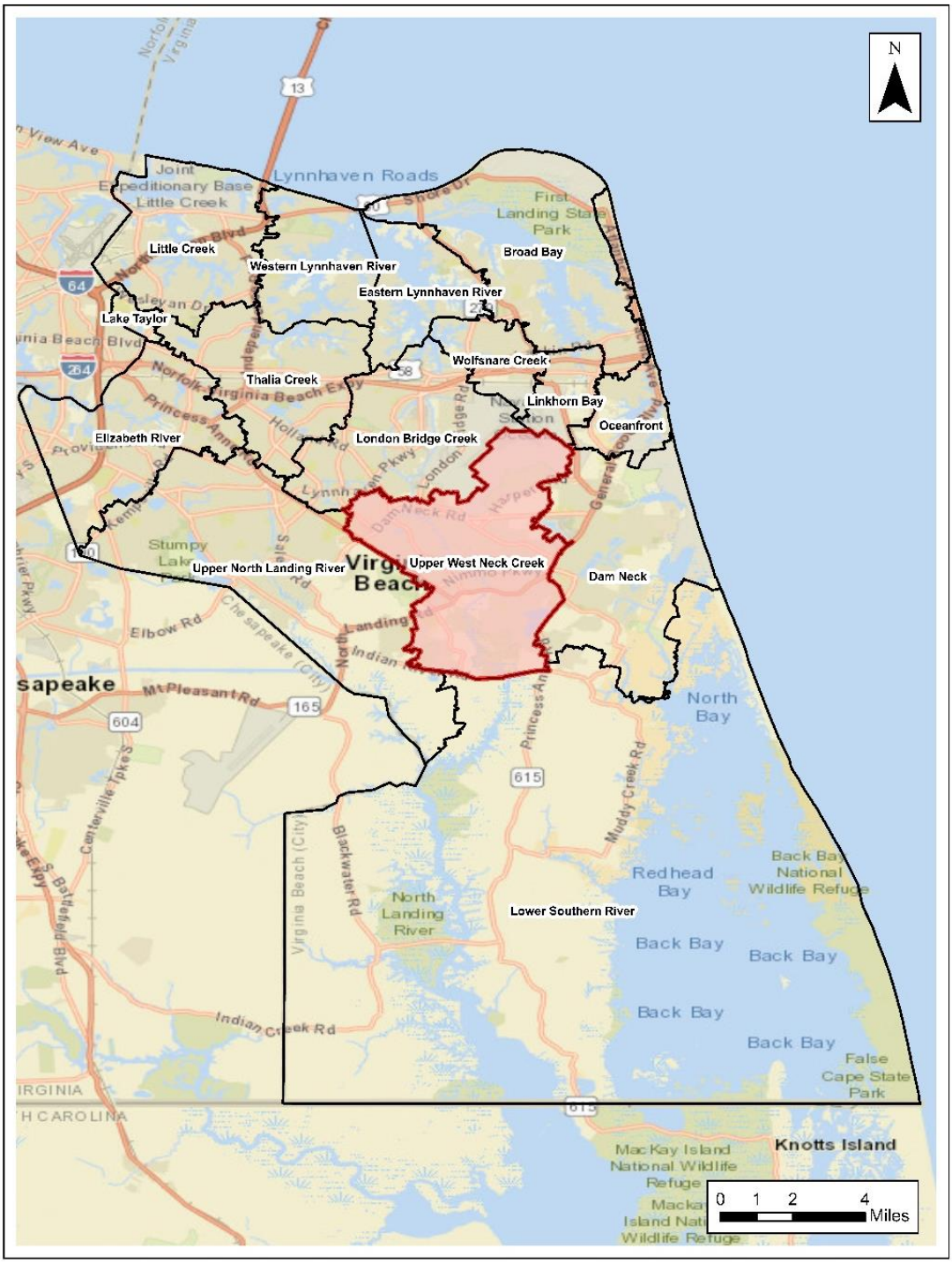


Figure 1. City Drainage Basins Location Map

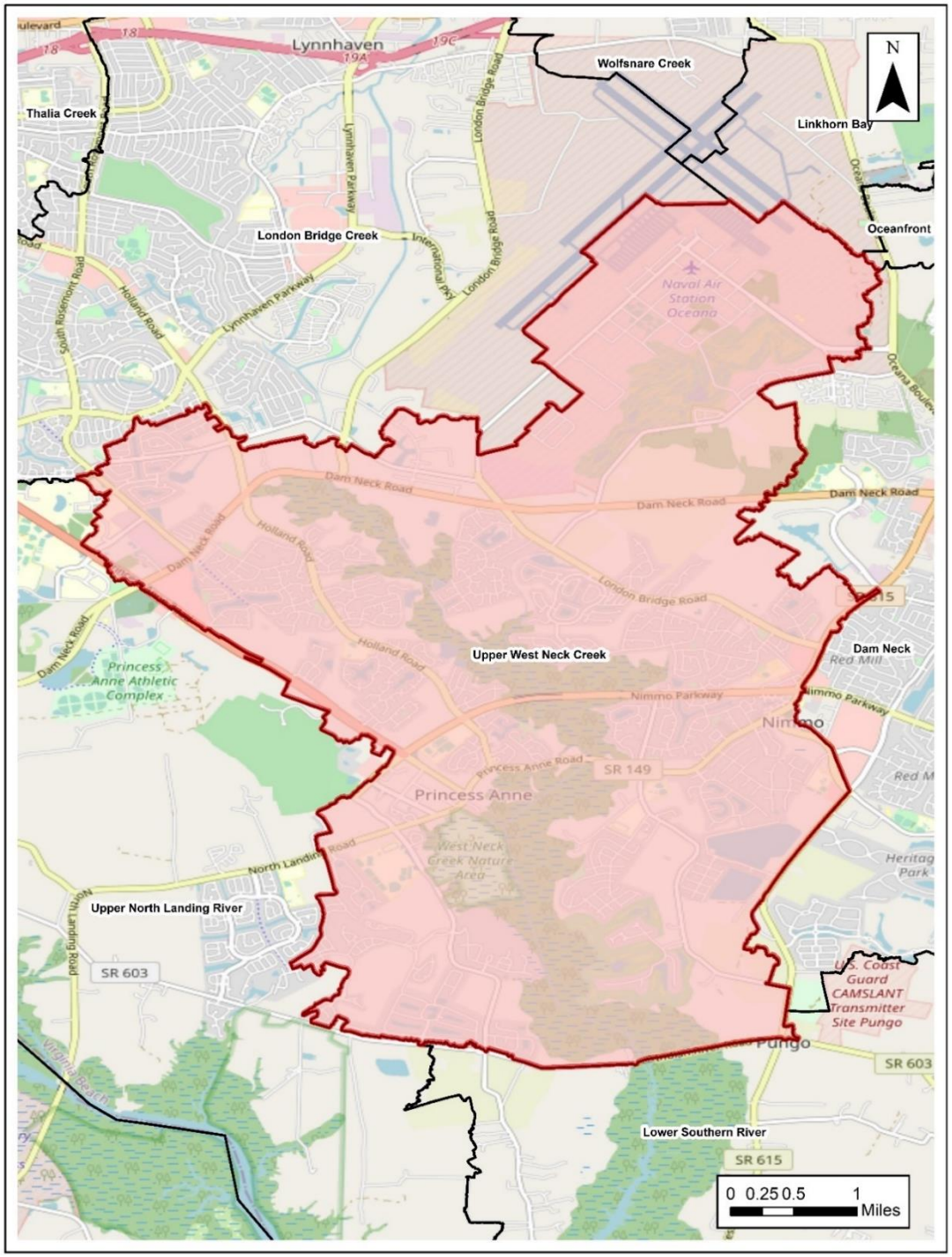


Figure 2. Upper West Neck Creek Drainage Basin Overall Map

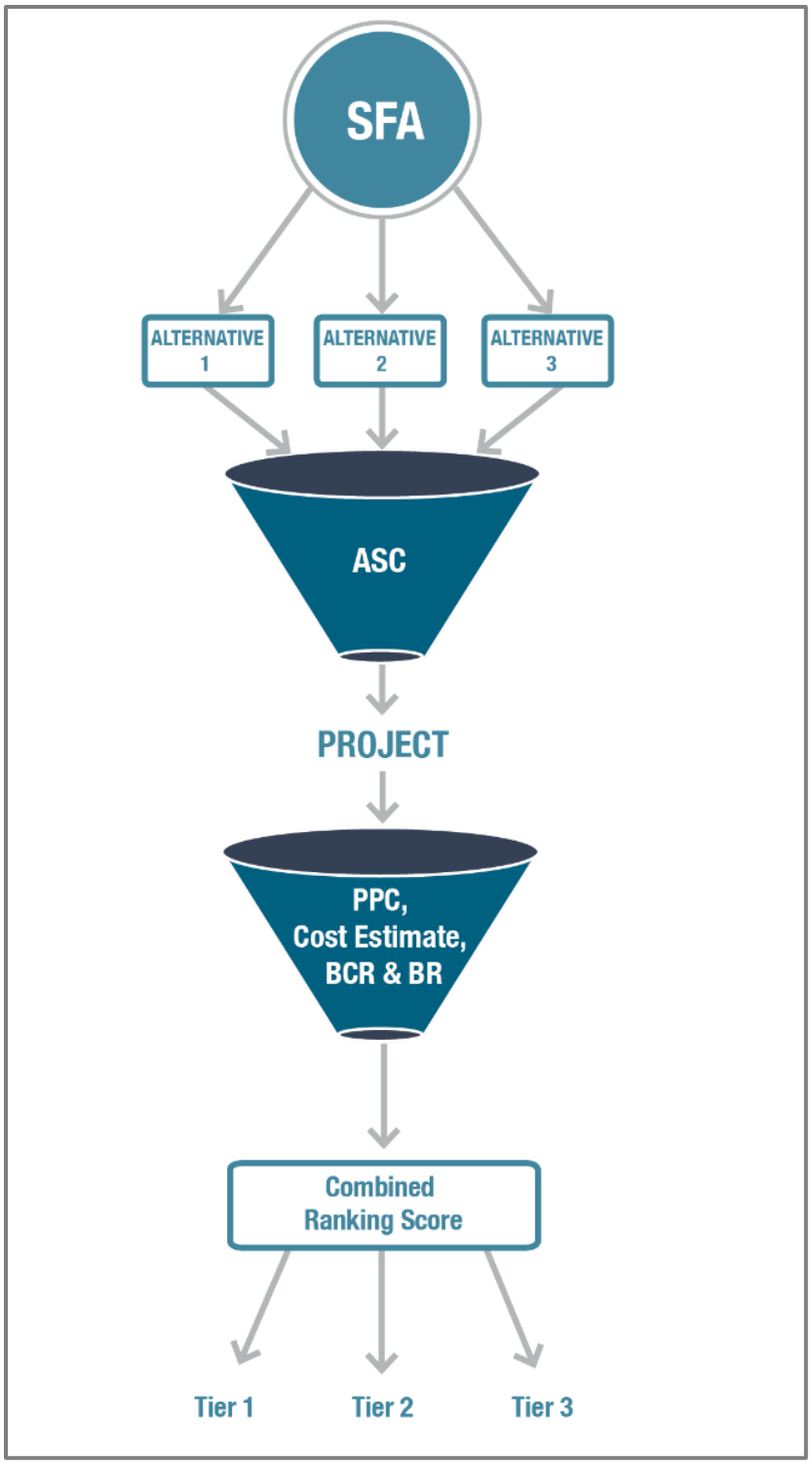


Figure 3. Stormwater Master Plan Process Flowchart

Methodology and Assumptions



2 Methodology and Assumptions

2.1 Hydraulic Modeling and Design

The existing conditions for the alternative analysis associated with the Upper West Neck Creek SWMP are based upon the City Stormwater Management Model (SWMM) for the Upper West Neck Creek Drainage Basin, part of the MDM, updated in August 2020. Throughout the process of developing the alternatives, several adjustments were made to the existing condition of the Upper West Neck Creek model in consultation with City staff. Some examples of modifications include updating stormwater pipes per recent Geographic Information Systems (GIS), survey information, and site observations. The existing model was also updated to contain several recent developments, including Princess Anne Middle School, Princess Anne Meadows, the Princess Anne Masonic Lodge, and West Neck Commons. These areas were updated based on as-built information or City-approved PCSWMM models from the developers with land cover, drainage boundaries, and stormwater infrastructure. Similarly, a number of road and intersection improvements have been completed since the completion of the Upper West Neck Creek MDM, which uses 2013 Light Detection and Radar (LiDAR). To reflect these improvements, areas along Seaboard Road and Holland Road were updated with City-provided 2018 LiDAR information accounting for the changes in road elevations. All other portions of the MDM are based on 2013 LiDAR information. Changes to the existing model and the proposed alternative modeling are consistent with the City's stormwater modeling development methodology, as described in the *Stormwater Model Development Methodology Final* (March 2020) by CDM Smith.

Flooding depths are mapped for the existing and proposed project conditions. The depths are calculated by using peak Hydraulic Grade Line (HGL) values and comparing them to existing land surface elevations represented by LiDAR information for each subcatchment. All flood depths shown are greater than 0.1 of a foot (1.2 inches).

Individual inlet capacity was not considered in the hydraulic analysis. As a result, upon more detailed design of the proposed projects, the extent of improvements may need to increase to comply with design requirements for gutter spread. This may have an impact on the opinions of probable construction cost (OPCC) developed as part of the SWMP.

Capital Improvement Program (CIP) projects currently under design that overlap with SFAs are intentionally not included in the alternative analysis. The objective of the SWMP is to identify and rank projects that resolve SFAs across the entire City. Tracking individual CIP project design details and status as well as schedules for implementation is a hindrance towards accomplishing this objective. As a result, preliminary designs of the CIP projects (as-is) are not being considered as potential alternatives, nor are the proposed conditions of these projects being considered during the development of SWMP alternatives and OPCCs. However, where overlaps do exist, the potential opportunity to construct multiple projects simultaneously is noted in the applicable project summaries and scoring. As projects are selected for design and construction from the SWMP, coordination is recommended across City departments to identify projects and improvements that can be constructed concurrently.

2.1.1 Pump Modeling and Design

In the Upper West Neck Creek Drainage Basin, stormwater pumps and lift stations have been included in several alternative designs. Assumptions that governed the design of the pumps include:

- Pumps were modeled in PCSWMM with typical pump curves.
- Each pump is designed to discharge approximately 100-150 cubic feet per second (cfs).
- The lift station footprint is based on the number of pumps needed for the given alternative. It is assumed the pumps will be programmed with different start elevations and the same stop elevation, so the lead-on pump alternates for each cycle, providing resiliency and a factor of safety against pump failure.
- All pumps are assumed to have formed suction intake (FSI), which reduces the total depth and footprint of the station. FSI also requires the station to be directly adjacent to the waterbody.
- When continuous pumping is not used, some alternatives will require pumps to lower the normal water surface elevation (NWSE) of the adjacent waterbody before the storm event.
    - Without the use of real-time weather monitoring with remote pump controls, drawdown for storms other than the 100-year storm event is not included at this time.
- Continuous pumping is considered for configurations that allow for traditional float-based operations. In these cases, pumps are activated in storms less than the 100-year storm event and do not require real-time weather monitoring and remote pump controls.

2.2 Level of Service

Alternatives developed for the primary stormwater management system (PSMS) improvements, for each SFA, will achieve a consistent design level of service (LOS). Up to three alternatives were developed for each SFA. Alternatives were only scored with the ASC if it could be demonstrated that they achieved the LOS summarized in Sections 2.2.1 and 2.2.2. For some SFAs, three alternatives could not be developed that achieved the LOS, and/or engineering judgment could eliminate the alternative for reasons of cost, constructability, etc., without having to use the ASC. The summaries for each SFA include those alternatives considered that have an official ASC score and those alternatives that did not achieve the required LOS or were eliminated. The assumptions made in defining the LOS are described below.

2.2.1 Application of the Public Works Design Standards Manual (PWDSM) to LOS

The LOS for the stormwater drainage network is based on the requirements of the PWDSM (June 2020). It should be noted that the PWDSM is a living document and will be updated over time. The following information was considered for the LOS:

- Design storms are based on the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 rainfall depth with a 20 percent increase above values last updated in 2006.
- Existing SFAs are determined with a 20 percent increase in rainfall without sea-level rise (SLR).
- No flooding shall occur during the 10-year storm event. The maximum HGL will remain below the rim elevation of storm drain structures.
- In accordance with the requirements of the PWDSM, the crown of the road shall be passable during the 100-year storm event.
- For the 100-year storm event, early analysis of the Upper West Neck Creek Drainage Basin shows that many SFAs are not resolved. When SLR is applied to the basin outfalls, several SFAs experience a starting tailwater that exceeds road and property elevations.
    - In order to evaluate these SFAs and develop a project, PW-SWEC made the decision to include the West Neck Creek City-Wide Alignment (refer to page 252

of *Virginia Beach Sea Level Wise Adaptation Strategy Report*) for designing alternatives for the 100-year storm event, eliminating SLR influence on the design tailwater elevation. While the City-Wide Alignment will eliminate SLR influence for the 100-year storm event, it will not be closed for more frequent storms. Full solutions were still conceptualized for the 10-year storm event with SLR for each SFA.

- Critical infrastructure, as defined in the PWDSM, shall be designed to incorporate 3.0 feet of SLR. Given the assumed implementation of the West Neck Creek City-Wide Alignment, the 3.0 feet of SLR scenario was only applied to the 10-year storm event for critical infrastructure design.
    - For SWMP efforts, reducing flooding at sanitary sewer pump stations is considered a benefit, but pump stations were not designed to incorporate 3.0 feet SLR. New pump stations moving forward will account for City model flood elevations to establish finished floor elevations. DPU has implemented waterproofing improvements to existing sanitary sewer systems and plans to put generators at each pump station.

2.2.2 Additional LOS Assumptions and Considerations

Additional LOS assumptions were developed during the application of the PWDSM requirements to the SWMP analysis. These additional assumptions and considerations include:

- All elevations are in the NAVD88 datum unless otherwise specified.
- The design storm and tide joint probability pairs were simplified to reduce the number of required model runs. All alternative designs are based on the following joint probability pairs:
    - 10-year rain and 1-year tide
    - 100-year rain and 3-year tide
- Some projects solve multiple SFAs with different existing flood frequencies. In these cases, the project is scored based on the SFA with the highest flood frequency.
- Where a road is superelevated, a minimum of one lane shall be passable during the 100-year storm event.
- Secondary evacuation routes are not considered critical infrastructure.
    - Secondary evacuation routes are designed for the 10-year storm event with 1.5 SLR and checked with the 10-year storm event with 3.0 feet SLR.
- Habitable structure flooding is defined as the intersection of GIS building footprints with the mapped flood extents.

2.2.3 Variances

For SFAs highly susceptible to tailwater conditions, meeting PWDSM requirements may not be practicable. In these conditions, alternatives are provided that improve the existing condition, to the maximum practical extent, but may not meet all PWDSM requirements.

- A 10-year LOS maintains the HGL in the system in the 10-year storm event with 1.5 feet of SLR and resolves any habitable structure flooding with less than 6” of flooding above the crown of the road in the 100-year storm event with no SLR.
- A 50-year LOS maintains the HGL in the system for the 10-year storm event with 1.5 feet of SLR and resolves any habitable structure flooding with less than 3” of flooding above the crown of the road in the 100-year storm event with no SLR.

    - A 50-year LOS is assumed in these cases because the 50-year models are not part of the SWMP.
    - This approach provides a means to have a lower PPC score for a project that allows minimal flooding above the crown of road (less than 3", 50-year LOS) compared to one that provides a visible crown (100-year LOS).
- 6" of flooding above the crown of the road is considered the maximum passable depth above the crown of the road for emergency vehicles.
- 3" of flooding above the crown of the road is considered the maximum passable depth above the crown of the road for all other vehicles.

2.3 Alternative and Project Scoring

Alternatives were scored based on criteria in the ASC, and projects were scored with the PPC. The assumptions and considerations for scoring developed during the Upper West Neck Creek SWMP process include:

- Environmental Permitting – The level of effort required to obtain permits from various agencies is dependent on the definitions and regulations surrounding wetlands, which are subject to change. The scoring in this category for Upper West Neck Creek is based on the 2020-2021 state and federal regulations.
- Other Accrued Benefits – The scoring for this category does not take into consideration pending neighborhood storm drain rehabilitation projects. Coordination with Public Works Operations indicates that these projects move through planning and construction within two to three years. Accounting for benefits associated with overlapping projects is not recommended based on the anticipated differences in implementation frequency between this program and the SWMP. However, as projects are selected for implementation from the SWMP, coordination with Public Works Operations is recommended to adjust upcoming project prioritization accordingly.
- As a result of the formal adoption of the PWDSM standards, the Upper West Neck Creek SWMP includes SFAs from the 1-year storm event. The PPC scoring required adjustment to include the benefits of solving flooding for 1-year storm events; however, the Linkhorn Bay Stormwater Master Plan did not account for 1-year SFAs because it was initiated prior to the adoption of the PWDSM. To account for the additional benefit of resolving lower-frequency SFAs and avoiding re-scoring projects in Linkhorn Bay, the total PPC score increased from 10 to 14.4. This scoring methodology is expected to be maintained throughout the remaining drainage basins.

2.4 Project Figures

Figures for each project are included in the appendices to convey the conceptual design. The following assumptions and clarifications should be noted:

- In some cases, the partial or total acquisition of public and private property is required for additional easements to increase existing pipes and channels or for the construction of stormwater management facilities (SWMF). These locations, shown graphically in the figures, are conceptual in nature and subject to changes based on additional information that may be obtained during a more detailed design.
- The type of acquisition is differentiated on the figures as easement required (ER and ER*) and property acquisition (PA).
    - Improvements with an ER* designation indicate locations that do not have adequate space for the full easement width, as required in the PWDSM based on

the size and depth of the proposed pipe or other requirements. However, in these cases, there is available space to acquire some additional easement as well as the space needed to install the pipe or other improvements. Where feasible, these situations are avoided by proposing parallel systems where additional room is available to acquire the minimum easement widths that are required by the PWDSM.

- Improvements with an ER designation indicate that space is available to acquire the full easement width required by PWDSM based on the size and depth of the proposed pipe or other requirements.
- Improvements with a PA designation indicate that acquisition of the entire or portions of the parcel is required for the proposed improvements.

2.5 Opinions of Probable Construction Cost (OPCC)

The opinions of probable cost represent a Class 3 Estimate as defined by the Association for the Advancement of Cost Engineering (AACE) International recommended practice No. 18R-97. These estimates are based on conceptual designs, with limited to no survey or geotechnical information. Street and surface elevations used for cost estimating are based on Virginia LiDAR, which includes data from NOAA, United States Geological Survey (USGS), and Virginia Geographic Information Network (VGIN). All costs are reported in 2021 dollars, and the City will need to account for inflation when projecting required CIP funding. The 20-city average Engineering News-Record (ENR) construction cost index of 12464, the average index for September 2021, can be used as a baseline for inflation calculations. Unit costs are based on a combination of current regional averages, recent construction bids available to the engineer, and engineering judgment.

In many cases, the stormwater best management practice (BMP) chosen for SFAs, when additional runoff storage is required, is a Level 2 Wet Pond, as specified in the Virginia Department of Environmental Quality (DEQ) BMP Clearinghouse. Wet ponds are recommended BMPs for geographies, such as Virginia Beach, with low topography and high groundwater tables. Level 2 Wet Ponds are well-suited for large drainage areas, maximize the amount of nutrients removed for water quality credit, and can provide significant dry storage volume to mitigate flooding. All components of Level 2 Wet Ponds have been incorporated into the OPCCs as a single lump sum item. This cost includes items such as excavation and grading, cell divisions, wetlands, and aeration. Quantities are extrapolated from the stage-storage information and surface area of the BMP as estimated using GIS and the SWMM model. Underground detention basins are considered in the event above-ground storage is not an option.

Costs for pump and lift stations are derived from recent and historic City project cost data compiled and reviewed by City staff. For lift stations that outflow 30 cubic feet per second or less, a unit cost of $95,000 per cubic feet per second is assumed. Lift stations that outflow over 30 cubic feet per second assume a unit cost of $60,000 per cubic feet per second.

Permanent drainage easement costs are based on the assessed values of the impacted properties. The value of the property is divided by the total square footage to determine an average cost per square foot for the easement. Costs for temporary construction easements are 25 percent of the cost for a permanent easement. Parcel acquisition costs assume twice the assessed value of the property as reported in the City GIS database. The methodology for

determining the costs of permanent and temporary easements is consistent with other recent projects for the City.

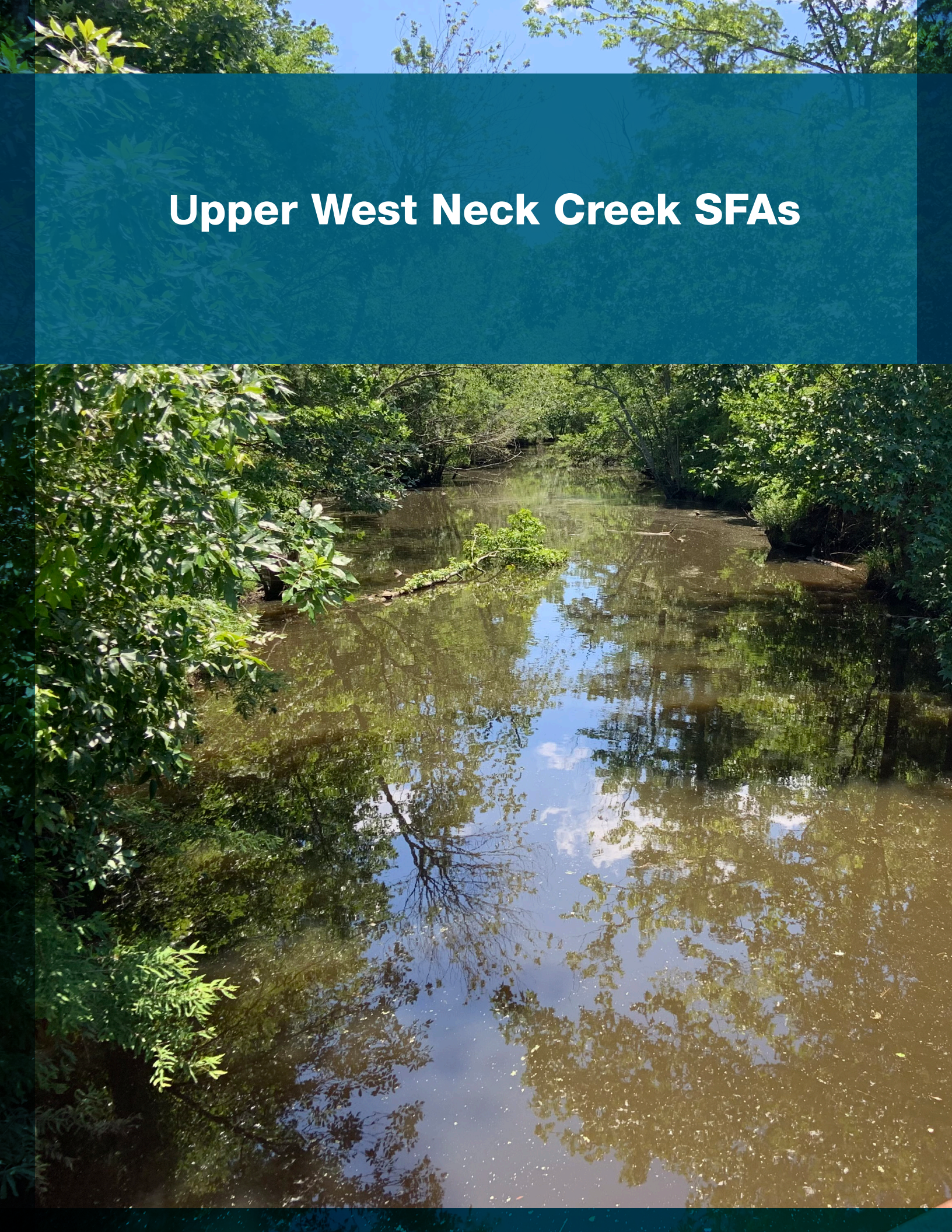
Mitigation is always required for permanent impacts to wetlands. Costs for mitigating impacts on tidal wetlands are approximately $1 million/acre. Costs for mitigating impacts on non-tidal wetlands are approximately $100,000/acre. Temporary impacts do not require mitigation and are not included in the cost estimates.

When comparing each project OPCC to the budgetary cost estimates that appear on the capital project detail sheets, two things should be noted for the figures summarized in the budgetary cost estimates. First, the design cost also includes any wetland mitigation costs associated with the project. Second, the total construction cost represents the sum of the construction subtotal and construction management, less any wetland mitigation costs.

2.6 Benefit-Cost Ratio (BCR) and Benefit Ratio (BR) Calculations

The BCR and BR were calculated for each project. Refer to Appendix A for a detailed description of the BCR and BR methodology.

Upper West Neck Creek SFAs



3 Upper West Neck Creek Drainage Basin SFAs

The analysis and results for each SFA, shown in Figure 4, are summarized below, and project exhibits and other supporting documentation are included in Appendices B-1 through B-63-8.

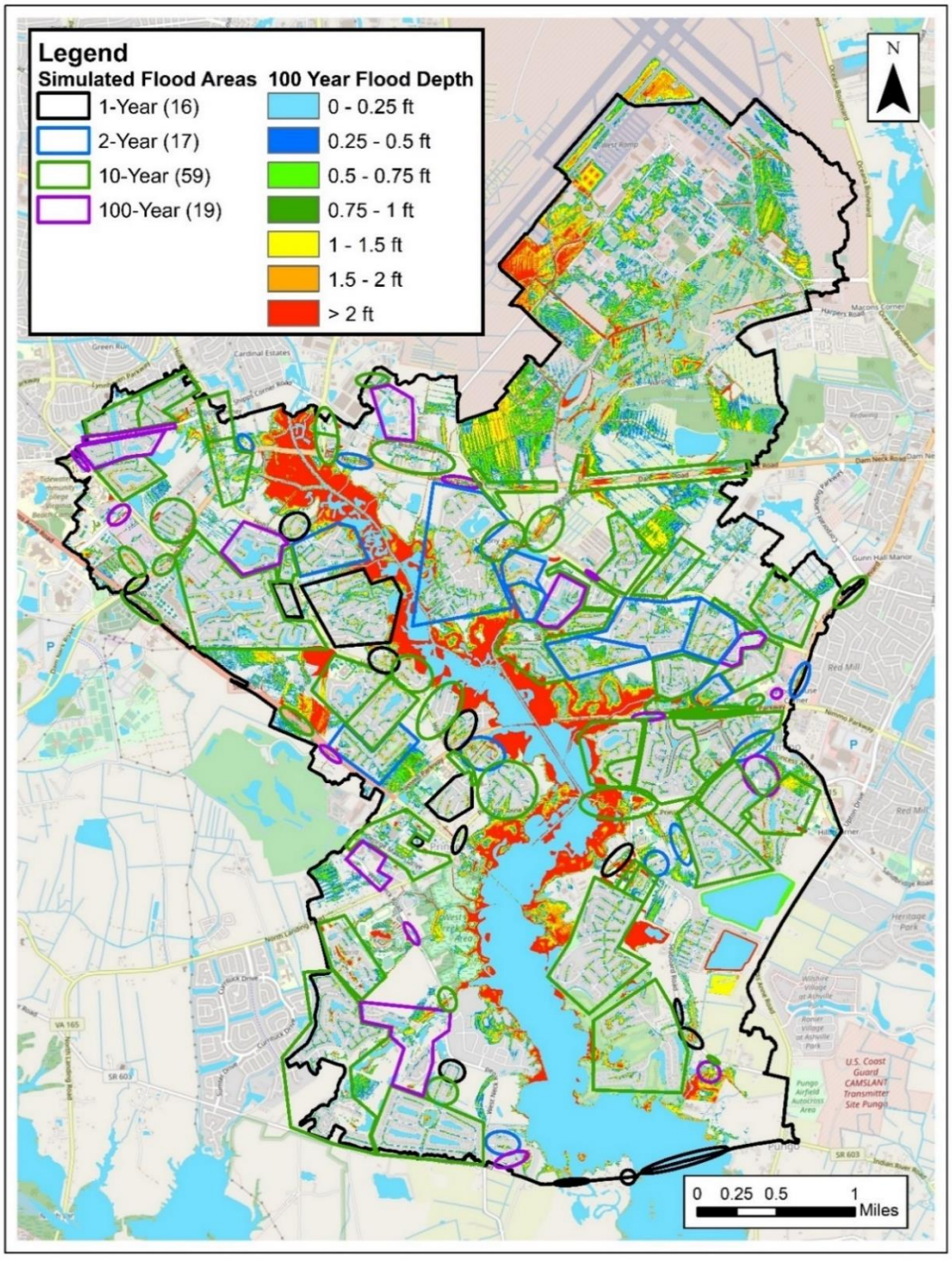


Figure 4. Upper West Neck Creek Drainage Basin Detailed SFA Map

3.1 Buckner Farms

Individual SFA locations, shown below in Figure 5 and further described below, are combined into the Buckner Farms project. Meeting the PWDSM requirements for the upstream SFAs is dependent on the improvements proposed for the downstream SFAs. A phased project is proposed considering the extent of improvements that are required and to accomplish the objective of the SWMP to develop "standalone" solutions that are not dependent on downstream improvements. Project phases are defined by the individual SFA boundaries and begin with the most downstream improvements. Future refinements to the proposed project phasing may be required. Refer to Appendix B-1-1 through B-1-8 for detailed project phase maps.

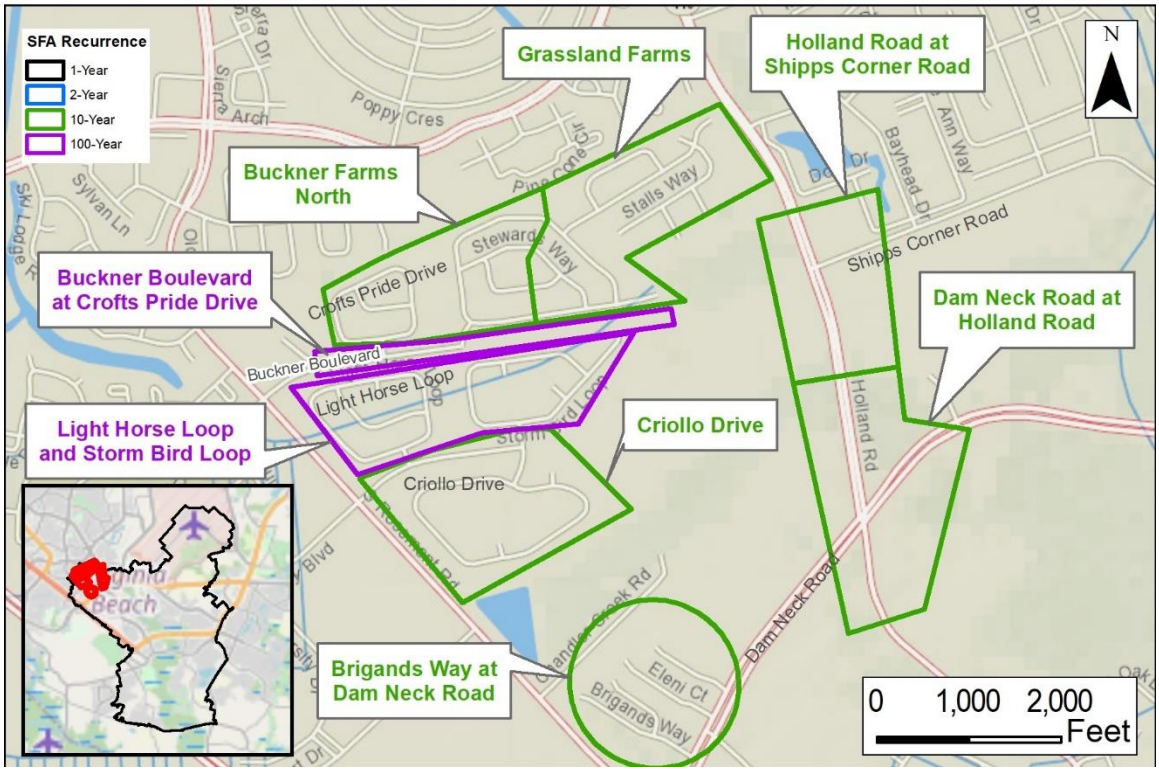


Figure 5. Location Map of Dam Neck Road at Holland Road, Holland Road at Shipps Corner Road, Light Horse Loop and Storm Bird Loop, Criollo Drive, Buckner Boulevard at Crofts Pride Drive, Brigands Way at Dam Neck Road, Grassland Farms, and Buckner Farms North SFAs

3.1.1 ***Phase 1: Dam Neck Road at Holland Road***

3.1.1.1 SFA Description

The Dam Neck Road and Holland Road intersection and surrounding private property flood due to inadequate stormwater infrastructure. The outfall for the intersection conveys flow from over 750 acres upstream and tailwater from downstream. Dam Neck Road is considered critical infrastructure as it provides access to Naval Air Station (NAS) Oceana and the Dam Neck Annex. Dam Neck Road and Holland Road are both documented as secondary evacuation routes. As shown in Figure 5, the models indicate Dam Neck and Holland Road begin to experience flooding in the 10-year storm event.

3.1.1.2 Project Description

The proposed project will add box culverts under Holland Road and Dam Neck Road and open channels to the northeast and west of the intersection. The new culverts outfall into the existing channel to the southeast of the intersection. The existing downstream channel will be widened by 20 feet to the main West Neck Creek channel. Finally, the intersection and portions of Holland and Dam Neck Road will be raised by 1 foot.

3.1.1.3 Project Benefits

The major benefits of the project include mitigating street flooding on Dam Neck Road and Holland Road, as well as reducing flooding occurring on surrounding private property. The project also mitigates flooding for one habitable structure. Since Dam Neck Road and Holland Road are both secondary evacuation routes, and Dam Neck Road is critical infrastructure, it is an important intersection to remain clear during a storm event.

The project also addresses one flood report that has been documented in the area, and there is a potential for cost-sharing with the Department of Public Utilities (DPU) for transmission main prioritization.

3.1.1.4 Project Analysis Assumptions

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. The project is given a BR of 1.0 because all street flooding is mitigated. Holland Road and Dam Neck Road, as secondary evacuation routes, remain passable in the 10-year storm event with 3.0 feet SLR and the 100-year storm event with no SLR. This also meets the design requirement for critical infrastructure.

Property acquisition and easements will be required for this project. Even though the proposed ditch widening will be within the drainage easement, access will be needed in the overlapping Dominion Energy power easement. It is anticipated that extensive maintenance of traffic and extensive utility relocation will be required during the construction of the project. There are Navy mission-critical utilities located in the area, and significant coordination with the utility owner and the military will be needed during the design and construction of the project. Finally, it is anticipated that extensive effort will be required to obtain environmental permits since over one acre of wetland impacts are anticipated.

3.1.1.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.1.1.6 Other Alternatives Not Scored

One additional alternative was considered but was not scored. To minimize the extent of the improvement and potentially lower the cost of the project, a small BMP was proposed on the northwestern side of the intersection with a pump station to move the water under the

intersection. However, this alternative was not as effective and would require an even higher elevation of the intersection. It also significantly increased the tailwater downstream.

3.1.1.7 Project Analysis Summary

Table 1 below provides a summary of the Dam Neck Road at Holland Road project analysis. Refer to Appendix B-1-1 for project exhibits and supporting documentation.

Table 1. Dam Neck Road at Holland Road Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	3.55/10
Other ASC Score(s)	N/A
PPC Score	7.62/14.4
BR	1.0
BCR	1.0 (based on updated model)
Project Cost	$16,095,000

3.1.2 ***Phase 2A: Holland Road at Shipps Corner Road***

3.1.2.1 SFA Description

Holland Road at Shipps Corner Road experiences flooding due to inadequate stormwater infrastructure within the area. Holland Road and Shipps Corner Road both experience street flooding. Additionally, Holland Road serves as a secondary evacuation route. As shown in Figure 5, the models indicate Holland Road at Shipps Corner Road begins to experience flooding in the 10-year storm event.

3.1.2.2 Project Description

This project will upsize existing inadequate pipes and provide an additional outfall, for the existing system, that will discharge to a proposed ditch on the east side of Holland Road. The downstream condition will be improved by adding a channel and box culverts. Buckner Farms Phase 2A: Holland Road at Shipps Corner Road is dependent on Buckner Farms Phase 1: Dam Neck Road at Holland Road improvements.

3.1.2.3 Project Benefits

The major benefits of the project include mitigating street flooding on Holland Road and Shipps Corner Road, as well as the flooding occurring on surrounding private property. The project also ensures that Holland Road can effectively serve as a secondary evacuation route. There is a potential cost-sharing opportunity with DPU for transmission line prioritization along Holland Road.

3.1.2.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated. Holland Road, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and 100-year storm event with no SLR.

Easement acquisition will be required to add additional channels through private property. These impacts are minimized by locating them parallel to the public Right-of-Way (ROW). It is anticipated that moderate maintenance of traffic will be required during the construction of the project along Holland Road and Shipps Corner Road. It is anticipated that moderate utility relocations will be required during the construction of the project. Along Holland Road, conflicts are expected with a 16-inch water line and 8-inch gravity sewer line. Minor improvements are expected for the HRSD 42-inch force main that will cross the proposed channel on the east side of Holland Road as it will need to be converted to an exposed crossing. Coordination with HRSD will be needed for this modification. The proposed improvements cross the alignment of Navy mission-critical utilities. Based on a cursory review of as-built information by the City, conflicts are not expected.

3.1.2.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.1.2.6 Other Alternatives Not Scored

One additional alternative was considered that would add a pipe from Holland Road along Buckner Boulevard and tie into the existing stormwater infrastructure to the west to alleviate the flooding at the intersection. Additionally, this alternative included pipe upgrades along Holland Road and the channel improvements south of Dam Neck Road. This alternative would avoid constructing the ditch along the east side of Holland Road. However, this alternative did not clear the flooding at the intersection of Shipps Corner Road and Holland Road and failed to meet the PWDSM requirements.

3.1.2.7 Project Analysis Summary

Table 2 below provides a summary of the Holland Road at Shipps Corner Road project analysis. Refer to Appendix B-1-2 for project exhibits and supporting documentation.

Table 2. Holland Road at Shipps Corner Road Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	5.62/10
Other ASC Score(s)	N/A
PPC Score	2.04/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$6,846,000

3.1.3 ***Phase 2B: Light Horse Loop and Storm Bird Loop***

3.1.3.1 SFA Description

The neighborhoods within and surrounding Light Horse Loop and Storm Bird Loop experience flooding on the streets and private property. The flooding is caused by inadequate stormwater infrastructure throughout the neighborhood and a high NWSE in the BMP, causing the pipes to be full before the start of the storm event. As shown in Figure 5, the models indicate Light Horse Loop and Storm Bird Loop begin to experience flooding in the 100-year storm event.

3.1.3.2 Project Description

This project will expand the downstream BMP to provide more storage and add a pipe outfall. Pipes throughout the neighborhood will be upsized, and the southern inflow pipe, into the BMP, will be reversed and outfall into the expanded BMP downstream. Buckner Farms Phase 2B: Light Horse Loop and Storm Bird Loop is dependent on Buckner Farms Phase 1: Dam Neck Road at Holland Road improvements.

3.1.3.3 Project Benefits

The major benefits of the project include mitigating street flooding on Light Horse Loop and Storm Bird Loop, as well as the flooding occurring on surrounding private property. The project also addresses several flood reports that have been documented in the area. There is a potential cost-sharing opportunity with DPU for transmission main prioritization along Celtic Drive.

3.1.3.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated.

Property acquisition will be required to upsize a pipe along Light Horse Loop. Easement acquisition will be required to expand the BMP, to add in the downstream outfall pipe, and for select pipe improvements. It is assumed that the Buckner Farms HOA will allow for the dedication of the easement for the proposed expanded BMP to improve drainage within the neighborhood. Easement acquisition costs have been included for the expanded BMP to be conservative. To limit the amount of property acquisition, improvements were made in the ROW when possible. It is anticipated that moderate maintenance of traffic will be required during the construction of the project. It is anticipated that moderate utility relocations will be required during the construction of the project. There are possible conflicts with 8-inch and 10-inch gravity sewer lines and 6-inch, 8-inch, and 10-inch water main lines throughout the neighborhood. The proposed outfall for the expanded BMP will likely conflict with a 12-inch sewer force main. Moderate effort will be required to obtain environmental permits to add a pipe outfall through nontidal wetlands.

Runoff is being diverted away from an existing BMP into the expanded BMP downstream. The expanded BMP is assumed to offset changes to the original design function of the existing BMPs. Coordination with the City's Virginia Stormwater Management Program (VSMP) Permit Coordinator is required.

3.1.3.5 Other Alternatives Scored

Other alternatives were not considered.

3.1.3.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.1.3.7 Project Analysis Summary

Table 3 below provides a summary of the Light Horse Loop and Storm Bird Loop project analysis. Refer to Appendix B-1-3 for project exhibits and supporting documentation.

Table 3. Light Horse Loop and Storm Bird Loop Project Summary

SFA Recurrence	100-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	6.08/10
Other ASC Score(s)	N/A
PPC Score	1.37/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$42,340,600

3.1.4 ***Phase 3A: Criollo Drive***

3.1.4.1 SFA Description

Criollo Drive and the surrounding streets experience flooding. The flooding is caused by inadequate stormwater infrastructure and a high NWSE in the pond causing the pipes to be full before the start of the storm event. As shown in Figure 5, the models indicate Criollo Drive begins to experience flooding in the 10-year storm event.

3.1.4.2 Project Description

This project will improve the inadequate stormwater infrastructure along Criollo Drive. The existing outfall for the pond will be removed, and the neighborhood will outfall to the proposed outfall pipe in Buckner Farms Phase 2B: Light Horse Loop and Storm Bird Loop project. Buckner Farms Phase 3A: Criollo Drive is dependent on Buckner Farms Phase 2B: Light Horse Loop and Storm Bird Loop improvements.

3.1.4.3 Project Benefits

The major benefits of the project include mitigating street flooding on Criollo Drive and the surrounding streets in the neighborhood. The project also addresses several flood reports that have been documented in the area.

3.1.4.4 Project Analysis Assumptions

A 50-year LOS is achieved for this project as the peak HGL within the existing pond is higher than the lowest elevations of Criollo Drive. The pond outfall is also heavily influenced by tailwater. Expanding the existing storage area is not feasible without significant impacts on adjacent residential property. Flood depths are less than 3 inches above the crown of the road, are summarized on the 100-year flood map, and will require approval for a reduced LOS from the City Engineer.

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. There is a decrease in street flooding in the 100-year storm event, but it is not completely mitigated. Therefore, the project is given a BR of 0.97.

Easement acquisition will be required for pipe improvements and to extend the downstream outfall. Property acquisition was limited by staying in the ROW when possible and by adding more storage downstream. It is anticipated that moderate maintenance of traffic and utility relocations will be required during the construction of the project. There are possible conflicts

with the 8-inch and 10-inch gravity sewer lines and 8-inch and 10-inch water lines. The proposed outfall is anticipated to have a conflict with a 12-inch sewer force main.

A minor diversion of runoff away from the existing BMP is anticipated, so coordination with the City's VSMP Permit Coordinator is required.

3.1.4.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.1.4.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.1.4.7 Project Analysis Summary

Table 4 below provides a summary of the Criollo Drive project analysis. Refer to Appendix B-1-4 for project exhibits and supporting documentation.

Table 4. Criollo Drive Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	50-year (1.5 feet SLR)
Selected Alternative	Alternative 1
ASC Score	4.69/10
Other ASC Score(s)	N/A
PPC Score	1.45/14.4
BR	0.97
BCR	1.0 (no habitable structure flooding)
Project Cost	$11,163,600

3.1.5 *Phase 3B: Buckner Boulevard at Crofts Pride Drive*

3.1.5.1 SFA Description

Buckner Boulevard experiences street flooding due to a high NWSE in the downstream BMP and inadequate stormwater infrastructure along Buckner Boulevard. As shown in Figure 5, the models indicate Buckner Boulevard at Crofts Pride Drive begins to experience flooding in the 100-year storm event.

3.1.5.2 Project Description

This project will remove the existing connection to the downstream BMP. An additional pipe will be added along Buckner Boulevard and will outfall to the expanded BMP proposed as a part of the Buckner Farms Phase 2B: Light Horse Loop and Storm Bird Loop project. Buckner Farms Phase 3B: Buckner Boulevard at Crofts Pride Drive is dependent on Buckner Farms Phase 2B: Light Horse Loop and Storm Bird Loop improvements.

3.1.5.3 Project Benefits

The major benefits of the project include mitigating street flooding on Buckner Boulevard. The project also addresses several flood reports that have been documented in the area. There is a

potential cost-sharing opportunity with Public Works Transportation for improvements along Buckner Boulevard.

3.1.5.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated.

Easement acquisition will be required to expand the existing easement for the proposed box culvert. The extent of the easement acquisition was limited by making upstream improvements. It is anticipated that moderate maintenance of traffic and utility relocations will be required during the construction of the project along Buckner Boulevard. There is an 8-inch water main and 10-inch gravity sewer line along Buckner Boulevard.

While runoff is being diverted from the existing BMP, changes to the original design function of the BMP are not anticipated as all the existing BMPs are interconnected. Coordination with the City's VSMP Permit Coordinator is required.

3.1.5.5 Other Alternatives Scored

Other alternatives were not considered.

3.1.5.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.1.5.7 Project Analysis Summary

Table 5 below provides a summary of the Buckner Boulevard at Crofts Pride Drive project analysis. Refer to Appendix B-1-5 for project exhibits and supporting documentation.

Table 5. Buckner Boulevard at Crofts Pride Drive Project Summary

SFA Recurrence	100-year (no SLR)
Project LOS	100-year (No SLR)
Selected Alternative	Alternative 1
ASC Score	6.09/10
Other ASC Score(s)	N/A
PPC Score	0.97/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$5,123,750

3.1.6 ***Phase 4A: Brigands Way at Dam Neck Road***

3.1.6.1 SFA Description

Residential streets in the Brigand's Quay, Dam Neck Cove, and Brinkley Estates neighborhoods and a habitable structure on Dam Neck Road experience flooding due to an inadequate outfall channel leading to a high tailwater in the pipes and a lack of storage. As shown in Figure 5, the models indicate Brigands Way at Dam Neck Road begins to experience flooding in the 10-year storm event.

3.1.6.2 Project Description

This project will remove the current outfall for the upstream BMP and create a new outfall for the BMP to a tributary of West Neck Creek. Pipes, within the neighborhood and along Dam Neck Road, will be upsized. A BMP, on City property (GPIN 14950204000000), will be added to provide overflow storage for Dam Neck Road. Buckner Farms Phase 4A: Brigands Way at Dam Neck Road is dependent on Buckner Farms Phase 3A: Criollo Drive improvements.

3.1.6.3 Project Benefits

The major benefits of the project include mitigating street flooding on Brigands Way, Schooner Strait Court, Eleni Court, and Purpose Drive, as well as flooding occurring on surrounding private property. Additionally, the project mitigates flooding of one habitable structure along Dam Neck Road. The project also addresses documented flood reports in the area.

3.1.6.4 Project Analysis Assumptions

A 50-year LOS is achieved for this project given the heavy tailwater influence at the neighborhood oufalls. Pipe improvements have been maximized within the neighborhood, and there are not any adjacent open spaces to add storage to the system. The peak HGL is above a portion of Schooner Strait. Flood depths are less than 3 inches above the crown of the road, are summarized on the 100-year flood map, and will require approval for a reduced LOS from the City Engineer.

HAZUS data is available for the habitable structure along Dam Neck Road. The structure no longer floods in the 100-year storm event. Based on the BCR methodology, the project BCR is 1.0007. There is a decrease in street flooding in the 100-year storm event, but it is not completely mitigated. Therefore, the project is given a BR of 0.99.

Easement acquisition will be required to expand existing easements for pipe outfalls within the neighborhoods, and new easements will be required for the proposed BMP outfall and upsized pipe outfall on Purpose Drive. It is anticipated that minimal maintenance of traffic and utility relocations will be required within the neighborhood during the construction of the project. 8-inch gravity sewer lines and 4-inch and 8-inch water lines are located within the neighborhood. Moderate effort is anticipated to obtain environmental permits to add pipes and additional storage near non-tidal wetlands.

A review of historical aerial imagery suggests that the existing BMP adjacent to Rosemont Road (Level 1 Wet Pond, SU1485837884) and the existing ditch/canal east of Chandler Creek Road (Level 1 Wet Pond, SU1485930000) were constructed as part of a contiguous BMP between 1990 and 1994. As the project diverts runoff away from the current outfall location, coordination with the City's VSMP Permit Coordinator is required.

3.1.6.5 Other Alternatives Scored

Another alternative, as described below, was considered, but was not scored.

3.1.6.6 Other Alternatives Not Scored

One additional alternative was considered but was not scored. Instead of having the existing upstream BMP outfall through a pipe, it was considered to outfall through a ditch. This alternative did meet the PWDSM requirements. However, due to the size of the ditch and the environmental permitting that is assumed to be required for the ditch, it was not considered further.

3.1.6.7 Project Analysis Summary

Table 6 below provides a summary of the Brigands Way at Dam Neck Road project analysis. Refer to Appendix B-1-6 for project exhibits and supporting documentation.

Table 6. Brigands Way at Dam Neck Road Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	50-year (1.5 feet SLR)
Selected Alternative	Alternative 1
ASC Score	4.79/10
Other ASC Score(s)	N/A
PPC Score	5.25/14.4
BR	0.99
BCR	1.0007
Project Cost	$10,383,500

3.1.7 ***Phase 4B: Grassland Farms***

3.1.7.1 SFA Description

Grassland Farms experiences flooding due to a lack of storage and a high NWSE in the BMP. Habitable structures along Purebred Drive experience flooding as well as street flooding on Pasture Lane, Stalls Way, and the surrounding streets. As shown in Figure 5, the models indicate Grassland Farms begins to experience flooding in the 10-year storm event.

3.1.7.2 Project Description

This project will improve the stormwater infrastructure within the neighborhood by upsizing inadequate pipes and adding pipe connections. Storage will be added to the system by expanding the existing BMPs and adding a submersible pump to draw down the initial elevation of the northern BMP before the 100-year storm event. The downstream condition will be improved, and the system will outfall into the proposed expanded BMP included in Buckner Farms Phase 2B: Light Horse Loop and Storm Bird Loop. Buckner Farms Phase 4B: Grassland Farms is dependent on Buckner Farms Phase 3B: Buckner Boulevard at Crofts Pride Drive improvements.

3.1.7.3 Project Benefits

The major benefits of the project include mitigating street flooding along Pasture Lane, Stalls Way, and the surrounding streets in the neighborhood. Habitable structure flooding for five structures along Purebred Drive is mitigated. The project also addresses several flood reports that have been documented in the area. There is a potential cost-sharing opportunity with DPU for water leak prioritization.

3.1.7.4 Project Analysis Assumptions

The project meets the PWDSM requirements in the 100-year storm event. As discussed in Section 2.2, preemptive pumping for storms more frequent than the 100-year storm event cannot be assumed at this time. As a result, the project does not provide preemptive pumping in the 10-year storm event with 1.5 and 3.0 feet SLR.

HAZUS data is available for the habitable structures along Purebred Drive. The structures no longer flood in the 100-year storm event. Based on the BCR methodology, the project BCR is 1.0012. The project is given a BR of 1.0 because all street flooding is mitigated.

Property acquisition will be required to expand the northern BMP, the southern BMP, and for select pipe improvements. Downstream improvements were made to limit the required amount of upstream storage and property acquisition. The southern BMP was expanded to the maximum extent without disturbing residential or commercial buildings. As an alternative to residential property acquisition for the northern BMP, it was considered to expand the BMP onto the adjacent church property. However, due to the cost of the non-residential property, this was not considered further.

It is anticipated that moderate maintenance of traffic will be required during the construction of the project for the pipe improvements crossing along Buckner Boulevard and within the neighborhood streets. Extensive utility relocations will be required during the construction of the project. Conflicts with a 36-inch force main that runs parallel to the existing ditch are expected. Additionally, conflicts are likely with an 8-inch gravity sewer line and a 4-inch, 6-inch, 8-inch, and 10-inch water line throughout both neighborhoods and crossing Buckner Boulevard.

The expanded southern BMP will be combined with the existing BMP behind the self-storage facility (information not listed in City GIS) as well as the existing BMP on the Beach FC property (Level 1 Wet Pond, SU1495062871A). It is assumed that the design requirements of the original BMPs will be provided by the combined BMP. Coordination with the City's VSMP Permit Coordinator is required.

3.1.7.5 Other Alternatives Scored

One additional alternative was scored as part of this analysis. Alternative 1 also added additional storage and upsized inadequate pipes. The additional storage areas in this alternative included additional residential parcels as well as a portion of the adjacent Holy Spirit Catholic Church property. This alternative scored lower than Alternative 2 because it required more residential acquisition as well as easement acquisition.

3.1.7.6 Other Alternatives Not Scored

Expanding the southern BMP onto the adjacent self-storage facility was considered to minimize residential property acquisition. However, to meet the PWDSM, acquiring the entire commercial parcel would be required. Due to the cost of the commercial property acquisition, this was not considered further.

3.1.7.7 Project Analysis Summary

Table 7 below provides a summary of the Grassland Farms project analysis. Refer to Appendix B-1-7 for project exhibits and supporting documentation.

Table 7. Grassland Farms Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 2
ASC Score	4.65/10
Other ASC Score(s)	Alternative 1 – 4.43/10
PPC Score	5.38/14.4
BR	1.0
BCR	1.0012
Project Cost	$37,300,600

3.1.8 *Phase 4C: Buckner Farms North*

3.1.8.1 SFA Description

Buckner Farms North experiences street and private property flooding due to a lack of storage in the system and inadequate pipes. As shown in Figure 5, the models indicate Buckner Farms North begins to experience flooding in the 10-year storm event.

3.1.8.2 Project Description

This project will improve the inadequate pipes throughout the neighborhood. An additional outfall will be created by connecting to the improvements along Buckner Boulevard, which will be constructed as part of Buckner Farms Phase 3B: Buckner Boulevard at Crofts Pride Drive project. Buckner Farms Phase 4C: Buckner Farms North is dependent on Buckner Farms Phase 3B: Buckner Boulevard at Crofts Pride Drive.

3.1.8.3 Project Benefits

The major benefits of the project include mitigating street flooding on Crofts Pride Drive and Purebred Drive, as well as the flooding occurring on surrounding private property. The project also addresses several flood reports that have been documented in the area.

3.1.8.4 Project Analysis Assumptions

A 50-year LOS is achieved for this project as the peak HGL within the existing pond is higher than the lowest elevations of Crofts Pride Drive and Purebred Drive. Expanding the existing storage area is not feasible without significant impacts on adjacent residential property. Flood depths are less than 3 inches above the crown of the road, are summarized on the 100-year flood map, and will require approval for a reduced LOS from the City Engineer.

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. Street flooding in the 100-year storm event is significantly reduced, but it is not completely mitigated. Therefore, the project is given a BR of 0.99.

Property acquisition will be required to upsize pipes along Crofts Pride Drive and Purebred Drive. Where possible, improvements were made within the ROW to avoid property acquisition. It is anticipated that moderate utility relocations will be required during the construction of the project. Conflicts are anticipated along Crofts Pride Drive with an 8-inch gravity sewer line and 6-inch water line and along Purebred Drive with an 8-inch gravity sewer line and 8-inch water line.

3.1.8.5 Other Alternatives Scored

Other alternatives were not considered.

3.1.8.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.1.8.7 Project Analysis Summary

Table 8 below provides a summary of the Buckner Farms North project analysis. Refer to Appendix B-1-8 for project exhibits and supporting documentation.

Table 8. Buckner Farms North Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	50-year (1.5 feet SLR)
Selected Alternative	Alternative 1
ASC Score	4.4/10
Other ASC Score(s)	N/A
PPC Score	1.45/14.4
BR	0.99
BCR	1.0 (no habitable structure flooding)
Project Cost	$8,065,200

3.1.9 *Buckner Farms Combined Summary*

Table 9 below provides a summary of the Buckner Farms project analysis. Refer to Appendix B-1-1 through B-1-8 for project exhibits and supporting documentation.

Table 9. Buckner Farms Project Summary

	Phase 1: Dam Neck Road at Holland Road	Phase 2A: Holland Road at Shipps Corner	Phase 2B: Light Horse Loop and Storm Bird Loop	Phase 3A: Criollo Drive	Phase 3B: Buckner Boulevard at Crofts Pride Drive	Phase 4A: Brigands Way at Dam Neck Road	Phase 4B: Grassland Farms	Phase 4C: Buckner Farms North
SFA Recurrence	10-year (no SLR)	10-year (no SLR)	100- year (no SLR)	10-year (no SLR)	100-year (no SLR)	10-year (no SLR)	10-year (no SLR)	10-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)	100-year (no SLR) 10-year (3.0 feet SLR)	100-year (no SLR)	50-year (1.5 feet SLR)	100-year (no SLR)	50-year (1.5 feet SLR)	100-year (no SLR)	50-year (1.5 feet SLR)
Selected Alternative	Alternative 1	Alternative 1	Alternative 1	Alternative 1	Alternative 1	Alternative 1	Alternative 2	Alternative 1
ASC Score	3.55/10	5.62/10	6.08/10	4.69/10	6.09/10	4.79/10	4.65/10	4.4/10
Other ASC Score(s)	N/A	N/A	N/A	N/A	N/A	N/A	Alternative 1 – 4.43/10	N/A
PPC Score	7.62/14.4	2.04/14.4	1.37/14.4	1.45/14.4	0.97/14.4	5.25/14.4	5.38/14.4	1.45/14.4
BR	1.0	1.0	1.0	0.97	1.0	0.99	1.0	0.99
BCR	1.0 (based on updated model)	1.0 (no habitable structure flooding)	1.0(no habitable structure flooding)	1.0 (no habitable structure flooding)	1.0 (no habitable structure flooding)	1.0007	1.0012	1.0(no habitable structure flooding)
Individual Project Cost	$16,095,000	$6,846,000	$42,340,600	$11,163,600	$5,123,750	$10,383,500	$37,300,600	$8,065,200
Total Project Cost	$137,318,250							

3.2 Buyrn Circle at Buyrn Court

3.2.1 SFA Description

Buyrn Circle is a residential road in the Buyrn Farm neighborhood. A portion of Buyrn Circle ranges in elevation from 4.5 to 6 feet. The design tailwater elevation for the 100-year storm event is 6.33 feet in West Neck Creek. The tailwater elevation, independent of the existing drainage infrastructure, floods the street. As shown in Figure 6, the models indicate Buyrn Circle and Buyrn Court begin to experience flooding in the 10-year storm event.

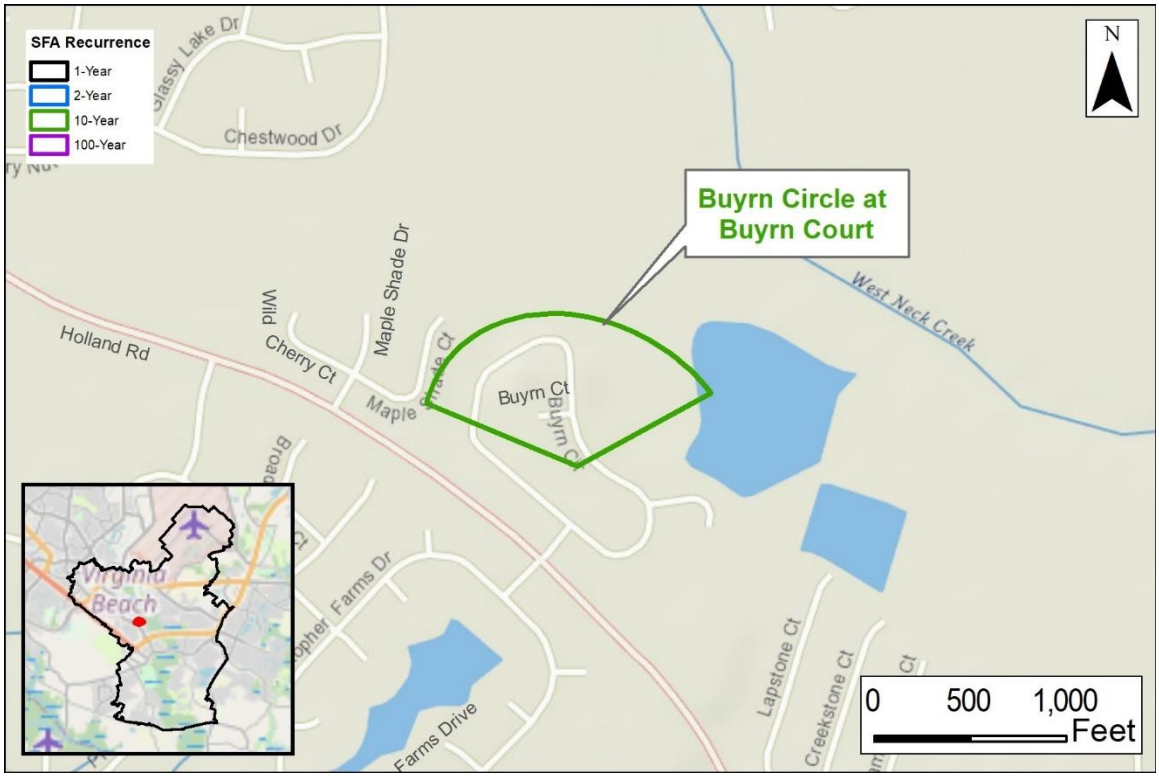


Figure 6. Location Map of Buyrn Circle at Buyrn Court SFA

3.2.2 Project Description

The downstream tailwater conditions severely limit the options for improvements in this neighborhood. The City will be evaluating this SFA with a Neighborhood Strategy in the future. Refer to Appendix B-2 for the extent of existing flooding in the area.

3.2.3 Project Benefits

There is no project, and there are no benefits.

3.2.4 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.2.5 Other Alternatives Not Scored

This neighborhood would benefit from a neighborhood solution similar to those shown in the SLW (Sea Level Wise) Adaptation Strategy Report. This neighborhood can be designed to resolve the flooding issues that occur from a smaller storm event. PW-SWEC will, in the future, have a neighborhood solution created to establish resiliency in this neighborhood.

3.3 Buyrn Farm

3.3.1 SFA Description

Buyrn Farm subdivision floods due to a lack of storage and inadequate pipes in the neighborhood. The neighborhood experiences habitable structure, street, and private property flooding. As shown in Figure 7, the models indicate Buyrn Farms Park begins to experience flooding in the 10-year storm event.

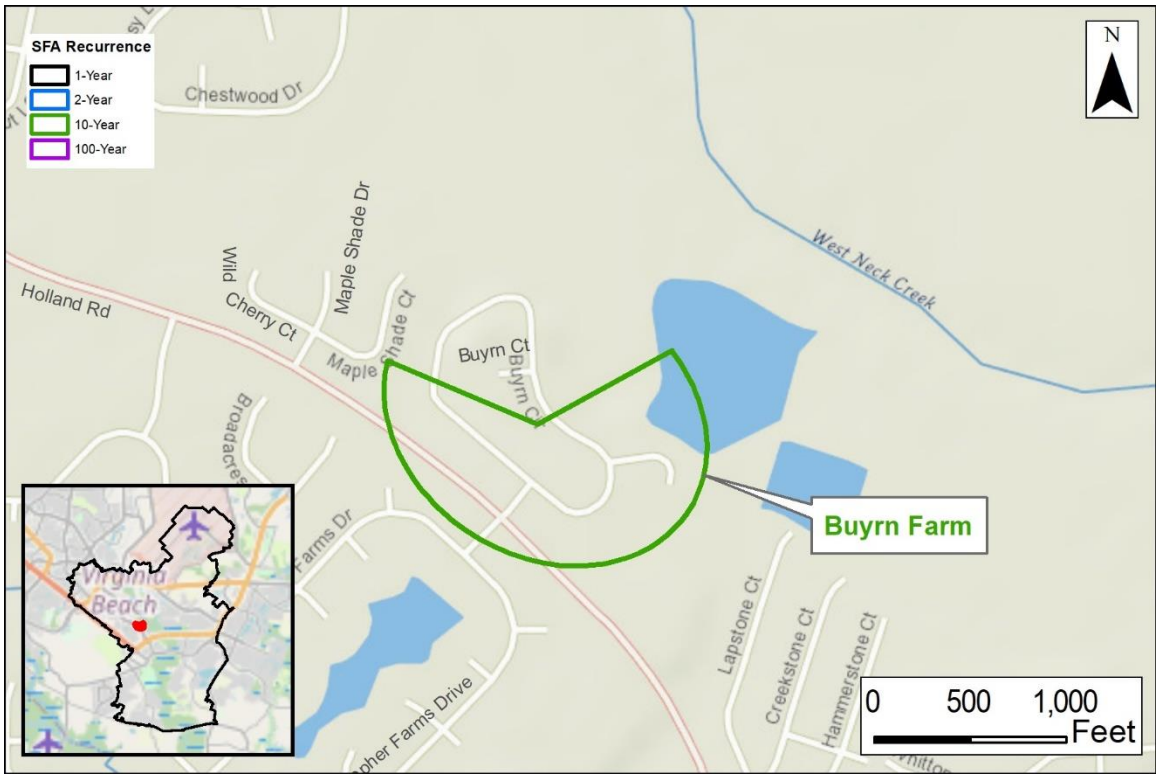


Figure 7. Location Map of Buyrn Farm SFA

3.3.2 Project Description

This project will improve the existing stormwater infrastructure along Buyrn Circle. Inadequate pipes along Buyrn Circle will be upsized, and an additional outfall will be added through Buyrn Farm Park.

3.3.3 Project Benefits

The major benefits of the project include mitigating habitable structure flooding on Buyrn Circle for two structures. The habitable structure flooding resolved is a part of the adjacent tailwater driven SFA, Buyrn Circle at Buyrn Court. Street flooding and private property flooding are also mitigated throughout the neighborhood. The project also addresses several flood reports in the area. There is a cost-sharing opportunity with DPU for transmission line prioritization along Buyrn Farm Road.

3.3.4 Project Analysis Assumptions

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. The project is given a BR of 1.0 because all street flooding is mitigated.

Property and easement acquisition is not required as all the construction will occur within the ROW or City property. It is anticipated that moderate maintenance of traffic will be required during the construction of the project. Moderate utility relocations will be required during the construction of the project. Conflicts are anticipated with an 8-inch gravity sewer line and an 8-inch water line. It is anticipated that minimal effort will be required to obtain environmental permits to add an inflow pipe to the pond.

3.3.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.3.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.3.7 Project Analysis Summary

Table 10 below provides a summary of the Buyrn Farm project analysis. Refer to Appendix B-3 for project exhibits and supporting documentation.

Table 10. Buyrn Farm Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	6.17/10
Other ASC Score(s)	N/A
PPC Score	5.88/14.4
BR	1.0
BCR	1.0 (based on updated model)
Project Cost	$3,081,000

3.4 Castleton

3.4.1 SFA Description

The Castleton neighborhood floods due to undersized stormwater ponds and tailwater from the adjacent floodplain. The FEMA 100-year floodplain is directly adjacent to the western portions of the neighborhood and encroaches within Tower Bridge Loop near the intersections of Seven Kings Road and Farmworth Trail. As shown in Figure 8, the models indicate Castleton begins to experience flooding in the 100-year storm event.

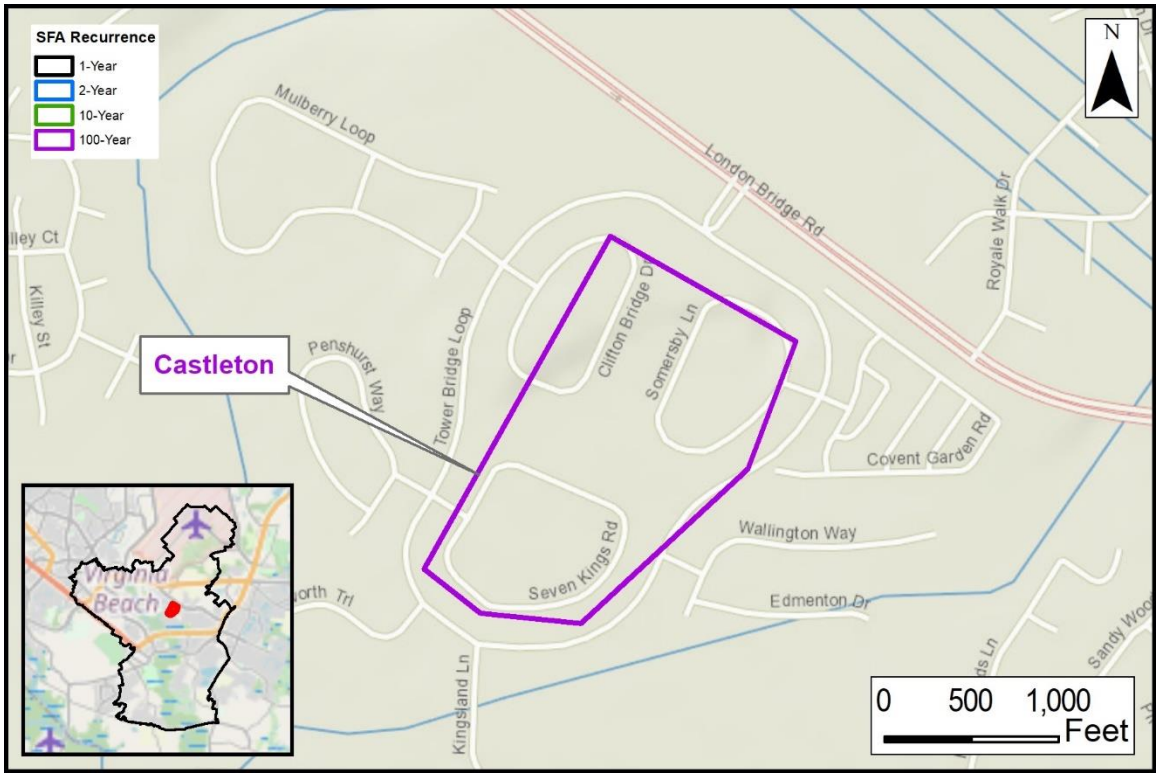


Figure 8. Location Map of Castleton SFA

3.4.2 Project Description

This project will remove the connection between two of the neighborhood ponds (BMP IDs SU2405200000 and SU2405206160). Additionally, a new outfall will be created for the central stormwater pond northeast of Seven Kings Road (BMP ID SU2405200000). The new outfall will cross Tower Bridge Road to a proposed trapezoidal ditch that outfalls through the floodplain to the main West Neck Creek channel. Pipes will be upsized in the neighborhood to increase capacity where needed.

3.4.3 Project Benefits

The major benefits of the project include mitigating habitable structure flooding for 10 structures on Somersby Lane and Seven Kings Road in the 100-year storm event and reducing street flooding in the 100-year storm event. The project also addresses several flood reports that have been documented in the area.

3.4.4 Project Analysis Assumptions

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. The project is given a BR of 1.0 because all street flooding is mitigated.

Easement acquisition is required for the new outfall and the proposed ditch. It is anticipated that moderate maintenance of traffic and moderate utility relocations will be required during the construction of the project. It is anticipated that extensive effort will be required to obtain environmental permits. Coordination with the City's VSMP Permit Coordinator is required since changes to the original BMP configuration are proposed.

This project and the Tower Bridge Loop North project are kept separate because the SFAs can be mitigated separately. However, the downstream ditch is the same in both projects. If the Tower Bridge North project is constructed first, then the downstream ditch improvements as part of this project would not be required. Refer to Section 3.55 for a description of the Tower Bridge Loop North project.

3.4.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.4.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.4.7 Project Analysis Summary

Table 11 below provides a summary of the Castleton project analysis. Refer to Appendix B-4 for project exhibits and supporting documentation.

Table 11. Castleton Project Summary

SFA Recurrence	100-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	3.56/10
Other ASC Score(s)	Alternative 1
PPC Score	4.67/14.4
BR	1.0
BCR	1.0 (based on updated model)
Project Cost	$4,880,500

3.5 Christopher Farms

The Princess Anne Crossing and North Christopher Farms projects are combined into the Christopher Farms project. Individual SFA locations are shown in Figure 9 and are further described below. The two projects are hydraulically connected and can be combined into one phased project. The North Christopher Farms project is dependent on the Princess Anne Crossing project. Refer to Appendix B-5 through B-5-2 for detailed project phase maps.

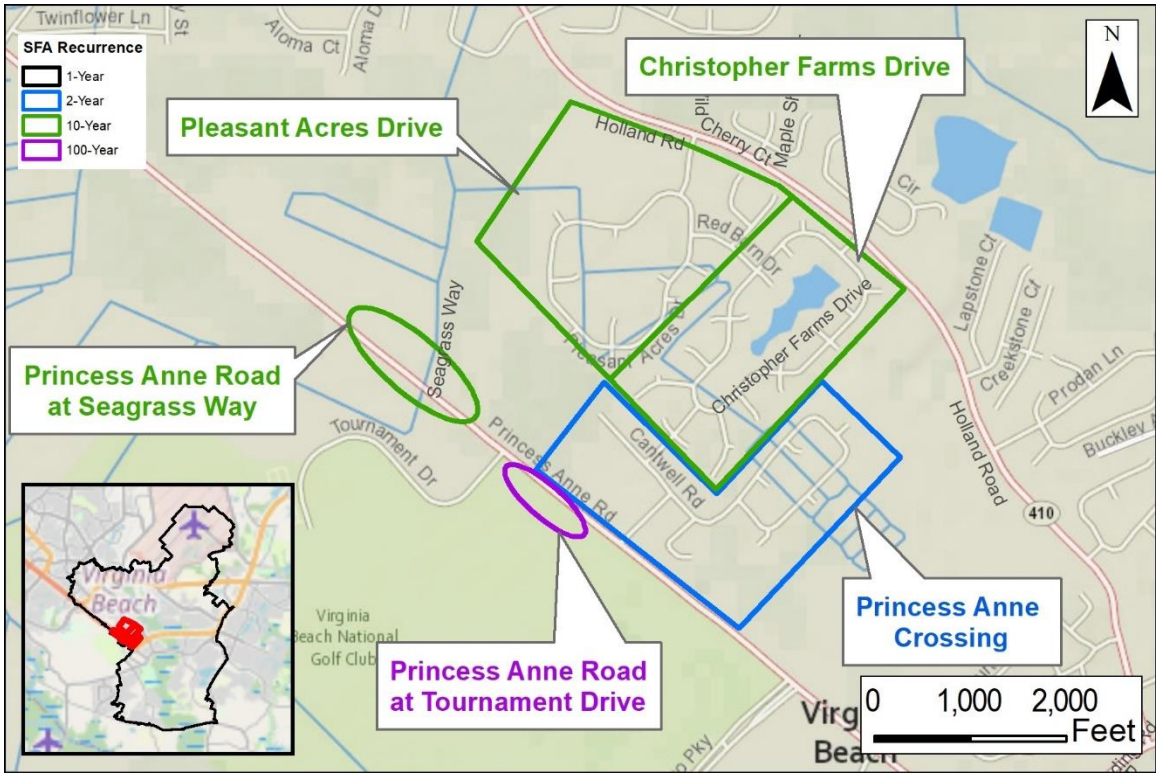


Figure 9. Location Map of Princess Anne Crossing, Princess Anne Road at Tournament Drive, Christopher Farms Drive, Pleasant Acres Drive, and Princess Anne Road at Seagrass Way SFAs

3.5.1 *Phase 1: Princess Anne Crossing*

3.5.1.1 SFA Description

The Princess Anne Crossing, Princess Anne at Tournament Drive, and Christopher Farms Drive SFAs are combined into the Princess Anne Crossing project. Individual SFA locations are shown in Figure 9 and are further described below. All three SFAs are hydraulically connected and can be combined into one project.

Princess Anne Crossing SFA

Princess Anne Crossing floods due to undersized pipes and lack of storage in the neighborhood. Habitable structures flood along Cantwell Road and Curry Comb Court. As shown in Figure 9, the models indicate Princess Anne Crossing begins to experience flooding in the 2-year storm event.

Princess Anne Road at Tournament Drive SFA

Princess Anne Road near Tournament Drive floods due to the existing downstream ditch. The ditch constricts flow during the 100-year storm event. As shown in Figure 9, the models indicate Princess Anne Road begins to experience flooding in the 100-year storm event.

Christopher Farms Drive SFA

Christopher Farms Drive floods due to the undersized pond and pipes in the neighborhood. As shown in Figure 9, the models indicate Christopher Farms Drive begins to experience flooding in the 10-year storm event.

3.5.1.2 Project Description

This project proposes a 12-acre BMP on private property to the northeast of the Princess Anne Crossing neighborhood. The new pond outfalls into the existing system along Holland Road, which will be upsized to maintain the current HGL downstream. Pipes throughout both neighborhoods are upsized and redirected to the new pond. Additionally, a new pipe is proposed under the existing ditch along Princess Anne Road and outfalls into the proposed pond.

3.5.1.3 Project Benefits

The major benefits of the project include mitigating habitable structure flooding and street flooding throughout the neighborhoods. Habitable structure flooding is resolved for six structures on Cantwell Road. The project also addresses several flood reports that have been documented in the area. There is a potential cost-sharing opportunity with DPU for transmission main prioritization and with the Public Works Stormwater Regulatory Division for the creation of a new BMP.

3.5.1.4 Project Analysis Assumptions

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. The project is given a BR of 1.0 because all street flooding is mitigated. Princess Anne Road, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and 100-year storm event with no SLR.

Property and easement acquisition is required for this project, but it is minimized in the neighborhood by using the dead-end streets to connect to the new pond. It is anticipated that extensive maintenance of traffic and extensive utility relocations will be required during the construction of the project. Moderate effort will be required to obtain environmental permits.

While changes to the original design function of the existing BMP are not anticipated, coordination with the City VSMP Permit Coordinator is required. Water is being diverted from the existing pond into the proposed pond that is assumed to provide equal or greater treatment.

3.5.1.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.5.1.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.5.1.7 Project Analysis Summary

Table 12 below provides a summary of the Princess Anne Crossing project analysis. Refer to Appendix B-5-1 for project exhibits and supporting documentation.

Table 12. Princess Anne Crossing Project Summary

SFA Recurrence	2-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	4.35/10
Other ASC Score(s)	N/A
PPC Score	7/14.4
BR	1.0
BCR	1.0 (based on updated model)
Project Cost	$42,646,600

3.5.2 *Phase 2: North Christopher Farms*

3.5.2.1 SFA Description

The Pleasant Acres Drive and Princess Anne Road at Seagrass Way SFAs are combined into the North Christopher Farms project. Individual SFA locations are shown in Figure 9 and are further described below. Both SFAs are hydraulically connected and can be combined into one project.

Pleasant Acres Drive SFA

Pleasant Acres Drive floods due to undersized pipes and inadequate storage. As shown in Figure 9, the models indicate the Pleasant Acres Drive SFA begins to experience flooding in a 10-year storm event.

Princess Anne Road at Seagrass Way SFA

Princess Anne Road near Seagrass Way floods due to undersized pipes. Princess Anne Road is documented as a secondary evacuation route. As shown in Figure 9, the models indicate Princess Anne Road begins to experience flooding in a 10-year storm event.

3.5.2.2 Project Description

This project connects both Christopher Farms BMPs to add additional storage to the neighborhood. Pipes are upsized to increase capacity. Pipes are also added underneath the existing ditch along Princess Anne Road. This new trunkline outfalls into the northwestern Christopher Farms BMP. Christopher Farms Phase 2: North Christopher Farms is dependent on Christopher Farms Phase 1: Princess Anne Crossing improvements.

3.5.2.3 Project Benefits

The major benefits of the project include mitigating street flooding in the North Christopher Farms neighborhood and along Princess Anne Road, as well as the flooding occurring on surrounding private property. The project also addresses several flood reports that have been documented in the area. There is a potential cost-sharing opportunity with DPU for transmission main prioritization.

3.5.2.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated. Princess Anne Road, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and 100-year storm event with no SLR.

Easement acquisition is required for this project, but no property acquisition is required. It is anticipated that moderate maintenance of traffic and utility relocations will be required during the construction of the project. Moderate effort will likely be required to obtain environmental permits as wetland impacts are anticipated. While changes to the original design function of the BMP are not anticipated, coordination with the City's VSMP Permit Coordinator is required.

3.5.2.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.5.2.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.5.2.7 Project Analysis Summary

Table 13 below provides a summary of the North Christopher project analysis. Refer to Appendix B-5 for project exhibits and supporting documentation.

Table 13. North Christopher Farms Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	4.22/10
Other ASC Score(s)	N/A
PPC Score	2.44/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$9,328,100

3.5.3 *Christopher Farms Combined Summary*

Table 14 below provides a summary of the Christopher Farms analysis. Refer to Appendix B-5 for project exhibits and supporting documentation.

Table 14. Christopher Farms Summary

	Phase 1: Princess Anne Crossing	**Phase 2: North Christopher Farms**
SFA Recurrence	2-year (no SLR)	10-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1	Alternative 1
ASC Score	4.35/10	4.22/10
Other ASC Score(s)	N/A	N/A
PPC Score	7/14.4	2.44/14.4
BR	1.0	1.0
BCR	1.0 (based on updated model)	1.0 (no habitable structures flooding)
Individual Project Cost	$42,646,600	$9,328,100
Total Project Cost	$51,974,700	

3.6 Court House Forest

3.6.1 SFA Description

Roads, private property, and a habitable structure located in the Court House Forest neighborhood flood due to inadequate pipes and stormwater infrastructure throughout the neighborhood. As shown in Figure 10, the models indicate Court House Forest begins to experience flooding in the 1-year storm event.

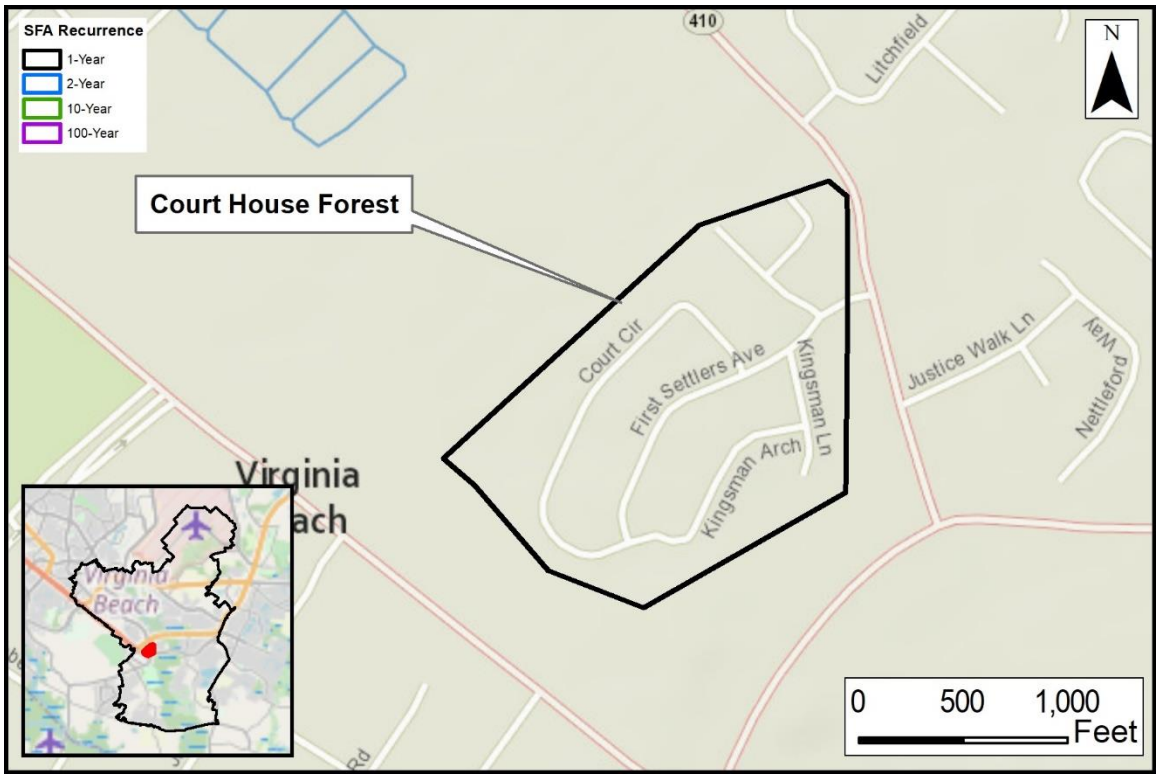


Figure 10. Location Map of Court House Forest SFA

3.6.2 Project Description

This project will add pipes and stormwater infrastructure to alleviate flooding. Two new outfalls and an underground storage system are proposed. One outfall will be created on the south end of Kingsman Lane and will cross Princess Anne Road into the West Neck Creek floodplain. The second outfall will be located along Court Circle and will discharge into a proposed underground storage system on the City of Virginia Beach Public Schools property (GPIN 14948485670000). The underground storage system will outfall through the City property and through First Colony Way. The existing pipes will be removed, and new larger pipes will be rerouted throughout the neighborhood to the new outfalls. A new pipe along Settlers Landing connects into the system to alleviate structure flooding in the area.

3.6.3 Project Benefits

The major benefits of the project include mitigating street flooding on Court Circle, First Settlers Avenue, Kingsman Lane, and Kingsman Arch, as well as the flooding occurring on surrounding private property. Additionally, this project mitigates flooding of one habitable structure on Settlers Landing. The project also addresses several flood reports that have been documented

in the area, and there is a potential cost-sharing opportunity with DPU for water leak prioritization.

3.6.4 Project Analysis Assumptions

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. The project is given a BR of 1.0 because all street flooding is mitigated.

Easement acquisition is minimized by using ROW and City property for the stormwater improvements. The underground storage is proposed beneath the former Kellam High School recreational fields. This school is currently being used as a "flex space" while other schools in the City are being renovated. It is assumed that the school will continue to be used as a flex space for the City of Virginia Beach Public Schools, and extensive coordination will be required when this project is constructed. It is anticipated that extensive utility relocations will be required during the construction of the project.

3.6.5 Other Alternatives Scored

No additional alternatives were scored for this SFA.

3.6.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.6.7 Project Analysis Summary

Table 15 below provides a summary of the Court House Forest project analysis. Refer to Appendix B-6 for project exhibits and supporting documentation.

Table 15. Court House Forest Project Summary

SFA Recurrence	1-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	4.25/10
Other ASC Score(s)	N/A
PPC Score	7.7/14.4
BR	1.0
BCR	1.0 (based on updated model)
Project Cost	$17,466,200

3.7 Courthouse Drive at James Madison Boulevard

3.7.1 SFA Description

The Courthouse Drive at Mattaponi Road and George Mason Drive at James Madison Boulevard SFAs are combined into the Courthouse Drive at James Madison Boulevard project. Individual SFA locations are shown in Figure 11 and are further described below. The two SFAs are hydraulically connected and can be combined into one project.

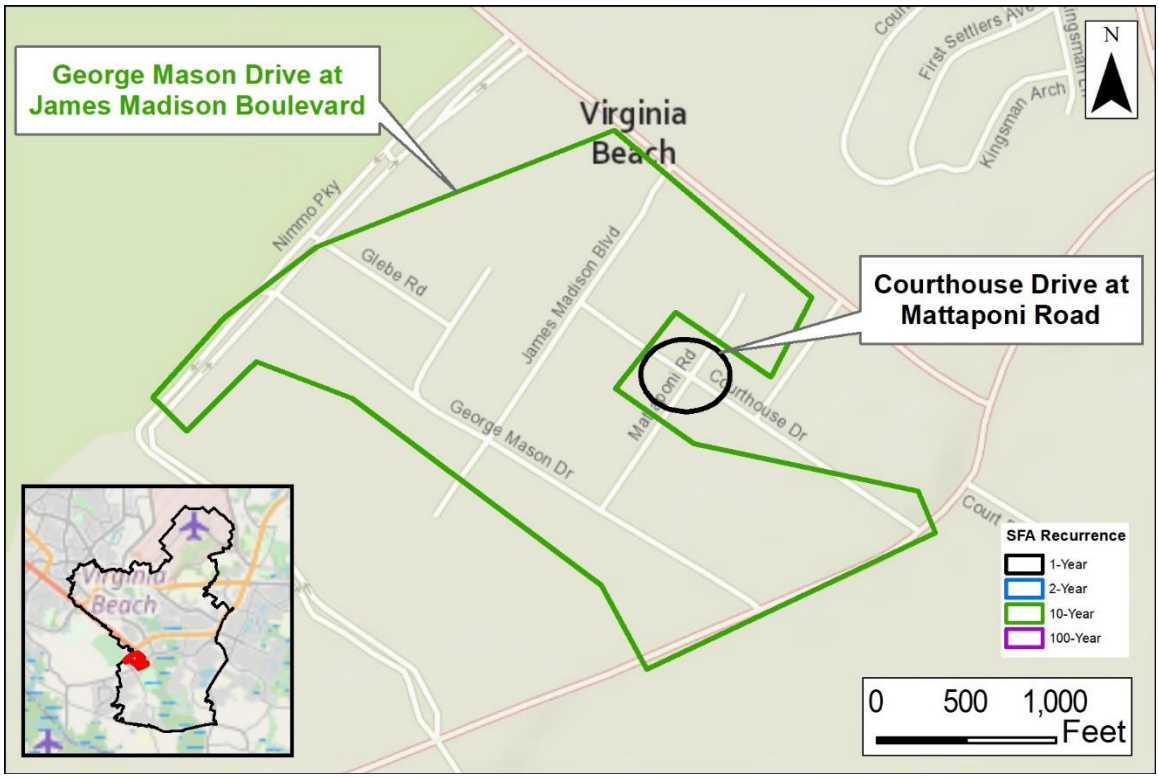


Figure 11 Location Map of Courthouse Drive at Mattaponi Road and George Mason Drive at James Madison Boulevard SFAs

Courthouse Drive at Mattaponi Road SFA

The intersection of Courthouse Drive and Mattaponi Road frequently experiences flooding due to inadequate stormwater infrastructure. The intersection serves as a route to critical infrastructure within the City Municipal Center. As shown in Figure 11, the models indicate Courthouse Drive and Mattaponi Road begin to experience flooding in the 1-year storm event.

George Mason Drive at James Madison Boulevard SFA

The area around George Mason Drive and James Madison Boulevard experiences significant flooding. The existing stormwater infrastructure is inadequate, and there is a lack of storage within the area leading to flooding. The roads in the area serve as a route to critical infrastructure within the City Municipal Center, and Nimmo Parkway serves as a secondary evacuation route. As shown in Figure 11, the models indicate George Mason Drive and James Madison Boulevard begin to experience flooding in the 10-year storm event.

3.7.2 Project Description

This project will add stormwater infrastructure along Courthouse Drive, James Madison Boulevard, and George Mason Drive. Underground storage will be constructed on City property (GPINs 14948149580000, 14947273780000, and 14947209690000). The downstream condition will be improved by lowering and expanding the existing downstream ditches.

3.7.3 Project Benefits

The major benefits of the project include mitigating street flooding on Courthouse Drive, James Madison Boulevard, Mattaponi Road, and George Mason Drive, as well as the flooding occurring on surrounding public property. The project also ensures that Courthouse Drive, James Madison Boulevard, Mattaponi Road, and George Mason Drive provide access to critical infrastructure within the City Municipal Center and that Nimmo Parkway can effectively serve as a secondary evacuation route. The project also addresses several flood reports that have been documented in the area.

3.7.4 Project Analysis Assumptions

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. The project is given a BR of 1.0 because all street flooding is mitigated. Nimmo Parkway, as a secondary evacuation route, remains passable in the 10-year storm event with the 3.0 feet SLR and the 100-year storm event with no SLR.

Property and easement acquisition is not required as all the construction will occur within the ROW or City property. It is anticipated that moderate maintenance of traffic will be required along North Landing Road and James Madison Boulevard during the construction of the project. Moderate utility relocations will likely be required along George Mason Drive with a 16-inch sewer forcemain, along Courthouse Drive with a 6-inch sewer forcemain, an 8-inch sewer gravity line, and an 8-inch water main, and along North Landing Road with a 4-inch sewer forcemain and 16-inch water line. Extensive effort will be required to obtain environmental permits from USACE and DEQ for over 2,000 feet of ditch improvements through nontidal wetlands.

Channel improvements are required on the City-owned parcel that includes the Whitehurst-Buffington House, which is listed in the Virginia Cultural Resource Information System. It is anticipated that moderate effort will be required to obtain permits to improve the channel.

3.7.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.7.6 Other Alternatives Not Scored

One additional alternative was considered to create an open water feature within the Municipal Center as opposed to creating multiple underground storage facilities. A parking structure would be added within the Municipal Center to account for the loss in parking. However, this alternative was assumed to be cost-prohibitive and was not considered further.

3.7.7 Project Analysis Summary

Table 16 below provides a summary of the Courthouse Drive at James Madison Boulevard project analysis. Refer to Appendix B-7 for project exhibits and supporting documentation.

Table 16. Courthouse Drive at James Madison Boulevard Project Summary

SFA Recurrence	1-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	4.96/10
Other ASC Score(s)	N/A
PPC Score	13.1/14.4
BR	1.0
BCR	1.0 (based on updated model)
Project Cost	$18,020,000

3.8 Dam Neck Road and Harpers Road

Individual SFA locations, shown below in Figure 12, and further described below, are combined into the Dam Neck Road and Harpers Road project. Meeting the PWDSM requirements for the upstream SFAs is dependent on the improvements proposed for the downstream SFAs. A phased project is proposed considering the extent of improvements that are required and to accomplish the objective of the SWMP to develop "standalone" solutions that are not dependent on downstream improvements. Project phases are defined by the individual SFA boundaries and begin with the most downstream improvements. Future refinements to the project phasing proposed may be required. Refer to Appendix B-8 for detailed project phase maps.

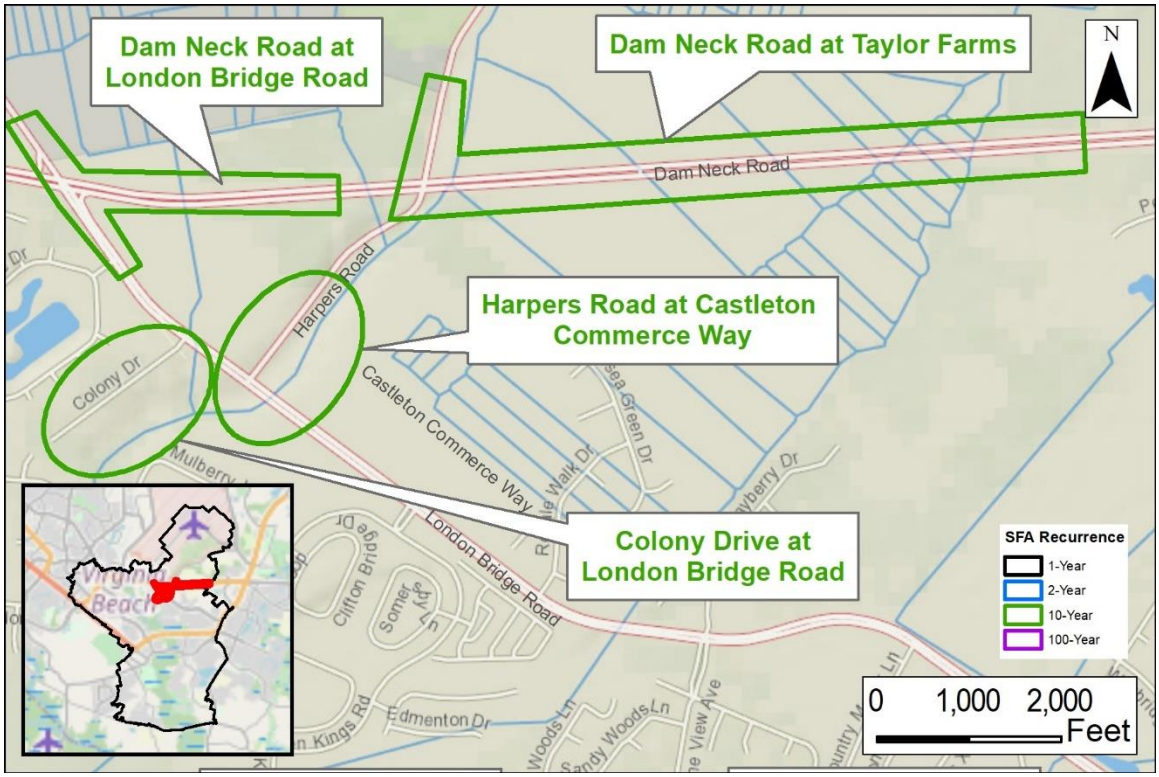


Figure 12. Location Map of Dam Neck Road at London Bridge Road, Dam Neck Road at Taylor Farms, Harpers Road at Castleton Commerce Way, and Colony Drive at London Bridge Road SFAs

3.8.1 ***Phase 1: London Bridge Road at Harpers Road***

3.8.1.1 SFA Description

The Harpers Road at Castleton Commerce Way and Colony Drive at London Bridge Road SFAs are combined into one project called London Bridge Road at Harpers Road. Individual SFA locations are shown in Figure 12 and are further described below. Both SFAs are hydraulically connected and can be combined into one project.

Harpers Road at Castleton Commerce Way SFA

Harpers Road at the intersection of Dam Neck Road floods due to undersized culverts. The undersized culverts also cause flooding on private property, including one habitable structure.

As shown in Figure 12, the models indicate London Bridge Road and Harpers Road begin to experience flooding in the 10-year storm event.

Colony Drive at London Bridge Road SFA

The entrance of Colony Drive, located south of London Bridge Road, floods due to a lack of stormwater infrastructure along Colony Drive. Habitable structure flooding occurs during the 100-year storm event. As shown in Figure 12, the models indicate Colony Road begins to experience flooding in the 10-year storm event.

3.8.1.2 Project Description

This project proposes significant improvements to this area. The culverts underneath London Bridge Road at the Harpers Road intersection will be replaced with a bridge. The bridge is assumed to be a precast, single-span bridge with a span of approximately 60 feet and a top elevation of 12.5 feet. This will require London Bridge Road to be raised at a maximum height of 3.5 feet. The length of road profile adjustments proposed along London Bridge is approximately 1,600 feet. The bridge will allow water to flow freely from the upstream channel. Additionally, Harpers Road will be terminated north of the intersection with London Bridge Road to eliminate the roadway flooding and to simplify bridge design and construction. Castleton Commerce Way will be raised to provide appropriate cover for the proposed box culverts. Road profile adjustments will be approximately 300 feet in length. The tributary of West Neck Creek will be dredged and widened to the connection with West Neck Creek to allow more capacity through the channel.

3.8.1.3 Project Benefits

The major benefits of the project include mitigating street flooding on Harpers Road and London Bridge Road, as well as the flooding occurring on surrounding private property and habitable structure flooding for one structure along Colony Drive. Another benefit of the project is ensuring that Dam Neck Road and London Bridge Road provide access to critical infrastructures such as the Naval Air Station (NAS) Oceana and the Dam Neck Annex and can effectively serve as a secondary evacuation.

The project also addresses several flood reports that have been documented in the area. There is a potential cost-sharing opportunity with DPU for transmission main prioritization.

3.8.1.4 Project Analysis Assumptions

HAZUS data is available for the habitable structure along Dam Neck Road. The structure no longer floods in the 100-year storm event. Based on the BCR methodology, the project BCR is 1.0389. The project is given a BR of 1.0 because all street flooding is mitigated. London Bridge Road and Dam Neck Road, as secondary evacuation routes, remain passable in the 10-year storm event with 3.0 feet SLR and 100-year storm event with no SLR.

Property and easement acquisition is required for this project. This includes the acquisition of drainage easements and one residential parcel at the location of the proposed cul-de-sac at Harpers Road. It is anticipated that extensive maintenance of traffic and utility relocations will be required during the construction of the project. It is anticipated that extensive effort will be required to obtain environmental permits to perform the required dredging improvements. A traffic study will be required by Traffic Engineering to assess the closure of Harpers Road.

3.8.1.5 Other Alternatives Scored

No additional alternatives were scored for this SFA.

3.8.1.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.8.1.7 Project Analysis Summary

Table 17 below provides a summary of the London Bridge Road at Harpers Road project analysis. Refer to Appendix B-8-1 for project exhibits and supporting documentation.

Table 17. London Bridge Road at Harpers Road Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	3.79/10
Other ASC Score(s)	N/A
PPC Score	6.24/14.4
BR	1.0
BCR	1.0389
Project Cost	$37,763,000

3.8.2 *Phase 2: Dam Neck Road at Harpers Road*

3.8.2.1 SFA Description

The Dam Neck Road at London Bridge Road and Dam Neck Road at Taylor Farms SFAs are combined into one project called Dam Neck Road at Harpers Road. Individual SFA locations are shown in Figure 12 and are further described below. Both SFAs are hydraulically connected and can be combined into one project.

Dam Neck Road at London Bridge Road SFA

Dam Neck Road and London Bridge Road flood due to undersized stormwater infrastructure. Additionally, the stormwater infrastructure downstream of the road is significantly undersized. Dam Neck Road and London Bridge Road are both documented as secondary evacuation routes. As shown in Figure 12, the models indicate Dam Neck Road and London Bridge Road begin to experience flooding in the 10-year storm event.

Dam Neck Road at Taylor Farms SFA

Dam Neck Road and Harpers Road flood due to undersized stormwater infrastructure. Additionally, the stormwater infrastructure downstream of the road is significantly undersized. Dam Neck Road is documented as a secondary evacuation route. As shown in Figure 12, the models indicate Dam Neck Road and Harpers Road begin to experience flooding in the 10-year storm event.

3.8.2.2 Project Description

This project proposes multiple pipe upgrades in addition to widening a tributary of West Neck Creek north of London Bridge Road to allow more capacity through the channel. A new channel and culverts are proposed to eliminate the flooding along Dam Neck Road. Pipes will be upsized in several locations to increase capacity. This project is dependent on the downstream improvements as a part of Dam Neck Road and Harpers Road Phase 1: London Bridge Road at Harpers Road project.

3.8.2.3 Project Benefits

The major benefits of the project include mitigating street flooding on Dam Neck Road and Harpers Road, as well as the flooding occurring on surrounding private property. This area is subject to frequent flooding. Another benefit of the project is ensuring that Dam Neck Road and London Bridge Road provide access to critical infrastructure (NAS Oceana and the Dam Neck Annex) and can effectively serve as a secondary evacuation route. The project has a potential cost-sharing opportunity with DPU for transmission main prioritization.

3.8.2.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated.

London Bridge Road and Dam Neck Road, as secondary evacuation routes, remain passable in the 10-year storm event with 3.0 feet SLR and 100-year storm event with no SLR.

Multiple easement acquisitions will be required for this project to widen existing channels and to construct new channels. It is anticipated that extensive maintenance of traffic and utility relocations will be required during the construction of the project. It is anticipated that extensive effort will be required to obtain environmental permits to perform the required channel improvements.

3.8.2.5 Other Alternatives Scored

No additional alternatives were scored for this SFA.

3.8.2.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.8.2.7 Project Analysis Summary

Table 18 below provides a summary of the Dam Neck Road at Harpers Road project analysis. Refer to Appendix B-8 for project exhibits and supporting documentation.

Table 18. Dam Neck Road at Harpers Road Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	4.29/10
Other ASC Score(s)	N/A
PPC Score	3.82/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$36,367,500

3.8.3 *Dam Neck Road and Harpers Road Combined Summary*

Table 19 below provides a summary of the Dam Neck Road and Harpers Road analysis. Refer to Appendix B-8 for project exhibits and supporting documentation.

Table 19. Dam Neck and Harpers Road Project Summary

	Phase 1: London Bridge Road at Harpers Road	**Phase 2: Dam Neck Road at Harpers Road**
SFA Recurrence	10-year (no SLR)	10-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1	Alternative 1
ASC Score	3.79/10	4.29/10
Other ASC Score(s)	N/A	N/A
PPC Score	6.24/14.4	3.82/14.4
BR	1.0	1.0
BCR	1.0389	1.0 (no habitable structure flooding)
Individual Project Cost	$37,763,000	$36,367,500
Total Project Cost	$74,130,500	

3.9 Dam Neck Road at Drakesmile Road

3.9.1 SFA Description

The tributary channel that crosses Dam Neck Road east of Drakesmile Road floods frequently. The culverts going underneath Dam Neck Road are undersized, and the elevation of the road is below the tailwater elevation in some locations. Dam Neck Road is documented as a secondary evacuation route and critical infrastructure. As shown in Figure 13, the models indicate Dam Neck Road begins to experience flooding in the 2-year storm event.

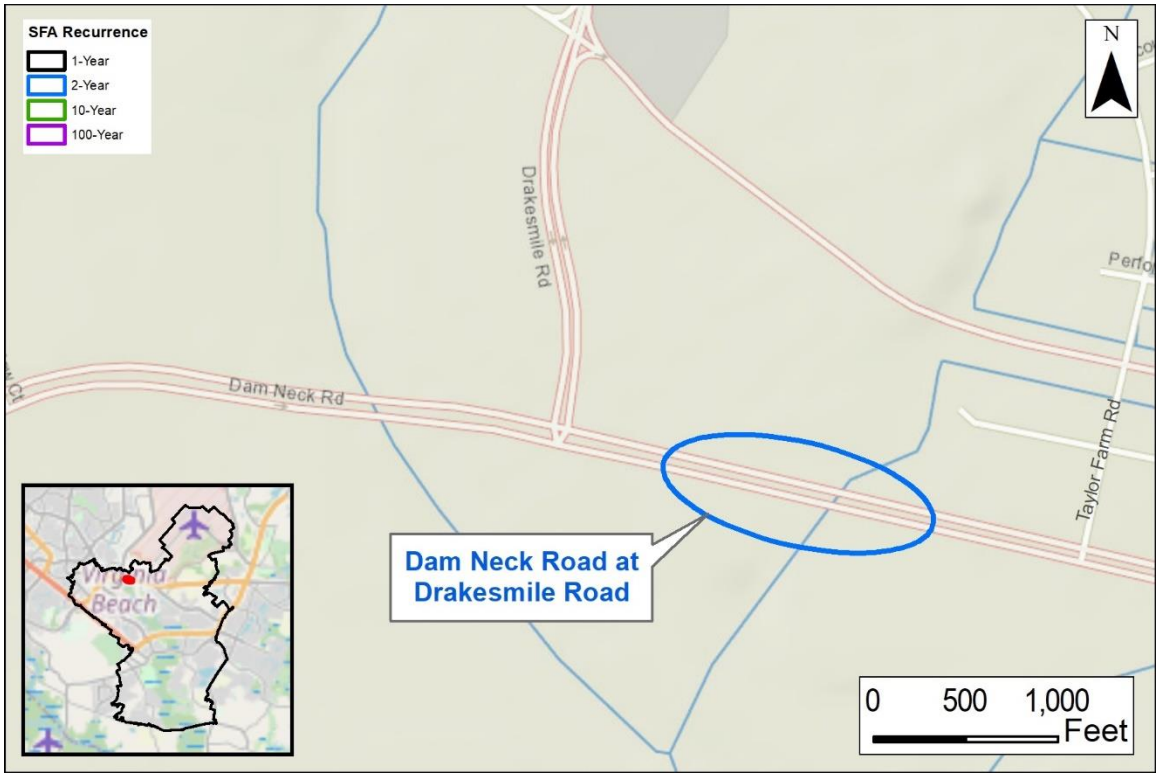


Figure 13. Location Map of Dam Neck Road at Drakesmile Road SFA

3.9.2 Project Description

This project will raise Dam Neck Road by 2 feet to reach a minimum elevation of 8.5 feet and tie into the existing grade. The total extent of the roadway improvements will be 1,300 feet.

3.9.3 Project Benefits

The major benefits of the project include mitigating street flooding on Dam Neck Road. There also is a potential cost-sharing opportunity with DPU for transmission main prioritization.

3.9.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated. Dam Neck Road, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and the 100-year storm event with no SLR.

Property and easement acquisition is not required as all the construction will occur within the ROW or City property. It is anticipated that moderate maintenance of traffic will be required

during the construction of the project along Dam Neck Road. Utility relocations are assumed to not be required during the construction of the project.

While the project is not dependent on any other projects, the extent of the roadway improvements could be reduced if the Taylor Farm at Aviator Drive project is completed. The increase in storage upstream of Dam Neck Road by the Taylor Farm at Aviator Drive project would decrease the height of the road that needs to be raised by 1 foot with a new elevation of 7.5 feet, which would result in a $50,000 cost reduction.

3.9.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.9.6 Other Alternatives Not Scored

There were four additional alternatives that were considered but were not scored. Increasing the capacity of the culverts underneath Dam Neck Road was considered to minimize the extent of elevating the road profile. The capacity of the culverts was increased by adding barrels and replacing the existing pipes with dual 8-foot by 4-foot box culverts. However, this failed to meet the PWDSM requirements since Dam Neck Road was not passable.

A second alternative considered additional storage upstream of Dam Neck Road was also considered. However, this also did not meet the PWDSM requirements since Dam Neck Road was not passable.

A third alternative was considered to minimize the extent of road profile adjustments while also providing a passable lane during the 100-year storm event. This alternative improved the median so that it could be used by emergency vehicles during the 100-year storm event. Since this location on Dam Neck Road floods during the 2-year storm event, median improvements were not considered.

A fourth alternative was considered to reduce the extents of road profile adjustments. This alternative would build a wall along the westbound lane of Dam Neck Road to prevent water from the channel from flooding the road. However, due to the depths and frequency of flooding, this was not considered further.

3.9.7 Project Analysis Summary

Table 20 below provides a summary of the Dam Neck Road at Drakesmile Road project analysis. Refer to Appendix B-9 for project exhibits and supporting documentation.

Table 20. Dam Neck Road at Drakesmile Road Project Summary

SFA Recurrence	2-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	6.36/10
Other ASC Score(s)	N/A
PPC Score	1.9/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$3,300,000

3.10 Dam Neck Road at Princess Anne Road

3.10.1 SFA Description

The Dam Neck Road at Princess Anne Road, Landstown Court, and Dam Neck Road at Public Utilities Operations SFAs are combined into one project called Dam Neck Road at Princess Anne Road. Individual SFA locations are shown in Figure 14 and are further described below. All three SFAs are hydraulically connected and can be combined into one project.

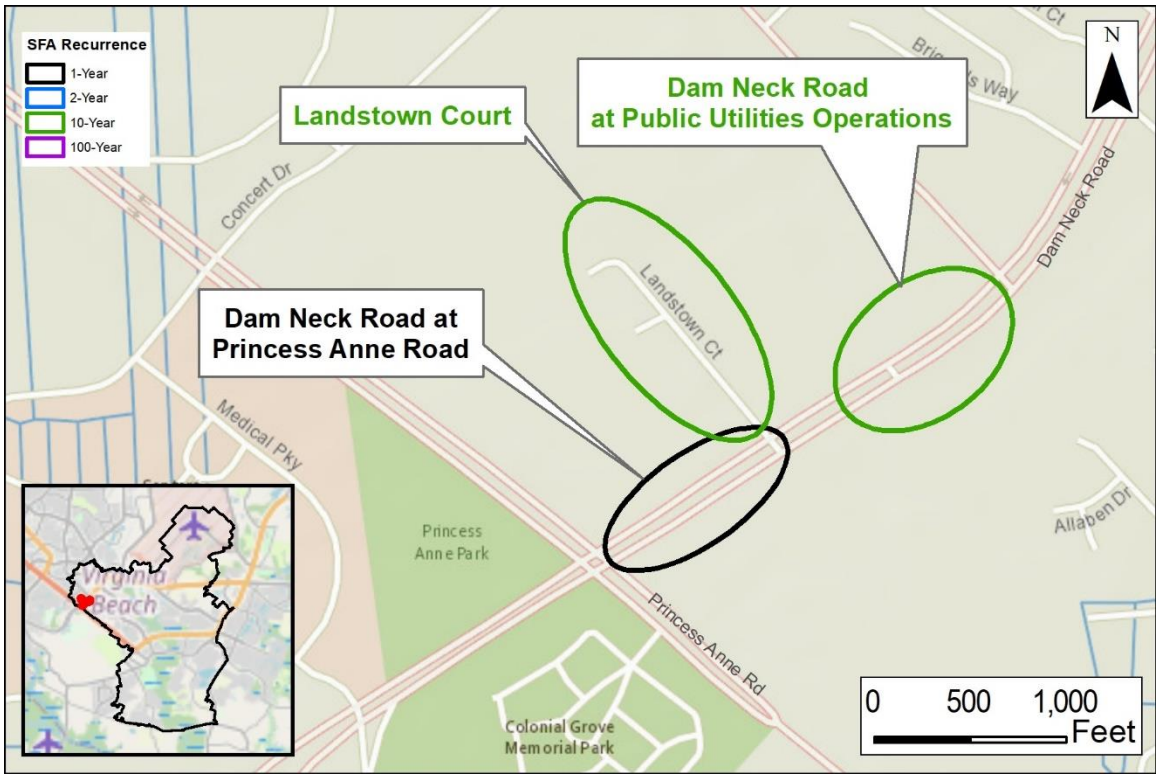


Figure 14. Location Map of Dam Neck Road at Princess Anne Road, Landstown Court, and Dam Neck Road at Public Utilities Operations SFAs

Dam Neck Road at Princess Anne Road SFA

Dam Neck Road at Princess Anne Road floods frequently. Dam Neck Road serves as a secondary evacuation route and is critical infrastructure for access to NAS Oceana and the Dam Neck Annex. As shown in Figure 14, the models indicate that Dam Neck Road begins to experience flooding in the 1-year storm event. In addition to street flooding, habitable structures and private property also experience flooding along Dam Neck Road. The pipes underneath and along Dam Neck Road are inadequate, causing the road to flood during storm events. Additionally, there is a lack of upstream storage.

Landstown Court SFA

Landstown Court experiences street flooding as well as flooding on the adjacent private property. No habitable structure flooding occurs. The pipes in the area are inadequate, and there is a lack of storage. As shown in Figure 14, the models indicate Landstown Court begins to experience flooding in the 10-year storm event.

Dam Neck at Public Utilities Operations SFA

Dam Neck Road experiences street flooding west of Rosemont Road in front of Public Utilities Operations. Dam Neck Road serves as a secondary evacuation route and is critical infrastructure for access to NAS Oceana and the Dam Neck Annex. There is not any habitable structure flooding, but flooding does occur on Operations property. The pipes along Dam Neck Road and on Operations property are inadequate, and there is a lack of storage, causing the area to flood. As shown in Figure 14, the models indicate Dam Neck Road begins to experience flooding in a 10-year storm event.

3.10.2 Project Description

The Dam Neck Road at Princess Anne Road project will add storage to the stormwater system and increase the size of pipes in this area. The BMP at the north end of Landstown Court will be expanded onto private and City properties (GPINs 14858146290000 and 14858115240000), and a backflow preventer and submersible pump will be added to the system. The submersible pump will draw down the elevation of the BMP before the 100-year storm event. Underground storage will be placed on City property (GPIN 14858286190000). Pipes along Dam Neck Road, Landstown Court, and within Operations property will be improved to resolve the flooding.

3.10.3 Project Benefits

The major benefits of the project include mitigating habitable structure flooding on Dam Neck Road and street flooding on Dam Neck Road and Landstown Court. Flooding is mitigated for three habitable structures. The project also addresses several flood reports that have been documented in the area. There is a potential cost-sharing opportunity for DPU transmission main and water leak mainline prioritization and with the Public Works Stormwater Regulatory Division for local total maximum daily load (TMDL) assistance or the creation of nutrient credits that could be used for other City projects. Additionally**,** this project ensures that Dam Neck Road provides access to the City Operations Yard, can effectively serve as a secondary evacuation route, and maintains access to critical facilities.

3.10.4 Project Analysis Assumptions

The project meets the PWDSM requirements in the 100-year storm event. As discussed in Section 2.2, preemptive pumping for storms more frequent than the 100-year storm event cannot be assumed at this time. As a result, the project does not require preemptive pumping in the 10-year storm event with 1.5 and 3.0 feet SLR.

HAZUS data is available for the habitable structures along Dam Neck Road. The structures no longer flood in the 100-year storm event. Based on the BCR methodology, the project BCR is 1.1013. The project is given a BR of 1.0 because all street flooding is mitigated. Dam Neck Road, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and the 100-year storm event with no SLR.

Easement acquisition will be required to expand the BMP but was minimized by utilizing City property for most of the expansion. Temporary construction access will also be needed to build a berm around the BMP and to install a backflow preventer onto the existing BMP outfall.

It is anticipated that extensive utility relocations will be required during the construction of the project. There is a 24-inch water main and a 4-inch sewer line located near the existing drainage system in the Public Works and Utilities Operations Yard. Additionally, 12-inch and 20-inch water lines are in front of the operations building. The proposed improvements cross

the alignment and potentially conflict with Navy mission-critical utilities. Significant coordination with the utility owner and the military will be needed during the design and construction of the project.

It is anticipated that extensive maintenance of traffic will be required during the construction of the project. With the pipe replacements and utility relocations along Dam Neck Road, night phasing and closures will likely be necessary for this work to be completed. Field observations suggest that minimal effort will be required to obtain environmental permits to expand the existing BMP.

While changes to the original design function of the BMP are not anticipated, coordination with the City's VSMP Permit Coordinator is required.

3.10.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.10.6 Other Alternatives Not Scored

One other alternative was considered but not scored. In an attempt to eliminate the need for the pump described in the selected alternative, the alternative explored draining the expanded BMP with a proposed outlet structure. However, there was not adequate storage above the NWSE to contain the 100-year storm event in the downstream ditch system. This alternative failed to meet the PWDSM standards and did not alleviate flooding on Dam Neck Road or Landstown Court.

Additionally, other alternatives were considered to drain the BMP without a pump in the 100-year storm event. Considering the location of the proposed berm, lowering the existing adjacent ditch by an additional 3 feet was determined not to be constructible. Therefore, draining the BMP with gravity methods was not considered further.

3.10.7 Project Analysis Summary

Table 21 below provides a summary of the Dam Neck Road at Princess Anne Road project analysis. Refer to Appendix B-10 for project exhibits and supporting documentation.

Table 21. Dam Neck Road at Princess Anne Road Project Summary

SFA Recurrence	1-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	5.14/10
Other ASC Score(s)	N/A
PPC Score	13.5/14.4
BR	1.0
BCR	1.1013
Project Cost	$18,038,400

3.11 Dam Neck Road at Taylor Farm Road

3.11.1 SFA Description

The Horse Pasture Road at Taylor Farm Road and Dam Neck Road at Horse Pasture Road SFAs are combined into one project called Dam Neck Road at Taylor Farm Road. Individual SFA locations are shown in Figure 15 and are further described below. The two SFAs are hydraulically connected and can be combined into one project.

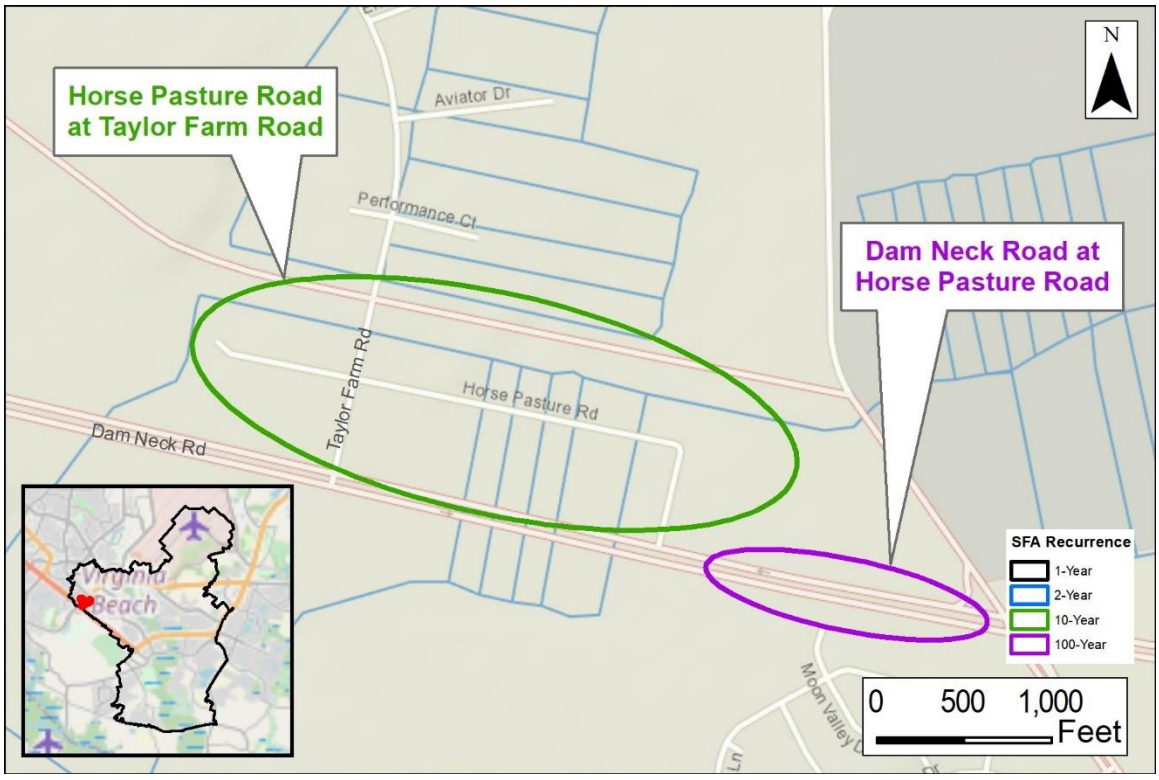


Figure 15. Location Map of Horse Pasture Road at Taylor Farm Road and Dam Neck Road at Horse Pasture Road SFAs

Horse Pasture Road at Taylor Farm Road SFA

Horse Pasture Road and Taylor Farm Road are in a heavy industrial area. The area lacks storage, which causes street flooding. As shown in Figure 15, the models indicate Horse Pasture Road at Taylor Farm Road begins to experience flooding in the 10-year storm event.

Dam Neck Road at Horse Pasture Road SFA

Dam Neck Road at Horse Pasture Road experiences street flooding but no structure flooding. Dam Neck Road serves as a secondary evacuation route and is critical infrastructure for access to NAS Oceana and the Dam Neck Annex. The pipes along the eastbound and westbound lanes are inadequate, and there is a lack of storage in the system. As shown in Figure 15, the models indicate Dam Neck Road at Horse Pasture Road begins to experience flooding in the 100-year storm event.

3.11.2 Project Description

This project will add an additional BMP that will require the acquisition of an undeveloped parcel along Horse Pasture Lane. Pipes along Horse Pasture Lane will be reversed, and proposed pipes will be added to direct flow to the proposed BMP, which ultimately will outfall to Dam Neck Road. The pipe system along Dam Neck Road will be upsized, and a grass swale will be added along the westbound lane. Additionally, the downstream ditch will be expanded to increase the capacity of the flow.

3.11.3 Project Benefits

The major benefits of the project include mitigating street flooding on Horse Pasture Road, as well as flooding occurring on surrounding private property. The project also allows Dam Neck Road to effectively serve as a secondary evacuation route and maintain access to critical facilities.

3.11.4 Project Analysis Assumptions

A 50-year LOS is achieved, given the minimal area available for storage. Flood depths are less than 3 inches above the crown of the road within the Taylor Farm Industrial Park, are summarized on the 100-year flood map, and will require approval for a reduced LOS from the City Engineer.

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. There is a decrease in street flooding in the 100-year storm event, but it is not completely mitigated. Therefore, the project is given a BR of 0.98. Dam Neck Road, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and 100-year storm event with no SLR.

Easement acquisition will be required to expand the downstream ditch, and property acquisition will be required for the proposed BMP. Easement acquisition will also be required for the proposed grass swale. The amount of property acquisition was minimized by upsizing the downstream pipes and ditch to increase the capacity of flow under Dam Neck Road.

It is anticipated that there will be moderate utility conflicts. Along Horse Pasture Road, there is an 8-inch gravity sewer line and an 8-inch water line. There is a 20-inch water main running along the westbound lane of Dam Neck Road. A 42-inch HRSD force main is running along Dam Neck Road. Conflicts with this utility are assumed to be avoided by matching the existing pipe size at the point of crossing. It is anticipated that moderate maintenance of traffic will be required during the construction of the project along Dam Neck Road. Moderate environmental permitting will be required to construct the proposed BMP and improve the existing ditch downstream of Dam Neck Road.

3.11.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.11.6 Other Alternatives Not Scored

The first additional alternative that was considered but not scored was to expand the existing BMP at the west end of Horse Pasture Road. The expanded BMP was limited to the space available on the current lot. The outfall structure was also changed to a weir to allow for more flow. This alternative was evaluated to add more storage within the system without requiring land acquisition; however, it failed to meet the PWDSM requirements as there was still street flooding on Horse Pasture Road.

The second alternative that was considered was to add a larger BMP to the east end of Horse Pasture Road. The existing pipes along Horse Pasture Road were separated at Taylor Farm Road, so half of the road and adjacent properties would continue to drain to the existing BMP to the west. The pipes to the east of Taylor Farm Road were reversed so water would drain to the proposed BMP; however, it failed to meet the PWDSM requirements as there was still street flooding. This alternative would also require more significant land acquisition.

The third alternative was to upsize the pipes along Horse Pasture Road to increase the capacity in the system, with and without the proposed BMP improvements. This failed to meet the PWDSM requirements since the streets were still flooding.

A fourth alternative considered adding two additional BMPs within the industrial development. This was considered along with the expansion of the existing BMPs and outfall connection on Dam Neck Road. This alternative did not require making improvements across Dam Neck Road and did meet the PWDSM requirements. However, it was not considered further due to the large amounts of land acquisition that would be required.

The last alternative that was considered was to add a BMP south of Dam Neck Road and to the east of the existing channel. The location of this BMP was selected in an attempt to minimize or avoid private land acquisition along Horse Pasture Road. This BMP was added with the expansion of the existing BMPs along Horse Pasture Road and an outfall connection to Dam Neck Road. This failed to meet the PWDSM since there was still flooding along Horse Pasture Road.

3.11.7 Project Analysis Summary

Table 22 below provides a summary of the Dam Neck Road at Taylor Farm Road Project analysis. Refer to Appendix B-11 for project exhibits and supporting documentation.

Table 22. Dam Neck Road at Taylor Farm Road Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	50-year (1.5 feet SLR) 10-Year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	5.24/10
Other ASC Score(s)	N/A
PPC Score	1.85/14.4
BR	0.98
BCR	1.0 (no habitable structure flooding)
Project Cost	$10,452,500

3.12 Drakesmile Road at HRSD Shipps Corner Pressure Reducing Station (PRS)

3.12.1 SFA Description

The intersection of Drakesmile Road and Dam Neck Road experiences frequent flooding due to inadequate stormwater pipes. Drakesmile Road and Dam Neck Road are secondary evacuation routes, and Dam Neck Road is critical infrastructure for access to NAS Oceana and the Dam Neck Annex. As shown in Figure 16, the models indicate the intersection begins to experience flooding in the 10-year storm event.

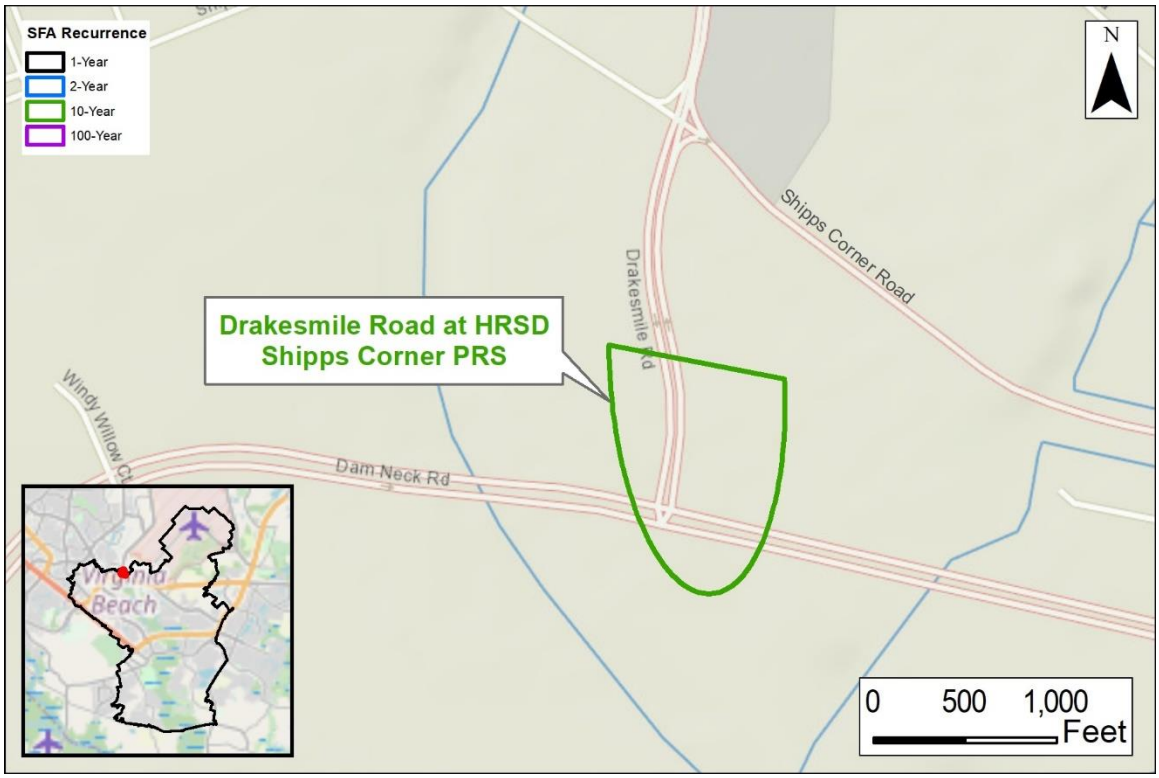


Figure 16. Location Map of Drakesmile Road at HRSD Shipps Corner PRS SFA

3.12.2 Project Description

This project will upsize the existing stormwater pipes adjacent to the westbound lane of Dam Neck Road. The pipes will be upsized from the intersection of Drakesmile Road and Dam Neck Road to the outfall into West Neck Creek.

3.12.3 Project Benefits

The major benefits of the project include mitigating street flooding on Drakesmile Road and Dam Neck Road. There is a potential cost-sharing opportunity with DPU for transmission main improvements that have been prioritized along Dam Neck Road. The project also allows Dam Neck Road to effectively serve as a secondary evacuation route and maintain access to critical facilities. The project had the highest score of the two alternatives because it creates less disturbance to the surrounding community.

3.12.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated. Dam Neck Road and Drakesmile Road, as secondary evacuation routes, remain passable in the 10-year storm event with the 3.0 feet SLR and the 100-year storm event with no SLR.

Property acquisition is not required as all the construction will occur within the ROW. The pipe improvements will run parallel to the HRSD easement, and there should not be conflicts with the pipe improvements and the existing HRSD utilities. It is anticipated that minimal maintenance of traffic will be required during the construction of the project.

3.12.5 Other Alternatives Scored

One additional alternative was scored as part of this analysis. Alternative 2 added an outfall pipe that crosses Dam Neck Road into West Neck Creek. The connecting pipe, along the eastbound lane of Dam Neck Road, would need to be upsized from an existing 24-inch pipe to a 30-inch pipe. This alternative did not score as high since crossing Dam Neck Road would cause significant disruption and coordination.

3.12.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.12.7 Project Analysis Summary

Table 23 below provides a summary of the Drakesmile Road at HRSD Shipps Corner PRS project analysis. Refer to Appendix B-12 for project exhibits and supporting documentation.

Table 23. Drakesmile Road at HRSD Shipps Corner PRS Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	6.45/10
Other ASC Score(s)	Alternative 2 – 5.6/10
PPC Score	1.54/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$990,000

3.13 Drakesmile Road at Shipps Corner Road

3.13.1 SFA Description

Drakesmile Road floods because the adjacent BMP storage and the size of the existing stormwater pipes are inadequate. Additionally, there is a large amount of water flowing onto the road from private property to the east. Drakesmile Road serves as a secondary evacuation route. As shown in Figure 17, the models indicate Drakesmile Road begins to experience flooding in the 10-year storm event.



Figure 17. Location Map of Drakesmile Road at Shipps Corner Road SFA

3.13.2 Project Description

This project will improve stormwater infrastructure along Drakesmile Road to mitigate flooding. The BMP on City property (GPIN14954684330000) will be expanded, and the outfall structure will be lowered to an elevation of 5.5 feet. The inflow pipe for the BMP will be increased to a double-barrel pipe. A 2-foot berm will be built along the northbound lanes of Drakesmile Road to keep water from the private property from flooding the road. The berm will also extend around the self-storage buildings to protect them from flooding. Pipe increases under Drakesmile Road are avoided due to a conflict with the 16-inch HRSD force main.

3.13.3 Project Benefits

The major benefit of the project is to mitigate street flooding on Drakesmile Road. The project also ensures that Drakesmile Road can serve as a secondary evacuation route.

3.13.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated.

Drakesmile Road, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and the 100-year storm event with no SLR.

The weir for the BMP's outfall is lowered from an elevation of 6.67 feet to 5.5 feet. Expansion of the BMP will replace the treatment volume lost by lowering the existing permanent pool elevation. While changes to the original design function of the BMP are not anticipated, coordination with the City's VSMP Permit Coordinator is required.

Property acquisition is required to construct the proposed berm on private property. It is anticipated that minimal maintenance of traffic will be required during the construction of the project and that minimal effort will be required to obtain environmental permits to modify the BMP's outfall.

3.13.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.13.6 Other Alternatives Not Scored

One alternative that was considered was to increase the size of the BMP and add a pump to drain the BMP in advance of the storm event. Without pipe size increases, Drakesmile Road was still impassable and did not meet the PWDSM requirements.

An additional alternative was considered that would raise Drakesmile Road 1.5 feet and tie into roadway improvements as part of the Dam Neck Road at Drakesmile Road Project. This alternative was not chosen since it was not as economically feasible as other alternatives.

3.13.7 Project Analysis Summary

Table 24 below provides a summary of the Drakesmile Road at Shipps Corner Road project analysis. Refer to Appendix B-13 for project exhibits and supporting documentation.

Table 24. Drakesmile Road at Shipps Corner Road Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	5.68/10
Other ASC Score(s)	N/A
PPC Score	1.14/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$3,560,000

3.14 Eagles Nest

3.14.1 SFA Description

The Eagles Nest at Coopers Arch and Eagles Nest at Kestrel Lane SFAs are combined into one project called Eagles Nest. Individual SFA locations are shown in Figure 18 and are further described below. Both SFAs are hydraulically connected and can be combined into one project.

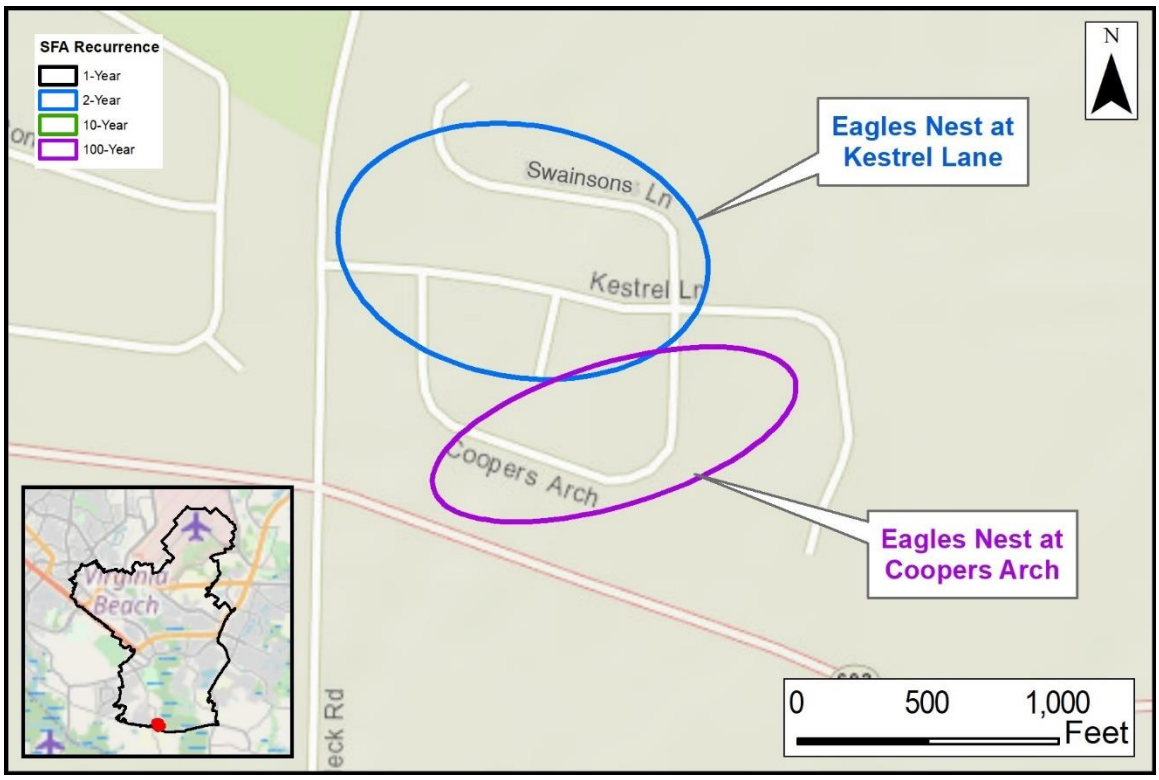


Figure 18. Location Map of Eagles Nest at Coopers Arch and Eagles Nest at Kestrel Lane SFAs

Eagles Nest at Coopers Arch SFA

Coopers Arch, south of Kestrel Lane, floods due to tailwater and inadequate pipe sizes. The flooding occurs on private property as well as the roadway. As shown in Figure 18, the models indicate Coopers Arch begins to experience flooding in the 100-year storm event.

Eagles Nest at Kestrel Lane SFA

Kestrel Lane, between Coopers Arch and Swainsons Lane, floods due to tailwater and inadequate pipe sizes. The flooding occurs on private property as well as the roadway. As shown in Figure 18, the models indicate Kestrel Lane and Swainsons Lane begin to experience flooding in the 2-year storm event.

3.14.2 Project Description

This project will increase the capacity of the pipe system and create more stormwater storage in the neighborhood. The proposed pipe system will remain in the same location as the existing pipes will be upsized. A new BMP is proposed to be constructed on City property (GPIN 24031248010000) and will connect to pipes on Swainsons Lane. Additionally, a new pipe is

added to bypass the existing BMP to the upsized existing ditch downstream. The water quality runoff, or “first flush” of the storm event, can be diverted through the existing pipe system to the existing BMP. In large storm events, higher flows will bypass the BMP through the new pipe.

3.14.3 Project Benefits

The major benefits of the project include mitigating street flooding on Coopers Arch, Kestrel Lane, and Swainsons Lane. The project also addresses a flood report that has been documented in the area.

The project has the highest score of the two alternatives because it only requires temporary disturbance to the surrounding community and less property acquisition.

3.14.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated.

Minimal easement acquisition is required as most construction will occur within the ROW, City property, or existing easements.

It is anticipated that minimal maintenance of traffic and moderate utility relocations will be required during the construction of the project. Extensive effort is assumed to be required to obtain environmental permits as the proposed BMP is likely located within jurisdictional wetlands, and extensive improvements are required for multiple outfall channels.

While changes to the original design function of the BMP south of Kestrel Lane are not anticipated, coordination with the City’s VSMP Permit Coordinator is required. It is assumed that the water quality storm can still be diverted to the BMP.

3.14.5 Other Alternatives Scored

One additional alternative was scored as a part of this analysis. Alternative 2 created a linear storage feature on the Homeowner’s Association (HOA) property north of Kestrel Lane. Additionally, two new outfalls were created for the neighborhood: one from Swainsons Lane and another on Kestrel Lane. The outfall for Swainsons Lane was proposed to the north through City property. The outfall for Kestrel Lane bypasses the existing BMP, like Alternative 1, to the existing ditch. The alternative did not score as high because it involved permanent impacts to the existing walking path and, therefore, more extensive property acquisition.

3.14.6 Other Alternatives Not Scored

One additional alternative was considered but not scored. A stormwater lift station was considered for the existing BMP to maintain the existing drainage pattern to the existing BMP. Based on City plat research, structural improvements, such as a lift station, are prohibited on HOA property. Additionally, a lift station would add significant cost and operation and maintenance requirements. Therefore, this alternative was not considered any further.

3.14.7 Project Analysis Summary

Table 25 below provides a summary of the Eagles Nest project analysis. Refer to Appendix B-14 for project exhibits and supporting documentation.

Table 25. Eagles Nest Project Summary

SFA Recurrence	2-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	5.19/10
Other ASC Score(s)	Alternative 2 – 4.97/10
PPC Score	2.6/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$3,403,750

3.15 Foxfire

3.15.1 SFA Description

The Foxfire neighborhood experiences frequent flooding. Streets, private property, and habitable structures experience flooding. The stormwater infrastructure in the neighborhood is inadequate, and there is a lack of storage within the neighborhood. As shown in Figure 19, the models indicate Foxfire begins to experience flooding in the 10-year storm event.

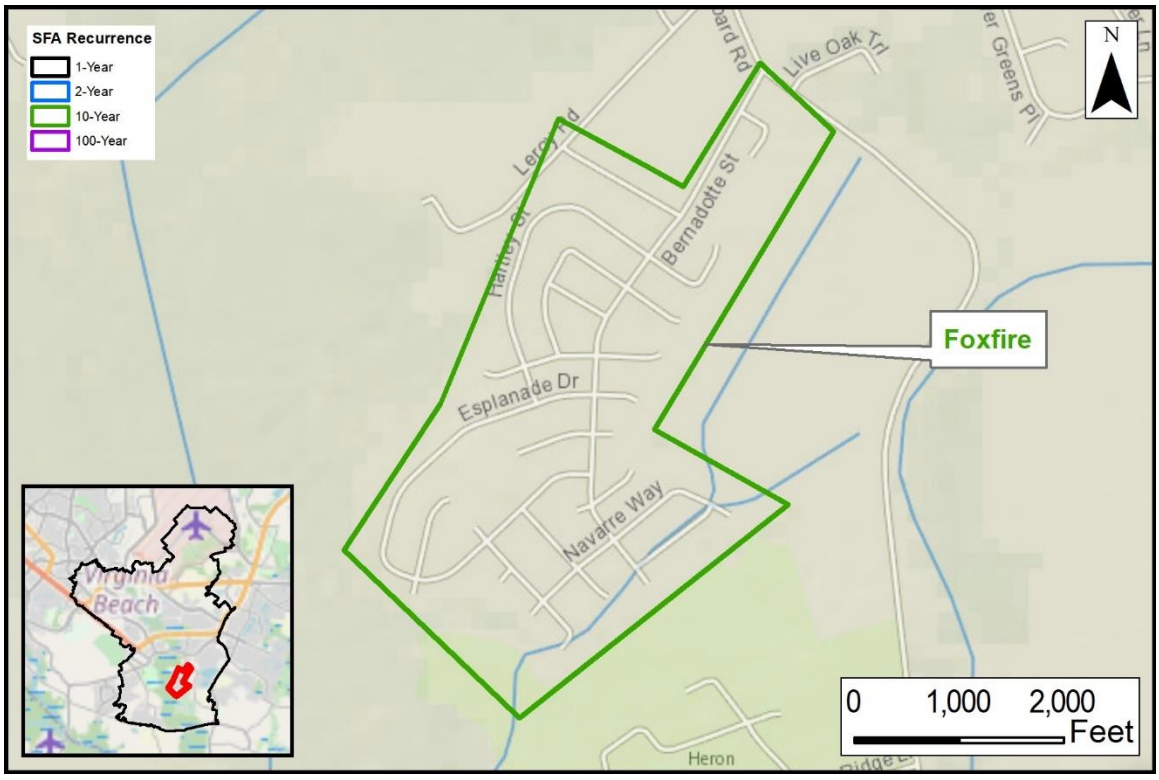


Figure 19. Location Map of Foxfire SFA

3.15.2 Project Description

This project will improve and provide additional stormwater infrastructure within the Foxfire neighborhood. Additional storage will be added to the system, with two BMPs located on private parcels requiring acquisition and underground storage on City property (GPIN 24033866590000). Additional outfalls will be created for the system to provide more direct relief upstream. Inadequate pipes will be upsized and diverted to the proposed storage and outfalls to better utilize the additional storage.

3.15.3 Project Benefits

The major benefits of the project include mitigating habitable structure flooding on Saint Charles Avenue, Navarre Way, and Charring Cross Road and street flooding throughout the neighborhood. The project mitigates flooding for nine habitable structures. The project also addresses several flood reports in the area.

3.15.4 Project Analysis Assumptions

A 50-year LOS is achieved for this project as the peak HGL is higher than the lowest points along Bernadotte Street. The available storage adjacent to these areas has been maximized.

Adjustments to the profile of the street were considered, but with the extent of improvements already proposed, flood depths are less than 3 inches above the crown of the road, are summarized on the 100-year flood map, and will require approval for a reduced LOS from the City Engineer. Alternate access is provided to the neighborhood from Lemans Way.

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. There is a decrease in street flooding in the 100-year storm event, but it is not completely mitigated. Therefore, the project is given a BR of 0.98.

Foxfire and Leroy Road at Farmers Court are kept separate because the Foxfire flooding can be mitigated without all of the Leroy Road at Farmers Court improvements. However, the downstream ditch and channel are the same in both projects. If the Leroy Road at Farmers Court project is constructed first, then the downstream improvements as part of this project would not be required. Refer to Section 3.25 for a description of the Leroy Road at Farmers Court project.

Property and easement acquisition will be required for this project. Property acquisition is limited by adding storage on City property and making improvements to the downstream channels and outfalls. The Heron Ridge Golf Course is City-owned property that has been leased to the golf course management company. Coordination will be required with the Heron Ridge Golf Club to make improvements through the golf course as detailed design advances. The underground storage within Foxfire East Park will also require coordination with Parks and Recreation. The proposed 5-foot ditch running along the east side of Foxfire will have space to obtain the required easement. However, due to the current grading, there is a ridge running along the east side of the ditch, so there will only be maintenance access from the west side.

It is anticipated that extensive maintenance of traffic and utility relocations will be required during the construction of the project. Throughout the neighborhood, there are 8-inch gravity sewer lines, 4-, 6-, and 8-inch sewer force mains, and 4-, 8-, and 12-inch water lines. It is anticipated that extensive effort will be required to obtain environmental permits to improve the downstream ditch through nontidal wetlands.

Some runoff is being diverted away from the existing stormwater BMP in the southeast corner of the neighborhood. However, these diversions can potentially be offset by the water quality benefits associated with the additional BMPs required for runoff storage. Coordination with the City's VSMP Permit Coordinator is required.

3.15.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.15.6 Other Alternatives Not Scored

One additional alternative was considered but was not scored. To minimize the extent of improvements throughout the neighborhood and the amount of property acquisition, it was considered to add a lift station to the existing BMP. In addition to the lift station, pipes were added, and inadequate pipes were upsized. This alternative failed to meet the PWDSM requirements and did not alleviate flooding throughout the Foxfire neighborhood, primarily because it was determined that additional storage is needed further upstream in the system.

3.15.7 Project Analysis Summary

Table 26 below provides a summary of the Foxfire project analysis. Refer to Appendix B-15 for project exhibits and supporting documentation.

Table 26. Foxfire Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	50-year (1.5 feet SLR)
Selected Alternative	Alternative 1
ASC Score	4.39/10
Other ASC Score(s)	N/A
PPC Score	5.25/14.4
BR	0.98
BCR	1.0 (based on updated model)
Project Cost	$60,782,800

3.16 General Booth Boulevard at Corporate Landing

3.16.1 SFA Description

General Booth Boulevard near Corporate Landing Business Park experiences flooding due to a lack of conveyance capacity within the existing stormwater system and high tailwater in the downstream ditch system. General Booth Boulevard is a secondary evacuation route. As shown in Figure 20, the models indicate that these areas begin to experience flooding in the 10-year storm event.

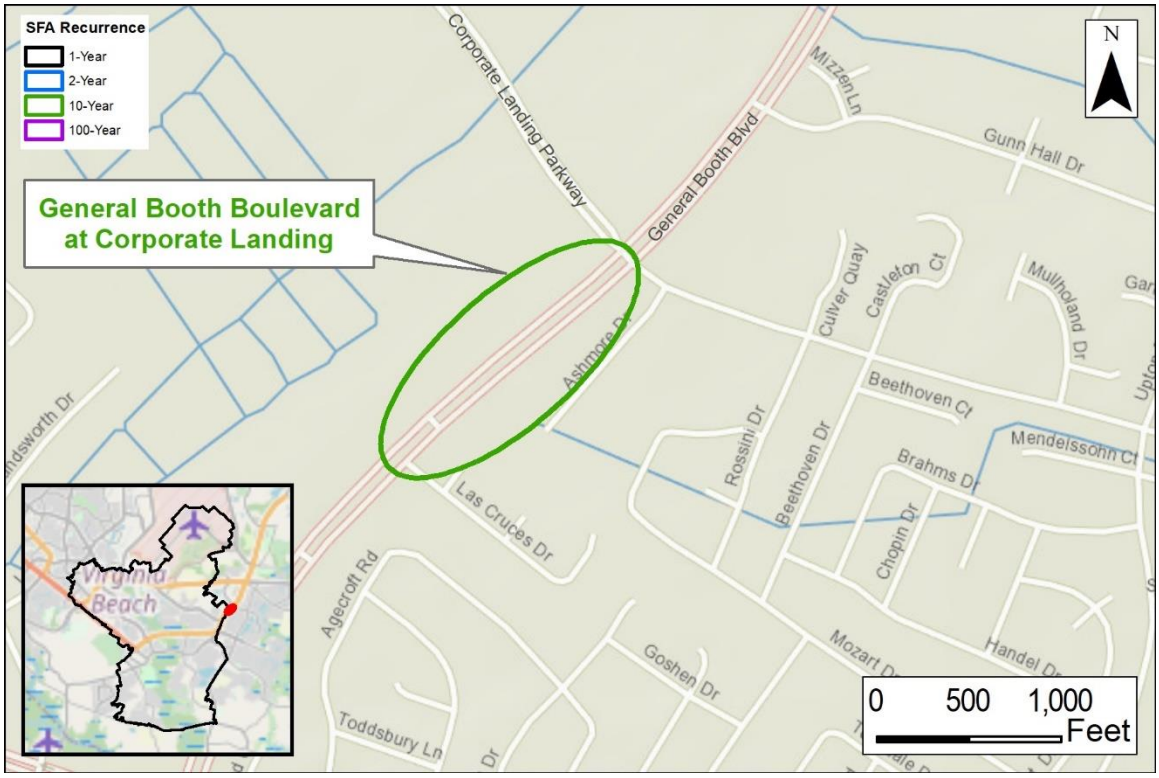


Figure 20. Location Map of General Booth Boulevard at Corporate Landing SFA

3.16.2 Project Description

This project will upsize the existing stormwater infrastructure along General Booth Boulevard to increase stormwater conveyance through the system. The improvements will follow the same drainage patterns as in the existing condition. Downstream a BMP will be added on City property at Corporate Landing Business Park (GPIN 24151226500000).

3.16.3 Project Benefits

The major benefits of the project include mitigating street flooding along General Booth Boulevard. The project will also provide a BMP that will be utilized with the future development of Corporate Landing Business Park. Additionally, there is a potential cost-sharing opportunity with DPU for a transmission main line prioritization along General Booth Boulevard.

3.16.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated. General

Booth Boulevard, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and the 100-year storm event with no SLR.

It is anticipated that moderate maintenance of traffic and minimal utility relocations will be required during the construction of the project. An HRSD force main runs along General Booth Boulevard, although no conflicts are expected due to moderate pipe size increases. Also, minimal effort to obtain environmental permits is anticipated for the project.

The General Booth Boulevard at Corporate Landing and Strawbridge Park North projects are kept separate because the General Booth Boulevard at Corporate Landing SFA can be mitigated without all the Strawbridge Park North improvements. However, the BMP located on City property at Corporate Landing Business Park is the same in both projects. If the Strawbridge Park North project is constructed first, then BMP construction as part of this project would not be required. Refer to Section 3.52 for a description of the Strawbridge Park North project.

3.16.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA, so none were scored.

3.16.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.16.7 Project Analysis Summary

Table 27 below provides a summary of the General Booth Boulevard at Corporate Landing project analysis. Refer to Appendix B-16 for project exhibits and supporting documentation.

Table 27. General Booth Boulevard at Corporate Landing Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	7.48/10
Other ASC Score(s)	N/A
PPC Score	1.64/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$10,051,250

3.17 Heron Ridge Estates

3.17.1 SFA Description

Heron Ridge Estates is a neighborhood located west of Seaboard Road and north of County Place. The neighborhood floods due to tailwater influenced BMPs and undersized pipes throughout the neighborhood and adjacent golf course. The tailwater fills up the BMPs and pipes in the neighborhood before the storm event. As shown in Figure 21, the models indicate Heron Ridge Estates begins to experience flooding in the 10-year storm event.

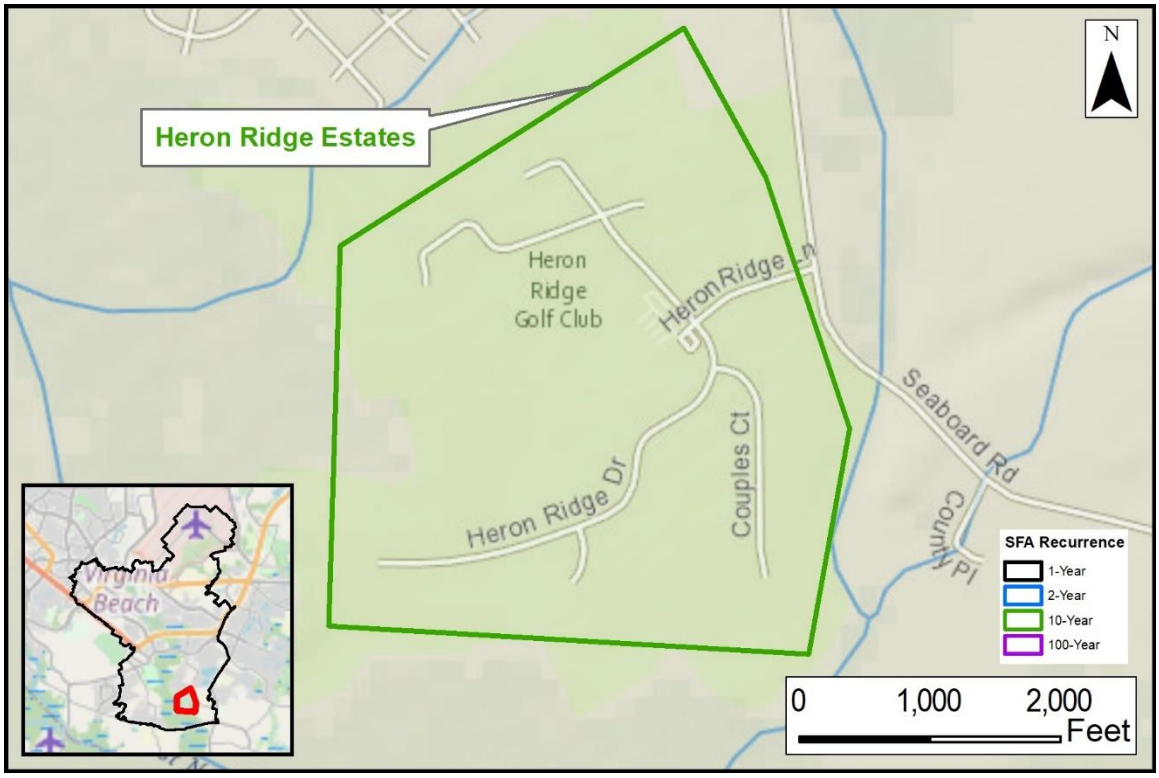


Figure 21. Location Map of Heron Ridge Estates SFA

3.17.2 Project Description

This project will add a lift station to Heron Ridge Lake 2 in the Heron Ridge Golf Course. The lift station will pump water from the BMP directly into the West Neck Creek floodplain. A gravity outfall to the floodplain will be added to Heron Ridge Lake 2 with the lift station. This outfall will be for smaller rain events. Existing pipes within the neighborhood and new pipes are redirected towards Heron Ridge Lake 2 with the lift station. Additionally, a new outfall is proposed into West Neck Creek from Heron Ridge Lake 1, and a new inlet pipe is added into Heron Ridge Lake 4. Three existing trunklines outfalling into Heron Ridge Lake 3 are upsized, and backflow prevention is proposed on Heron Ridge Lake 3 to block tailwater from the downstream channel.

3.17.3 Project Benefits

The major benefits of the project include mitigating habitable structure flooding on Lynx Drive, Heron Ridge Drive, and Heron Ridge Lane and street flooding throughout the neighborhood. Habitable structure flooding is eliminated for ten houses in the neighborhood.

3.17.4 Project Analysis Assumptions

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. The flooding in the 100-year storm event is completely mitigated in the proposed conditions, therefore the project is given a BR of 1.0.

Heron Ridge Estates and Foxfire projects are kept separate because the Heron Ridge Estates SFA can be mitigated without all the Foxfire improvements. However, the outfall for Lake 1 is the same for both projects. If Foxfire is constructed first, then the outfall improvements to Lake 1 as a part of this project would not be required. Refer to Section 3.15 for a description of the Foxfire project.

Property and easement acquisition is not required as all the construction will occur within the ROW or City property. The Heron Ridge Golf Course is City-owned property and has been leased to the golf course management company. Extensive coordination with the golf course will be required as detailed design advances and when the project is built.

It is anticipated that moderate maintenance of traffic and extensive utility relocations will be required during the construction of the project. It is anticipated that moderate effort will be required to obtain environmental permits.

While changes to the original design function of the existing BMPs are not anticipated, coordination with the City's VSMP Permit Coordinator is required.

3.17.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.17.6 Other Alternatives Not Scored

Two additional alternatives were considered but not scored. In an attempt to avoid a lift station, several pipes were upsized to dual elliptical pipes, many of which would be located between houses. Additionally, large trunklines were added throughout the neighborhood to the existing BMPs. This option was not explored any further because it failed to meet PWDSM standards and would require large easements or property acquisition.

The second alternative considered upsizing the Heron Ridge Lake 2 and increasing the size of the roadside ditches. However, this did not make a significant impact on the HGLs in the neighborhood and did not meet PWDSM standards, so the alternative was not considered further.

3.17.7 Project Analysis Summary

Table 28 below provides a summary of the Heron Ridge Estates project analysis. Refer to Appendix B-17 for project exhibits and supporting documentation.

Table 28. Heron Ridge Estates Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (No SLR)
Selected Alternative	Alternative 1
ASC Score	3.61/10
Other ASC Score(s)	N/A
PPC Score	5.88/14.4
BR	1.0
BCR	1.0 (based on updated model)
Project Cost	$43,360,000

3.18 Highgate Greens and Seaboard Forest

The Live Oak Trail at Seaboard Road, Bodnar Lane, and Highgate Greens are combined into one project called Highgate Greens and Seaboard Forest. Individual SFA locations are shown in Figure 22 and are further described below. Meeting the PWDSM requirements for the Highgate Greens SFA is dependent on the improvements proposed for the Live Oak Trail at Seaboard Road and Bodnar Lane SFA. A phased project is proposed considering the extent of improvements that are required and to accomplish the objective of the SWMP to develop "standalone" solutions that are not dependent on downstream improvements. Project phases are defined by the individual SFA boundaries and begin with the most downstream improvements. Future refinements to the project phasing proposed may be required. Refer to Appendix B-18 for detailed project phase maps.

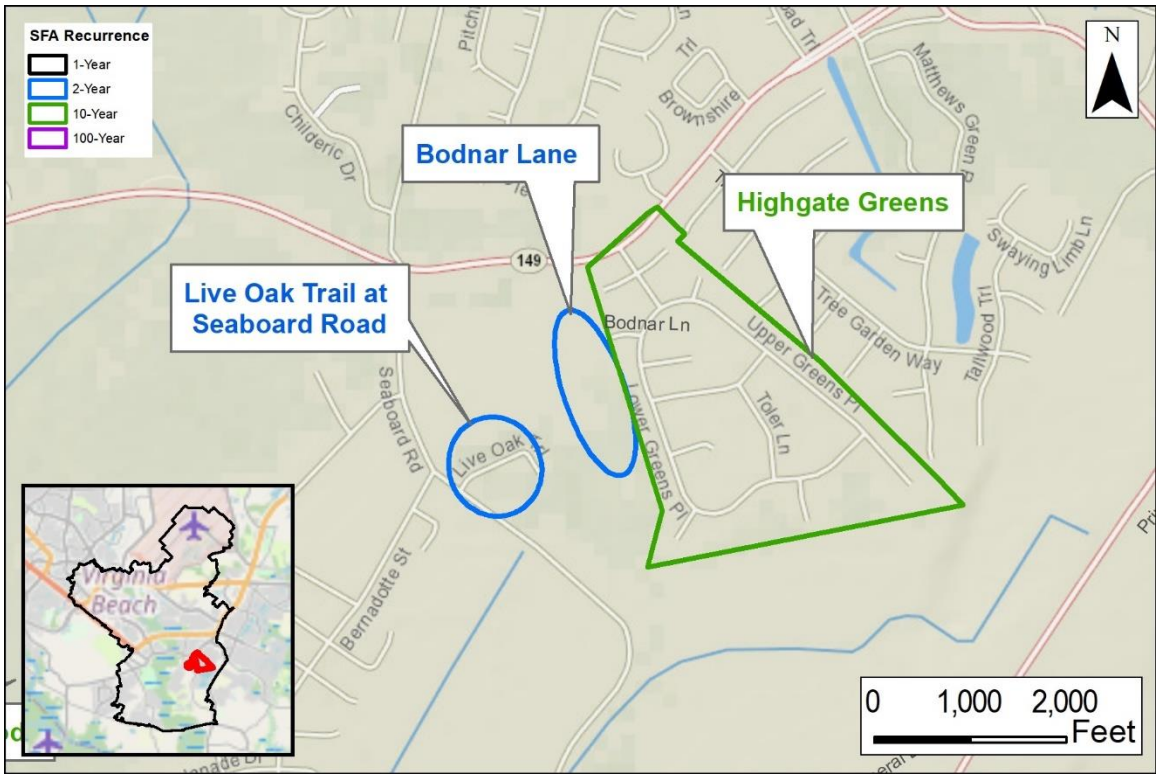


Figure 22. Location Map of Live Oak Trail at Seaboard Road, Highgate Greens, and Bodnar Lane SFAs

3.18.1 ***Phase 1: Live Oak Trail at Seaboard Road***

3.18.1.1 SFA Description

Live Oak Trail and the surrounding private property experience flooding due to an undersized BMP and inadequate pipes. As shown in Figure 22, the models indicate Live Oak Trail begins to experience flooding in the 2-year storm event.

3.18.1.2 Project Description

This project will improve stormwater infrastructure along Live Oak Trail and Seaboard Road. The BMP at the corner of Live Oak Trail and Seaboard Road will be expanded on to City property (Seaboard Forest, GPINs 24046175780000 and 24047205820000) and private property and will outfall North along Seaboard Road before outfalling into West Neck Creek. In

accordance with direction from City staff, a 150-foot buffer is maintained between the BMP and residential parcels. The BMP is sized for both phases of the project.

3.18.1.3 Project Benefits

The major benefits of the project include mitigating street flooding on Live Oak Trail, as well as the flooding occurring on surrounding private property. The project also addresses several flood reports that have been documented in the area.

3.18.1.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated.

Property and easement acquisition will be required for this project. Property acquisition is required to expand the BMP. The majority of the expanded BMP will be on City property. However, to maintain the 150-foot buffer between the BMP and parcels, property acquisition will be required from private parcels to provide enough space for the BMP. It is anticipated that extensive maintenance of traffic will be required during the construction of the project along Seaboard Road.

It is anticipated that there will be moderate utility relocations. Conflicts are anticipated along Live Oak Trail with an 8-inch gravity sewer line and an 8-inch water line. Along Seaboard Road, conflicts are anticipated with a 12-inch water line, 10-inch sewer force main, and 8-inch gravity sewer line. Extensive effort will likely be required to obtain environmental permits to add a BMP in nontidal wetlands and for downstream ditch improvements associated with the outfall west of Seaboard Road.

3.18.1.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.18.1.6 Other Alternatives Not Scored

One additional alternative was considered that would outfall to Sherwood Lakes, taking advantage of the recently constructed lift station, as opposed to creating a BMP in Seaboard Forest. This alternative did meet the PWDSM requirements, but due to historical flooding within Sherwood Lakes, this alternative was not considered further.

Another alternative was considered to modify the outfall of the existing pond at the intersection of Live Oak Trail and Seaboard Forest to drain south along Seaboard Road to the outfall ditch of Sherwood Lake. To provide enough relief along Live Oak Trail, the normal water surface elevation needed to be lowered in the existing pond. The downstream ditch would require extensive improvements to lower the inverts to provide enough relief, so this alternative was not considered further.

3.18.1.7 Project Analysis Summary

Table 29 below provides a summary of the Live Oak Trail at Seaboard Road project analysis. Refer to Appendix B-18-1 for project exhibits and supporting documentation.

Table 29. Live Oak Trail at Seaboard Road Project Summary

SFA Recurrence	2-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	4.36/10
Other ASC Score(s)	N/A
PPC Score	2.6/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$18,597,800

3.18.2 *Phase 2: Highgate Greens and Sawyer's Meadow*

3.18.2.1 SFA Description

The Bodnar Lane and Highgate Greens SFAs are combined into one project called Highgate Greens and Sawyer's Meadow. Individual SFA locations are shown in Figure 22 and are further described below. The two SFAs are hydraulically connected and can be combined into one project.

Bodnar Lane SFA

Bodnar Lane experiences flooding on the roadway and surrounding private properties due to the lack of storage and inadequate pipes. As shown in Figure 22, the models indicate Bodnar Lane begins to experience flooding in the 2-year storm event.

Highgate Greens SFA

The streets and private property in Highgate Greens experience flooding due to inadequate stormwater infrastructure and an inadequate outfall to Princess Anne Road. One habitable structure experiences flooding along Wild Oak Crescent. As shown in Figure 22, the models indicate Highgate Greens begins to experience flooding in the 10-year storm event.

3.18.2.2 Project Description

The project will expand the BMP that is located North of Bodnar Lane. The flow along Bodnar Lane and the existing BMPs within Highgate Greens will be redirected to the proposed BMP in the Highgate Greens and Seaboard Forest Phase 1: Live Oak Trail at Seaboard Road project. Furthermore, inadequate pipes throughout the neighborhood will be upsized. Highgate Greens and Seaboard Forest Phase 2: Highgate Greens and Sawyer's Meadow is dependent on Highgate Greens and Seaboard Forest Phase 1: Live Oak Trail at Seaboard Road improvements.

3.18.2.3 Project Benefits

The major benefits of this project include mitigating structure flooding of one structure on Wild Oak Crescent and street flooding within Highgate Greens and along Bodnar Lane. The project also addresses several flood reports that have been documented in the area.

3.18.2.4 Project Analysis Assumptions

A 50-year LOS is achieved for this project as the peak HGL is higher than the lowest points along Bodnar Lane. The available storage adjacent to this area has been maximized, and further expansion of the BMP to the south does not improve this condition. Flood depths are less than 3 inches above the crown of the road, are summarized on the 100-year flood map, and will require approval for a reduced LOS from the City Engineer.

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. There is a decrease in street flooding in the 100-year storm event, but it is not completely mitigated. Therefore, the project is given a BR of 0.99.

Easement acquisition will be required for some pipe improvements but is limited by maintaining improvements within the ROW and City property. The expanded BMP will be contained within a restrictive easement that belongs to the City and does not preclude this improvement.

It is anticipated that moderate maintenance of traffic and utility relocations will be required during the construction of the project in the neighborhood. In Highgate Greens, utility conflicts are anticipated with 8-inch water lines and 4-inch and 8-inch vacuum sewer lines. Along Bodnar Lane, conflicts are anticipated with a 4-inch water line and 4-inch vacuum sewer line. It is anticipated that minimal effort will be required to obtain environmental permits to add an outfall into nontidal wetlands.

3.18.2.5 Other Alternatives Scored

No additional alternatives were considered.

3.18.2.6 Other Alternatives Not Scored

No additional alternatives were considered.

3.18.2.7 Project Analysis Summary

Table 30 below provides a summary of the Highgate Greens and Sawyer's Meadow project analysis. Refer to Appendix B-18-2 for project exhibits and supporting documentation.

Table 30. Highgate Greens and Sawyer's Meadow Project Summary

SFA Recurrence	2-year (no SLR)
Project LOS	50-year (1.5 feet SLR)
Selected Alternative	Alternative 1
ASC Score	5.91/10
Other ASC Score(s)	N/A
PPC Score	6.27/14.4
BR	0.99
BCR	1.0 (based on updated model)
Project Cost	$15,723,600

3.18.3 *Highgate Greens and Seaboard Forest Combined Summary*

Table 31 below provides a summary of the Highgate Greens and Seaboard Forest analysis. Refer to Appendix B-18 for project exhibits and supporting documentation.

Table 31. Highgate Greens and Seaboard Forest Project Summary

	Phase 1: Live Oak Trail at Seaboard Road	Phase 2: Highgate Greens and Sawyer's Meadow
SFA Recurrence	2-year (no SLR)	2-year (no SLR)
Project LOS	100-year (no SLR)	50-year (1.5 feet SLR)
Selected Alternative	Alternative 1	Alternative 1
ASC Score	4.36/10	5.91/10
Other ASC Score(s)	N/A	N/A
PPC Score	2.6/14.4	6.27/14.4
BR	1.0	0.99
BCR	1.0 (no habitable structure flooding)	1.0 (based on updated model)
Individual Project Cost	$18,597,800	$15,723,600
Total Project Cost	$34,321,400	

3.19 Holland Oaks and Holland Pines North

3.19.1 SFA Description

The Holland Oaks neighborhood and the portion of the Holland Pines neighborhood surrounding Chestwood Drive have streets that range in elevation from approximately 5 to 7 feet. The lots in the neighborhood reach up to an elevation of 10 feet. The design tailwater elevation for the 100-year storm event is 6.38 feet in West Neck Creek. Much of the neighborhood is located in the FEMA 100-year floodplain. Several habitable structures flood in the 100-year storm event. The tailwater elevation, independent of the existing drainage infrastructure, floods the neighborhood streets. As shown in Figure 23, the models indicate the Holland Oaks and Holland Pines North SFA begins to experience flooding in the 1-year storm event.

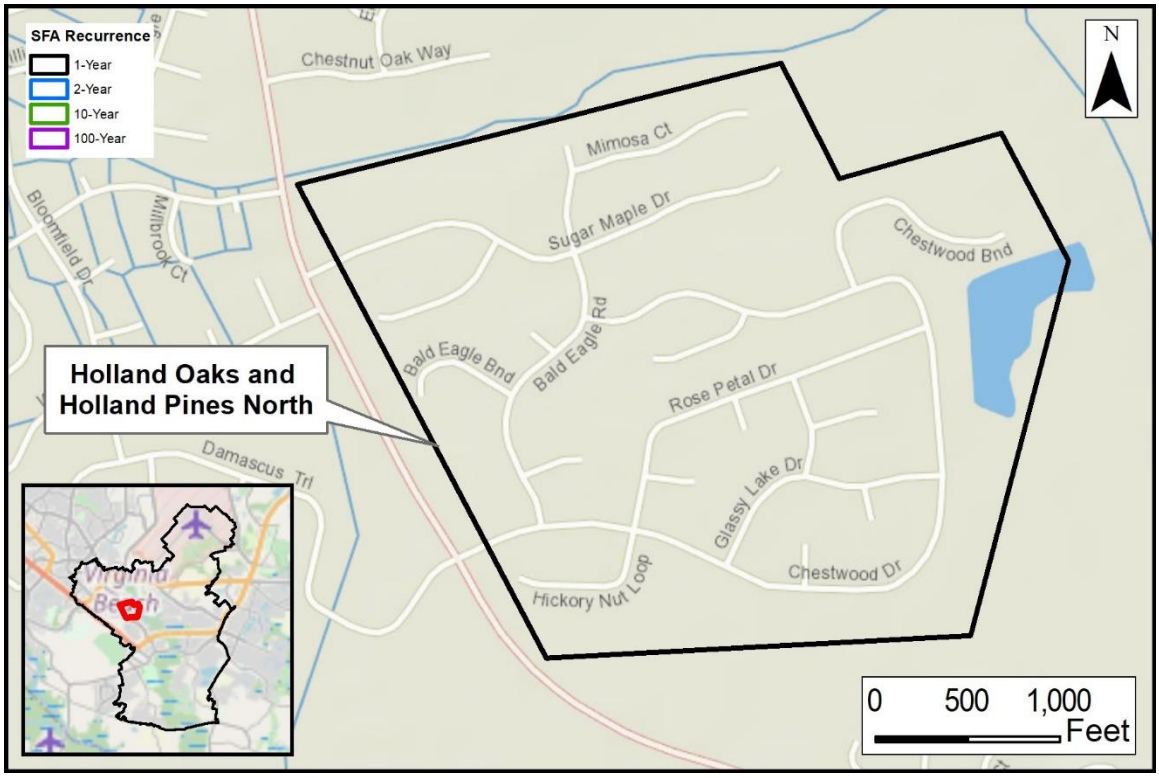


Figure 23. Location Map of Holland Oaks and Holland Pines North SFA

3.19.2 Project Description

The downstream tailwater conditions severely limit the options for improvements in this neighborhood. The City will be evaluating this SFA with a Neighborhood Strategy in the future. Refer to Appendix B-19 for the extent of existing flooding in the area.

3.19.3 Project Benefits

There is no project, and there are no benefits.

3.19.4 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.19.5 Other Alternatives Not Scored

This neighborhood would benefit from a neighborhood solution similar to those shown in the SLW Adaptation Strategy Report. This neighborhood can be designed to resolve the flooding issues that occur from a smaller storm event. PW-SWEC will, in the future, have a neighborhood solution created to establish resiliency in this neighborhood.

3.20 Holland Woods

3.20.1 SFA Description

The Holland Woods neighborhood is located north of the Holland Road and Nimmo Parkway intersection. Holland Woods floods due to inadequate pipe sizes throughout the neighborhood. As shown in Figure 24, the models indicate Holland Woods begins to experience flooding in the 10-year storm event.

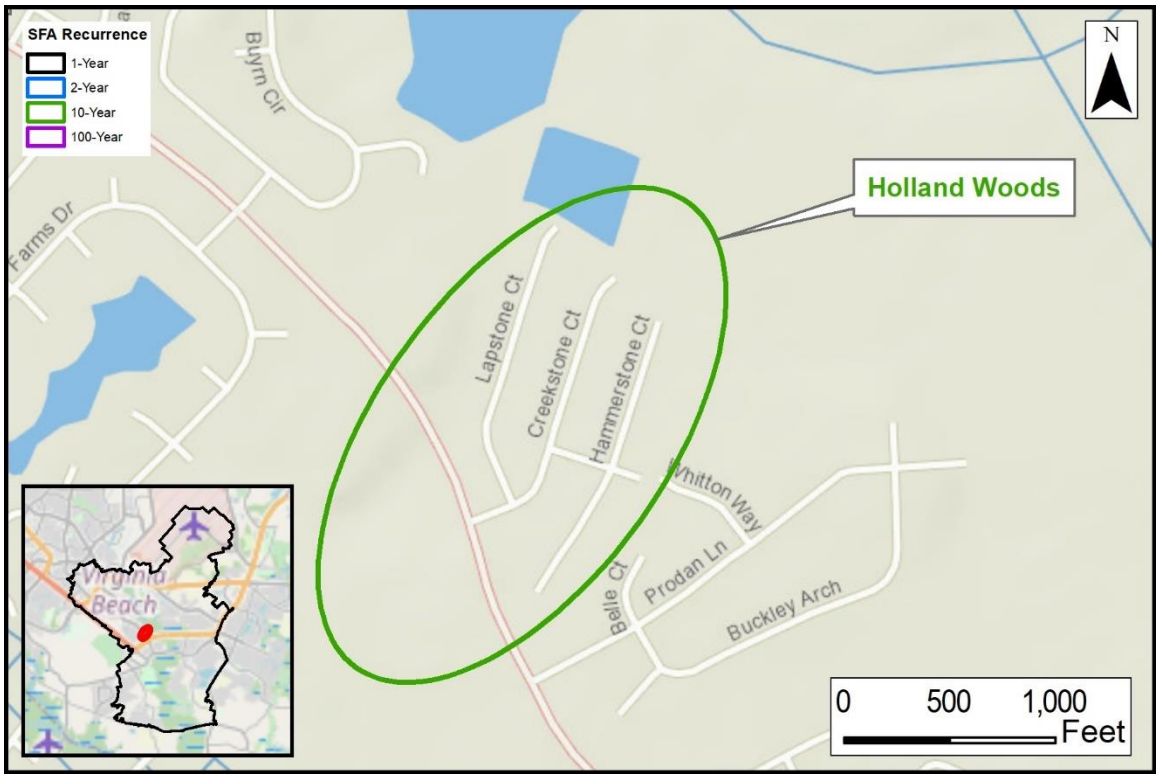


Figure 24. Location Map of Holland Woods SFA

3.20.2 Project Description

This project will add another outfall into the existing BMP from Lapstone Court. Additionally, the pipe system along Edgestone Court and Hammerstone Court will be replaced with larger pipes. A pipe will be added underneath Whitton Way to connect the ditch behind Edgestone Court to the floodplain.

3.20.3 Project Benefits

The major benefits of the project include mitigating habitable structure flooding on Edgestone Court and street flooding along Edgestone Court, Hammerstone Court, and Lapstone Court. Habitable structure flooding is resolved for eight structures. The project also addresses one flood report that has been documented in the area.

3.20.4 Project Analysis Assumptions

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. The project is given a BR of 1.0 because all street flooding is mitigated.

Additional drainage easements are required, but most construction will occur within the ROW or City property. It is anticipated that minimal utility relocations will be required during the construction of the project, and minimal effort will be required to obtain environmental permits.

Holland Woods and Rollingwood projects are kept separate because the Holland Woods SFA can be mitigated without all of the Rollingwood improvements. However, the 30-inch pipe across Whitton Way is the same in both projects. If the Rollingwood project is constructed first, then the 30-inch pipe across Whitton Way as part of this project would not be required. Refer to Section 3.42 for a description of the Rollingwood project.

3.20.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.20.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.20.7 Project Analysis Summary

Table 32 below provides a summary of the Holland Woods project analysis. Refer to Appendix B-20 for project exhibits and supporting documentation.

Table 32. Holland Woods Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	4.86/10
Other ASC Score(s)	N/A
PPC Score	5.38/14.4
BR	1.0
BCR	1.0 (based on updated model)
Project Cost	$2,773,200

3.21 Indian River Road

3.21.1 SFA Description

The SFAs marked along Indian River Road (1, 2, and 3) were studied in the Rural Road Flooding Study ("Study," September 2018). All three SFAs were identified in the Study as areas where the road should be raised to an elevation of 4 feet or higher to remain passable in the 100-year storm event. According to the Study, the two smaller western SFAs (see Figure 25 below) can be raised with a typical fill section. However, due to the FEMA regulated floodway upstream of the road for West Neck Creek and the results of "no rise" analysis, the easternmost SFA (see Figure 25 below) would need to be raised and converted to a bridge structure.

In the Study, the cost estimated for mitigating all three SFAs was $44.7M and recommended a "no-build" option for this roadway due to the cost-prohibitive nature.

Since these SFAs were previously studied, no additional analysis was completed as a part of the SWMP. Refer to Appendix B-21 for the extent of existing flooding in the area.

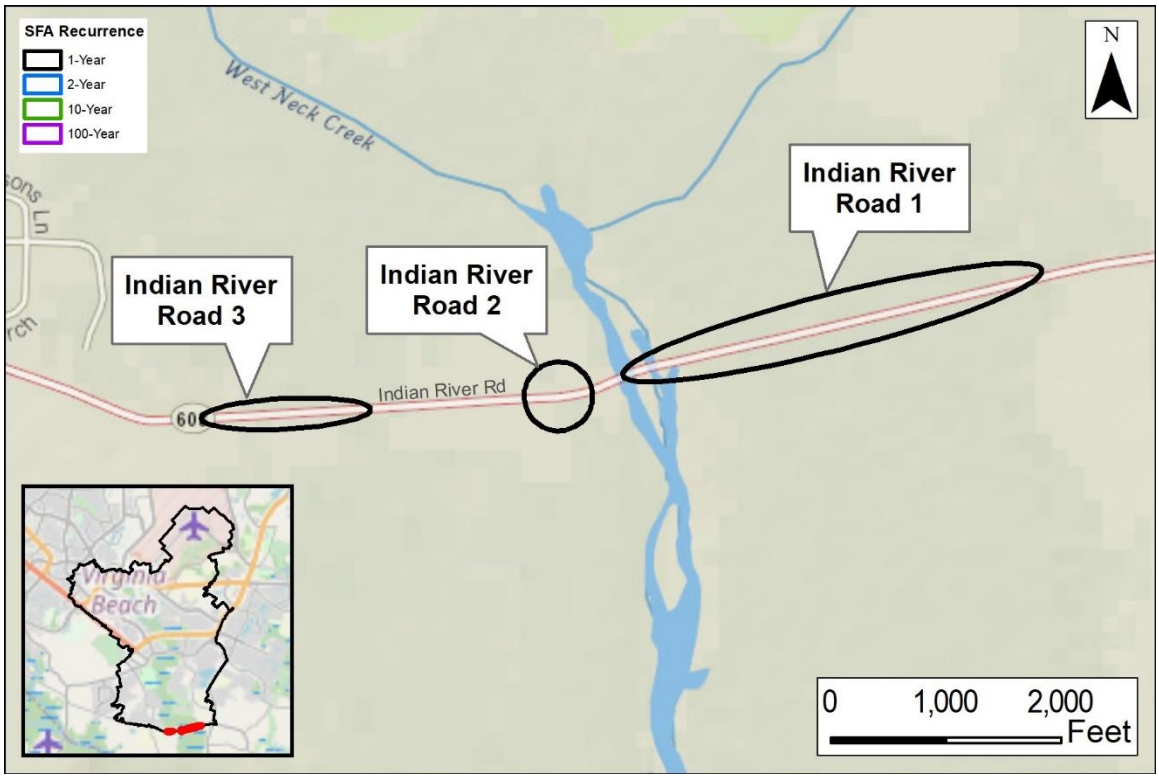


Figure 25. Location Map of Indian River Road 1-3 SFAs

3.22 Lake Placid

3.22.1 SFA Description

Lake Placid is a residential neighborhood with streets that range in elevation from approximately 5 to 7 feet. The lots in the neighborhood go up to an elevation of 10 feet in some locations. The design tailwater elevation for the 100-year storm event is 6.38 feet in West Neck Creek. Much of the neighborhood is located in the FEMA 100-year floodplain. Several habitable structures flood in the 100-year storm event. The tailwater elevation, independent of the existing drainage infrastructure, floods the neighborhood streets. As shown in Figure 26, the models indicate Lake Placid begins to experience flooding in the 2-year storm event.

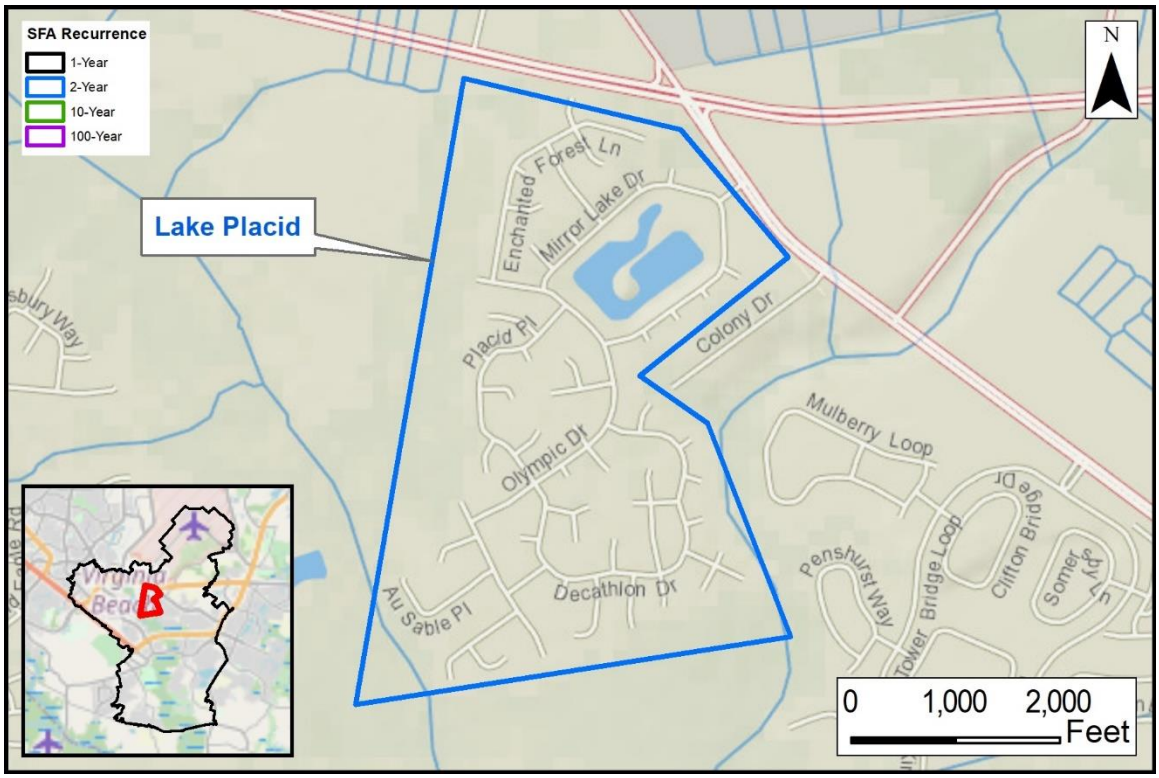


Figure 26. Location Map of Lake Placid SFA

3.22.2 Project Description

The downstream tailwater conditions severely limit the options for improvements to this neighborhood. The City will be evaluating this SFA with a neighborhood strategy in the future. Refer to Appendix B-22 for the extent of existing flooding in the area.

3.22.3 Project Benefits

There is no project, and there are no benefits.

3.22.4 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.22.5 Other Alternatives Not Scored

This neighborhood would benefit from a neighborhood solution similar to those shown in the SLW Adaptation Strategy Report. This neighborhood can be designed to resolve the flooding

issues that occur from a smaller storm event. PW-SWEC will, in the future, have a neighborhood solution created to establish resiliency in this neighborhood.

3.23 Landstown Meadows and Landstown Lakes

3.23.1 SFA Description

The Barberry Lane and Bloomfield Drive, Glastonberry Drive at Monet Drive, and Winterberry Lane at Holland Road SFAs are combined into the Landstown Meadows and Landstown Lakes project. Individual SFA locations are shown in Figure 27 and are further described below. All three SFAs are hydraulically connected and can be combined into one project.

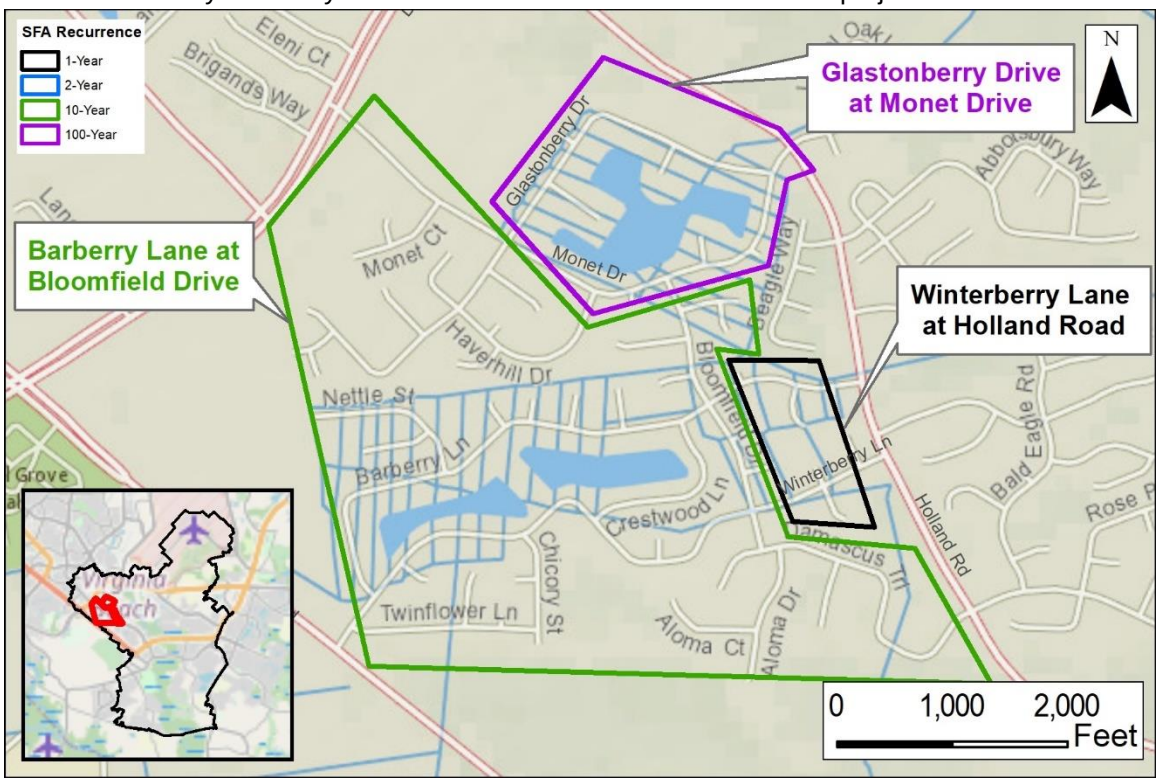


Figure 27. Location Map of Barberry Lane at Bloomfield Drive, Glastonberry Drive at Monet Drive, and Winterberry Lane at Holland Road SFAs

Barberry Lane and Bloomfield Drive SFA

Barberry Lane, Bloomfield Drive, the surrounding streets, private property, and habitable structures experience flooding. The flooding is due to inadequate pipes and a high NWSE in the ponds. As shown in Figure 27, the models indicate Barberry Lane and Bloomfield Drive begin to experience flooding in a 10-year storm event.

Glastonberry Drive and Monet Drive SFA

Glastonberry Drive, Monet Drive, and the surrounding private property experience flooding due to inadequate pipes, lack of storage, and a high NWSE in the pond. As shown in Figure 27, the models indicate Glastonberry Drive and Monet Drive begin to experience flooding in a 100-year storm event.

Winterberry Lane at Holland Road SFA

Winterberry Lane, Barberry Lane, the surrounding streets, private property, and habitable structures experience flooding. The flooding is caused by a lack of stormwater infrastructure

within the neighborhood. Additionally, the roadway elevations on Winterberry Lane and Barberry Lane are 6.5 feet. The neighborhood is susceptible to the 100-year tailwater elevation due to its proximity to a tributary of West Neck Creek, which has an HGL of 6.52 feet at this location. As shown in Figure 27, the models indicate Winterberry Lane at Holland Road begins to experience flooding in the 1-year storm event.

3.23.2 Project Description

Two BMPs will be added north and south of the neighborhood, with one to be constructed on City property (GPIN 14942806150000). Dry storage will be added north and south of Glastonberry Drive and within Landstown Meadows West Park. Additional water will be directed to the proposed BMPs via numerous pipe upgrades and proposed pipes throughout the neighborhood. Additionally, Winterberry Lane and Winter Forest Court will be raised above the 10-year flood elevation.

3.23.3 Project Benefits

The major benefits of the project include mitigating structure flooding along Glastonbury Drive, Barberry Lane, Crestwood Lane, and Damascus Trail for a total of five structures. Flooding on private property and streets is also relieved within the neighborhood. The project also addresses several flood reports that have been documented in the area. There is a potential cost-sharing opportunity with DPU for a transmission line prioritization along Barberry Lane and Winterberry Lane.

3.23.4 Project Analysis Assumptions

Given the tailwater influence on the 100-year design of drainage improvements, a 10-year LOS is achieved for this project. This is necessary as the peak HGLs in the West Neck Creek tributary and existing BMPs are higher than the lowest point of some neighborhood streets, and the available storage areas and downstream improvements have been maximized. Flood depths are less than 6 inches above the crown of the road, are summarized on the 100-year flood map, and will require approval for a reduced LOS from the City Engineer.

HAZUS data is available for the habitable structures along Glastonbury Drive, Barberry Lane, Winterberry Lane, and Damascus Trail. The structures no longer flood in the 100-year storm event. Based on the BCR methodology, the project BCR is 1.006. There is a decrease in street flooding in the 100-year storm event, but it is not completely mitigated. Therefore, the project is given a BR of 0.90.

Property and easement acquisition will be required for the proposed BMPs, proposed pipe improvements, and roadway profile adjustments. The amount of property acquisition is limited by utilizing City property where possible for the proposed improvements.

Coordination will be required with Dominion Energy to construct the proposed dry storage within the power easement. Coordination will also be required with Parks and Recreation to construct dry storage within Landstown Meadows West Park. It is anticipated that extensive maintenance of traffic will be required during the construction of the project throughout the neighborhood. Moderate utility relocations will likely be required during the construction of the project. Extensive effort will be required to obtain environmental permits from USACE and DEQ to construct a BMP in nontidal wetlands.

While changes to the original design function of the BMPs are not anticipated, coordination with the City's VSMP Permit Coordinator is required.

3.23.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.23.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.23.7 Project Analysis Summary

Table 33 below provides a summary of the Landstown Meadows and Landstown Lakes project analysis. Refer to Appendix B-23 for project exhibits and supporting documentation.

Table 33. Landstown Meadows and Landstown Lakes Project Summary

SFA Recurrence	1-year (no SLR)
Project LOS	10-year (1.5 feet SLR)
Selected Alternative	Alternative 1
ASC Score	3.59/10
Other ASC Score(s)	N/A
PPC Score	6.92/14.4
BR	0.90
BCR	1.006
Project Cost	$93,238,200

3.24 Laurel Oak Lane at Holland Road

3.24.1 SFA Description

Laurel Oak Lane is a residential street connected to Holland Road. The roadway elevations on Laurel Oak Lane range from 6 feet to 6.5 feet. This neighborhood's drainage system is susceptible to the 100-year tailwater elevation due to its proximity to West Neck Creek, which has an HGL of 6.44 feet. The roads are also located in FEMA Flood Zone X. The neighborhood streets outfall to a pond that does not have an outfall structure and is directly influenced by the tailwater. As shown in Figure 28, the models indicate Laurel Oak Lane at Holland Road begins to experience flooding in the 1-year storm event.

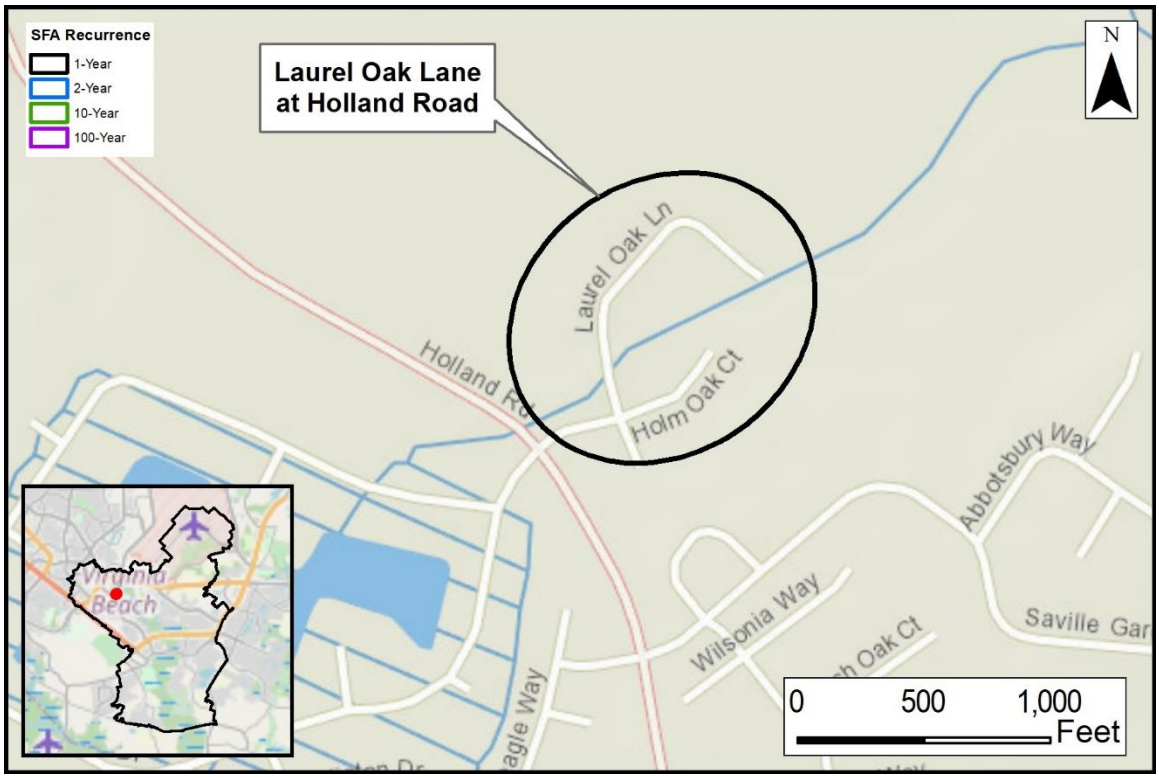


Figure 28. Location Map of Laurel Oak Lane at Holland Road SFA

3.24.2 Project Description

This project creates a small pond in City ROW between the neighborhood and Holland Road. Runoff from Holland Road and portions of the neighborhood are directed into the pond. The pond outfalls into an existing ditch to the northwest. The outfall to the pond has backflow preventers to prevent the pond from filling up with tailwater. Additionally, some existing pipes are upsized, and others are proposed to outfall into the existing pond in areas where easements and space allowed.

3.24.3 Project Benefits

The major benefits of the project include mitigating habitable structure flooding for six structures on Laurel Oak Lane and Holm Oak Court in the 100-year storm event. Additionally, street and private property flooding are reduced in the 100-year and resolved in the 10-year storm event. The project also addresses several flood reports that have been documented in the area. There

is a potential cost-sharing opportunity with DPU based on the replacement prioritization of a nearby transmission main.

3.24.4 Project Analysis Assumptions

A 50-year LOS is achieved for this project given the proximity of the neighborhood to the 100-year floodplain as described above and the associated tailwater influence on the 100-year design of drainage improvements. This is necessary as the peak HGL within West Neck Creek is higher than the lowest point of some neighborhood streets. Flood depths are less than 3 inches above the crown of the road, are summarized on the 100-year flood map, and will require approval for a reduced LOS from the City Engineer.

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. There is a decrease in street flooding in the 100-year storm event, but it is not completely mitigated. Therefore, the project is given a BR of 0.73.

Easement acquisition will be required from multiple property owners. The easements were limited by maintaining the majority of the construction within the ROW or on City property. It is anticipated that minimal maintenance of traffic and utility relocations will be required during the construction of the project. Similarly, minimal environmental permitting is required to add an outfall to a non-tidal ditch.

While changes to the original design function of the BMP are not anticipated, coordination with the City's VSMP Permit Coordinator is required.

3.24.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.24.6 Other Alternatives Not Scored

Several alternatives were considered, but none were scored. The alternatives attempted to reduce the tailwater influence to the existing BMP but with different operational methodologies. The first included a berm and backflow preventer with a pump that drained the BMP before the large storm events. The second alternative involved a flood gate, which would drain the pond by way of gravity. These alternatives did not meet the PWDSM standards for the 100-year storm event and were not considered further.

3.24.7 Project Analysis Summary

Table 34 below provides a summary of the Laurel Oak Lane at Holland Road project analysis. Refer to Appendix B-24 for project exhibits and supporting documentation.

Table 34. Laurel Oak Lane at Holland Road Project Summary

SFA Recurrence	1-year (no SLR)
Project LOS	50-year (1.5 feet SLR)
Selected Alternative	Alternative 1
ASC Score	5.39/10
Other ASC Score(s)	N/A
PPC Score	6.94/14.4
BR	0.73
BCR	1.0 (based on updated model)
Project Cost	$3,441,600

3.25 Leroy Road at Farmers Court

3.25.1 SFA Description

Leroy Road, near the new Princess Anne Middle School, experiences flooding due to high tailwater and inadequate stormwater infrastructure. As shown in Figure 29, the models indicate Leroy Road begins to experience flooding in the 1-year storm event. No habitable structures are flooded in existing conditions.

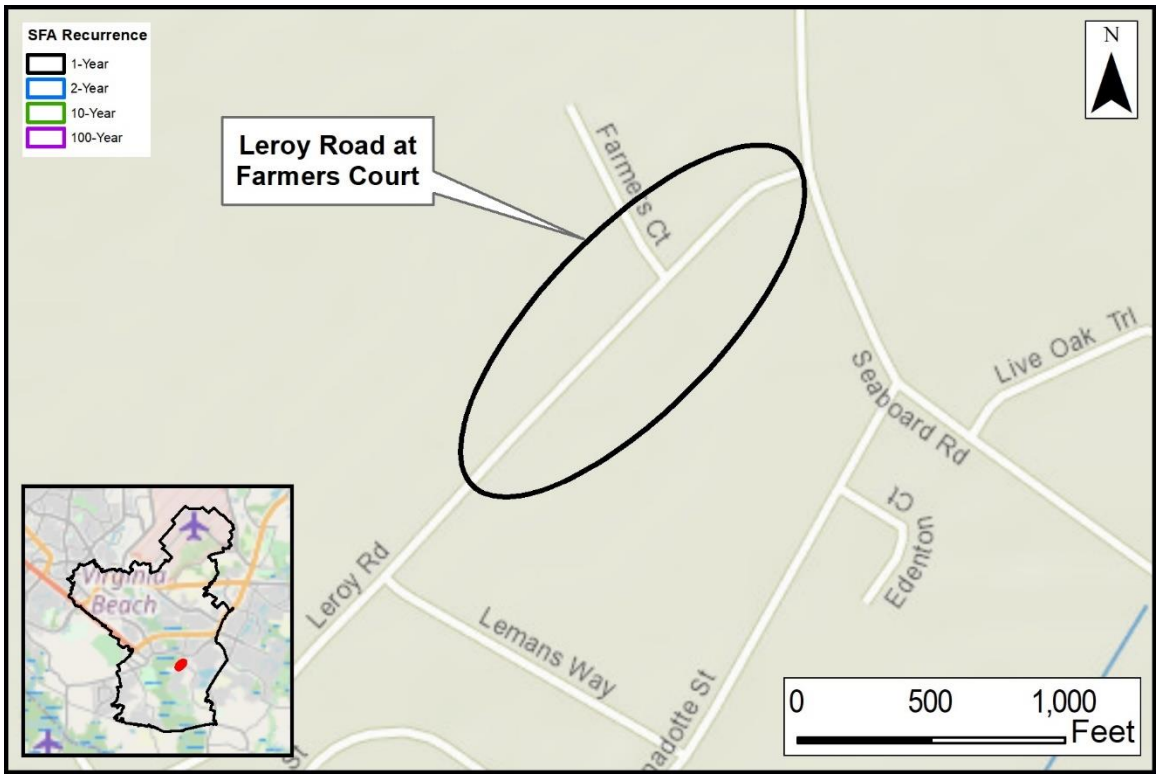


Figure 29. Location Map of Leroy Road at Farmers Court SFA

3.25.2 Project Description

The project will add additional stormwater infrastructure to Leroy Road and create a new outfall to West Neck Creek to mitigate flooding. A new pipe system is proposed on the northwestern side of Leroy Road and outfalls to a proposed ditch on the City property (GPIN 24042068350000) at the end of Leroy Road. The new ditch outfalls to West Neck Creek. Additionally, the existing ditch across from Princess Anne Middle School will be widened, and a new dual-pipe is proposed crossing under Leroy Road to the existing outfall.

3.25.3 Project Benefits

The major benefits of the project include mitigating street flooding on Leroy Road. The road is passable in the 100-year storm event.

3.25.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated.

Leroy Road at Farmers Court and Foxfire projects are kept separate because the Leroy Road at Farmers Court SFA can be mitigated without all of the Foxfire improvements. However, the downstream ditch and channel are the same in both projects. If the Foxfire project is constructed first, then the downstream improvements as part of this project would not be required. Refer to Section 3.15 for a description of the Foxfire project.

Extensive maintenance of traffic will be required during the construction of the project while the pipe system is being constructed along Leroy Road. This is expected due to City facilities located at the end of Leroy Road. Additionally, extensive utility relocations will be required during the construction of the project. A sewer force main is located along the southwestern side of Leroy Road and will need to be relocated to allow the new dual-pipe system crossing Leroy Road near Princess Anne Middle School. Other water and sewer utilities located underneath Leroy Road will need to be relocated to accommodate the new pipe systems.

It is anticipated that extensive effort will be required to obtain environmental permits. For the new ditch outfall, there is anticipated to be over one acre of non-tidal wetland impacts.

Drainage easements will be required to widen the existing ditch across from Princess Anne Middle School. The improvements on this ditch and easements are minimized by creating the new pipe system and outfall to the southwest along Leroy Road. It is also anticipated that easements will be needed for the new pipe system due to tight ROW constraints.

3.25.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.25.6 Other Alternatives Not Scored

One additional alternative was considered, but not scored. A second outfall was considered farther north through private property to the West Neck Creek channel near the intersection of Leroy Road and Lemans Way to minimize the length of the pipe along Leroy Road. However, this alternative would require large easements or property acquisition. Based on the proximity of the City property to the south, this alternative was not considered any further.

3.25.7 Project Analysis Summary

Table 35 below provides a summary of the Leroy Road at Farmers Court project analysis. Refer to Appendix B-25 for project exhibits and supporting documentation.

Table 35. Leroy Road at Farmers Court Project Summary

SFA Recurrence	1-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	3.78/10
Other ASC Score(s)	N/A
PPC Score	3.4/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$4,287,500

3.26 Litchfield Manor, Highcourt and Princess Anne Quarter

3.26.1 SFA Description

The Holland Road at Litchfield Way, Litchfield Manor, and the Highcourt and Princess Anne Quarter SFAs are combined into the Litchfield Manor, Highcourt and Princess Anne Quarter project. Individual SFA locations are shown in Figure 30 and are further described below. The SFAs are hydraulically connected and can be combined into one project.



Figure 30. Location Map of Highcourt and Princess Anne Quarter, Holland Road at Litchfield Way, and Litchfield Manor SFAs

Highcourt and Princess Anne Quarter

The Highcourt and Princess Anne Quarter neighborhood floods due to inadequately sized pipes and lack of storage throughout the neighborhood. Additionally, the ditch in between Litchfield Way that drains Holland Road is undersized and causes water to back up into the neighborhood. As shown in Figure 30, the models indicate the Highcourt and Princess Anne Quarter neighborhood begin to experience flooding in the 2-year storm event.

Holland Road at Litchfield Way

Holland Road, between Nimmo Parkway and Litchfield Way, floods due to undersized stormwater infrastructure. Additionally, private property and one habitable structure near the roadway are flooding. Holland Road is a secondary evacuation route. As shown in Figure 30, the models indicate Holland Road begins to experience flooding in the 10-year storm event.

Litchfield Manor

The Litchfield Manor neighborhood floods due to inadequately sized pipes and lack of storage throughout the neighborhood. As shown in Figure 30, the models indicate the Litchfield Manor neighborhood begins to experience flooding in the 10-year storm event.

3.26.2 Project Description

This project will add a 500 cfs lift station to the central BMP (ID SU2404050000A). The lift station is required to maintain the HGL within the BMP during large storm events at an elevation low enough to prevent water from filling up the inlet stormwater pipes. Backflow preventers and a raised weir are proposed to prevent water from re-entering the BMP. Additionally, backflow preventers are proposed on the northern BMP (ID SU2404050000B). Improvements are proposed to the Holland Road ditch outfall, and the pipes crossing Holland Road are upsized to box culverts. Additionally, pipes from the south of Holland Road are rerouted into the central BMP (BMP ID: SU2404050000A). These pipes divert some of the drainage that flows to the existing undersized ditch outfall. Pipes are upsized and to increase capacity throughout the neighborhood. An outfall crossing Princess Anne Road to the floodplain is upsized to eliminate structure flooding.

3.26.3 Project Benefits

The major benefits of the project include mitigating habitable structure flooding and street flooding throughout the neighborhood. The project also addresses several flood reports that have been documented in the area. There is a potential cost-sharing opportunity with DPU for transmission main prioritization.

3.26.4 Project Analysis Assumptions

A 50-year LOS is achieved for this project given the proximity of the neighborhood to the 100-year floodplain as described above and the associated tailwater influence on the 100-year design of drainage improvements. This is necessary as the peak HGL is higher than the lowest points along Litchfield Way. Downstream conveyance has been maximized and already requires property acquisition. Flood depths are less than 3 inches above the crown of the road, are summarized on the 100-year flood map, and will require approval for a reduced LOS from the City Engineer.

HAZUS data is available for the habitable structures along Litchfield Way and MJ Beasley Trail. The structures no longer flood in the 100-year storm event. Based on the BCR methodology, the project BCR is 1.0601. There is a decrease in street flooding in the 100-year storm event, but it is not completely mitigated. Therefore, the project is given a BR of 0.99.

Holland Road, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and the 100-year storm event with no SLR. Property acquisition is required for this project to construct the Holland Road ditch improvements. The ditch construction will be limited to one side to minimize the number of properties affected. Additional easements are required to upsize pipes. It is anticipated that extensive maintenance of traffic and utility relocations will be required during the construction of the project. It is anticipated that moderate effort will be required to obtain environmental permits.

Additional water from First Settlers and Holland Road will be routed into the existing BMP (BMP ID: SU2404050000A). There is a potential water quality benefit from diverting more stormwater into an existing BMP. As this area is larger than that being diverted under Princess Anne Road

away from the existing pond, changes to the original design functions of the BMPs are not anticipated. Coordination with the City's VSMP Permit Coordinator is still required.

Princess Anne Road is not shown as flooding based on the current subcatchment boundaries. However, based on HGL elevations upstream of Princess Anne Road, it is believed that the road may be overtopping near the Holland Road intersection. During the detailed design of this project, the model should be refined along Princess Anne Road, and additional improvements should be included if needed.

3.26.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.26.6 Other Alternatives Not Scored

One additional alternative was considered for the Holland Road at Litchfield Road SFA but was not scored. To minimize the pipe upgrades across Holland Road, the alternative considered underground storage in the east parking lot of the former Kellam High School. However, the overall problem for flooding in this area was determined to be capacity-related, and the underground storage was not effective. This alternative was not evaluated further.

3.26.7 Project Analysis Summary

Table 36 below provides a summary of the Litchfield Manor, Highcourt and Princess Anne Quarter project analysis. Refer to Appendix B-26 for project exhibits and supporting documentation.

Table 36. Litchfield Manor, Highcourt and Princess Anne Quarter Project Summary

SFA Recurrence	2-year (no SLR)
Project LOS	50-year (1.5 feet SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	2.47/10
Other ASC Score(s)	N/A
PPC Score	6.81/14.4
BR	0.99
BCR	1.0601
Project Cost	$59,960,300

3.27 London Bridge Road at Hunt Club Farm

3.27.1 SFA Description

London Bridge Road, south of Hunt Club Farm, experiences flooding due to the lack of storage within the stormwater system. Habitable structure flooding occurs during the 100-year storm event. London Bridge Road is a secondary evacuation route. As shown in Figure 31, the model indicates that this area begins to experience flooding in the 10-year storm event.



Figure 31. Location Map of London Bridge Road at Hunt Club Farm SFA

3.27.2 Project Description

This project will add two BMPs to serve as additional storage for the stormwater flows from Hunt Club Farm and London Bridge Road (GPIN 24058121850000 and 24049907760000). An additional trunk line will be installed to convey more water underneath London Bridge Road, starting at the intersection of Strawbridge Road and London Bridge Road. This system will outfall into the existing ditch southeast of Mansion Cross Lane.

3.27.3 Project Benefits

The major benefit of the project includes mitigating habitable structure flooding for two structures at Hunt Club Farm and street flooding along London Bridge Road. The project also addresses flood reports that have been documented in the area.

3.27.4 Project Analysis Assumptions

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. The project is given a BR of 1.0 because all street flooding is mitigated. London Bridge Road, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and the 100-year storm event with no SLR. As one BMP will need to be

placed at Hunt Club Farm to store water from that parcel before flowing to London Bridge Road, easement acquisition is required. The second BMP will be built on a City parcel. It is anticipated that minimal effort will be required to obtain environmental permits. Additionally, it is also anticipated that moderate utility relocations and maintenance of traffic will be required during the construction of the project.

London Bridge Road at Hunt Club Farm and Strawbridge Park North are kept separate because the London Bridge Road at Hunt Club Farm SFA can be mitigated without all of the Strawbridge Park North improvements. However, the downstream BMP and pipe improvements are the same in both projects. If the Strawbridge Park North project is constructed first, then the downstream improvements as part of this project would not be required. Refer to Section 3.52 for a description of the Strawbridge Park North project.

3.27.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.27.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.27.7 Project Analysis Summary

Table 37 below provides a summary of the London Bridge Road at Hunt Club Farm project analysis. Refer to Appendix B-27 for project exhibits and supporting documentation.

Table 37. London Bridge Road at Hunt Club Farm Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	5.86/10
Other ASC Score(s)	N/A
PPC Score	5.74/14.4
BR	1.0
BCR	1.0 (based on updated model)
Project Cost	$3,566,250

3.28 Maple Shade Drive at Wild Cherry Court

3.28.1 SFA Description

Maple Shade Drive at Wild Cherry Court floods due to undersized pipes and tailwater-influenced pipes. Additionally, stormwater from Holland Road runs off into the neighborhood and increases flooding. Holland Road serves as a secondary evacuation route. As shown in Figure 32, the models indicate Maple Shade Drive at Wild Cherry Court begins to experience flooding in the 1-year storm event.

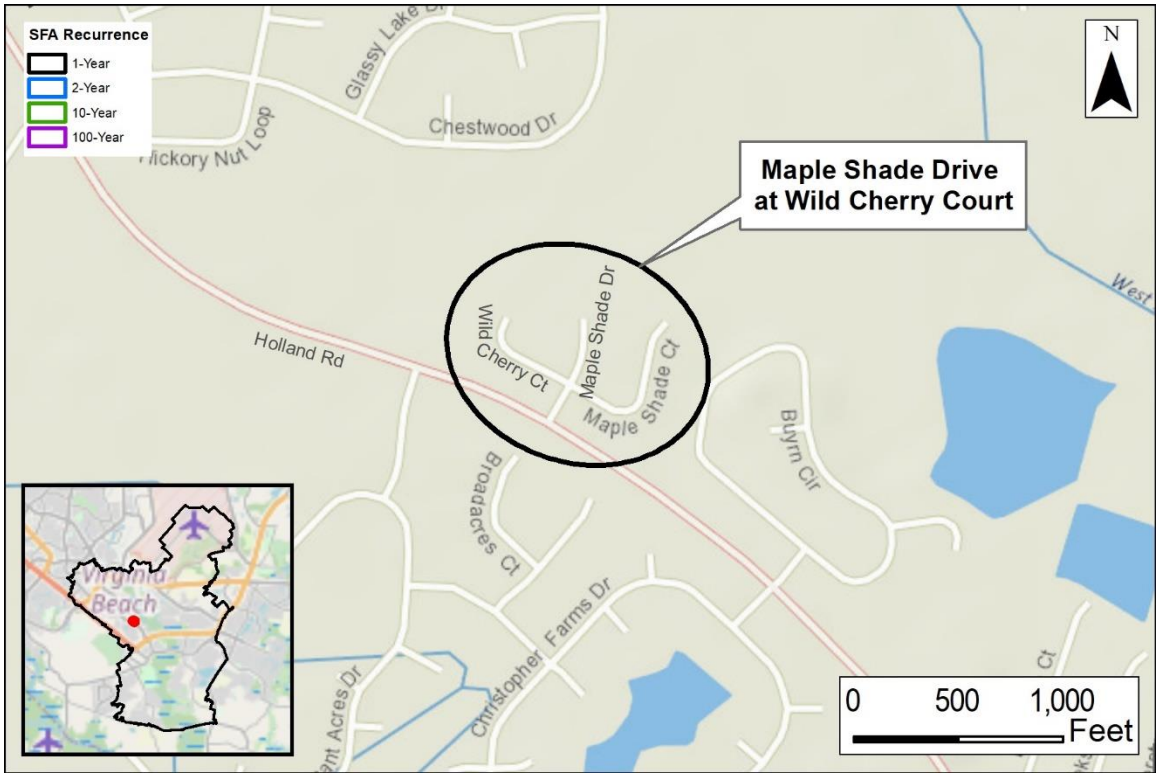


Figure 32. Location Map of Maple Shade Drive at Wild Cherry Court SFA

3.28.2 Project Description

This project will remove the connection to the northern neighborhood, which is currently flooding. Outfalls will be constructed in the back part of the neighborhood to a new trapezoidal channel that leads to West Neck Creek. The project will also upsize pipes throughout the neighborhood and add more stormwater infrastructure. Additionally, stormwater is being diverted away from the existing Holland Road ditch between Maple Shade Court and Buyrn Circle.

3.28.3 Project Benefits

The major benefits of the project include mitigating habitable structure flooding on Maple Shade Court and Maple Shade Drive and street flooding throughout the neighborhood. Structure flooding is eliminated for five structures. The project also addresses several flood reports that have been documented in the area.

3.28.4 Project Analysis Assumptions

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. The project is given a BR of 1.0 because all street flooding is mitigated.

Holland Road, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and the 100-year storm event with no SLR.

Property acquisition is required to direct water away from Holland Road and outfall into the new ditch. However, this has been minimized by locating most improvements within City ROW and property. Additionally, a small easement will be required for one pipe improvement.

It is anticipated that moderate maintenance of traffic and utility relocations will be required during the construction of the project. Moderate effort will likely be required to obtain environmental permits.

3.28.5 Other Alternatives Scored

One additional alternative was scored as a part of this analysis. Alternative 1 was similar to the selected project because it improved pipes and added outfalls to the neighborhood. However, this project proposed upsizing the ditches and pipes between Maple Shade Court and Buyrn Circle. This alternative would involve significantly more property acquisition.

3.28.6 Other Alternatives Not Scored

Another alternative was considered for this SFA. This alternative involved creating a storage facility behind the neighborhood for water quality since the existing connection to the BMP in the northern neighborhood was removed. However, the existing BMP is designated as a volume control facility according to the City GIS website. This alternative was not evaluated any further.

3.28.7 Project Analysis Summary

Table 38 below provides a summary of the Maple Shade Drive at Wild Cherry Court project analysis. Refer to Appendix B-28 for project exhibits and supporting documentation.

Table 38. Maple Shade Drive at Wild Cherry Court Project Summary

SFA Recurrence	1-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 2
ASC Score	3.43/10
Other ASC Score(s)	Alternative 1 – 3.07/10
PPC Score	8.4/14.4
BR	1.0
BCR	1.0 (based on updated models)
Project Cost	$6,967,700

3.29 Mayberry Drive at London Bridge Road

3.29.1 SFA Description

Mayberry Drive, Mount Airy Court, and Lenoir Court experience flooding due to the lack of storage and conveyance capacity within the existing stormwater system. As shown in Figure 33, the model indicates that this area begins to experience flooding in the 10-year storm event. Habitable structure flooding occurs during the 100-year storm event.

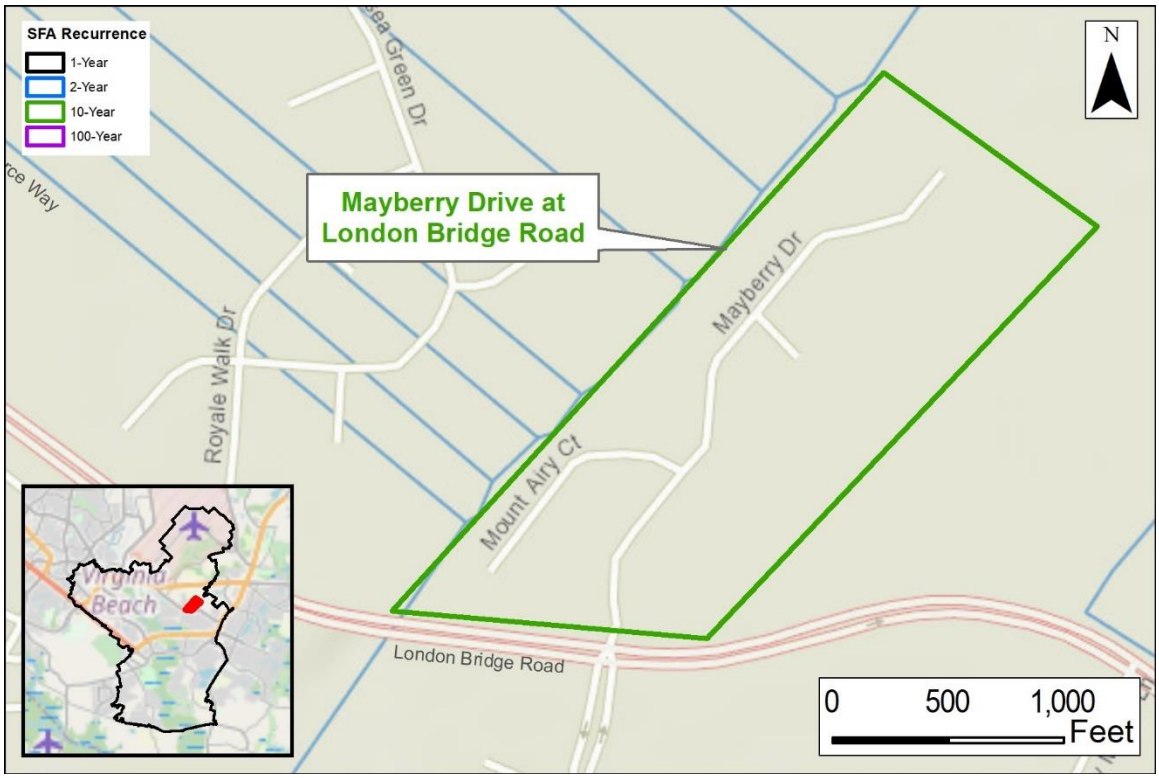


Figure 33. Location Map of Mayberry Drive at London Bridge Road SFA

3.29.2 Project Description

This project includes adding one stormwater BMP to serve as additional storage for the stormwater flows coming from undeveloped parcels southeast of Lenoir Court. Some pipes are upsized or added to the system to improve stormwater conveyance to the outfall. Outfall structures at two of the existing BMPs are replaced with weir structures to allow more flow out of the BMP in larger storm events. The existing ditch that the system outfalls into is widened to have a 30-foot bottom north of London Bridge Road and a 50-foot bottom south of London Bridge Road to improve conveyance to West Neck Creek. The culvert underneath London Bridge Road is upsized to a larger sized culvert.

3.29.3 Project Benefits

The major benefit of the project is mitigating habitable structure flooding for one structure along Mount Airy Court and street flooding within the area. The project also addresses flood reports that have been documented in the area.

3.29.4 Project Analysis Assumptions

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. The project is given a BR of 1.0 because all street flooding is mitigated. Property acquisition is required, as a BMP will need to be placed to the southeast of Lenoir Court on an undeveloped parcel to store water before flowing into the residential stormwater system. Acquisition of a maintenance and access easement for the BMP will also be required from the HOA.

Mayberry Drive at London Bridge Road and Pine Ridge and Middle Oaks Plantation are kept separate because the Mayberry Drive at London Bridge Road SFA can be mitigated without all the Pine Ridge and Middle Oaks Plantation improvements. However, the ditch widening improvements south of London Bridge Road are the same in both projects. If the Pine Ridge and Middle Oaks Plantation project is constructed first, then the downstream improvements south of London Bridge Road as part of this project would not be required. Refer to Section 3.34 for a description of the Pine Ridge and Middle Oaks Plantation project.

To be conservative, it is anticipated that significant effort will be required to obtain environmental permits for construction of all ditch improvements, including south of London Bridge Road, as part of this project. However, should the ditch improvements south of London Bridge Road be permitted and constructed first as part of the Pine Ridge and Middle Oaks Plantation project, only minimal effort would be required to permit and construct the ditch improvements north of London Bridge Road. The proposed ditch improvements on the north side of London Bridge Road and the first 1,300 feet downstream of London Bridge Road (3,400 feet total) are located primarily in uplands. Beyond this point, based on site observations in June 2021, wetlands may be present along the ditch approximately 30 feet south of the existing top of bank. For this reason, an individual permit will likely be required from both USACE and DEQ to widen the existing ditch south of London Bridge Road.

Additionally, it is also anticipated that moderate utility relocations will be required due to an existing sanitary sewer pump station, 8-inch gravity sewer main, and 6-inch force main located near the ditch improvements. Moderate maintenance of traffic will be required to construct neighborhood drainage improvements and improve the culvert crossing London Bridge Road. Coordination with the VSMP authority will be necessary due to the change in the outfall structure proposed at two existing BMPs.

3.29.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.29.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.29.7 Project Analysis Summary

Table 39 below provides a summary of the Mayberry Drive at London Bridge Road project analysis. Refer to Appendix B-29 for project exhibits and supporting documentation.

Table 39. Mayberry Drive at London Bridge Road Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	5.15/10
Other ASC Score(s)	N/A
PPC Score	5.38/14.4
BR	1.0
BCR	1.0 (based on updated model)
Project Cost	$12,476,800

3.30 Mulberry Loop

3.30.1 SFA Description

Mulberry Loop is a residential street, and the southwestern portion ranges in elevations from approximately 6 to 7 feet. The design tailwater elevation for the 100-year storm event is 7.34 feet in West Neck Creek. The tailwater elevation, independent of the existing drainage infrastructure, floods the street. As shown in Figure 34, the models indicate Mulberry Loop begins to experience flooding in a 2-year storm event.

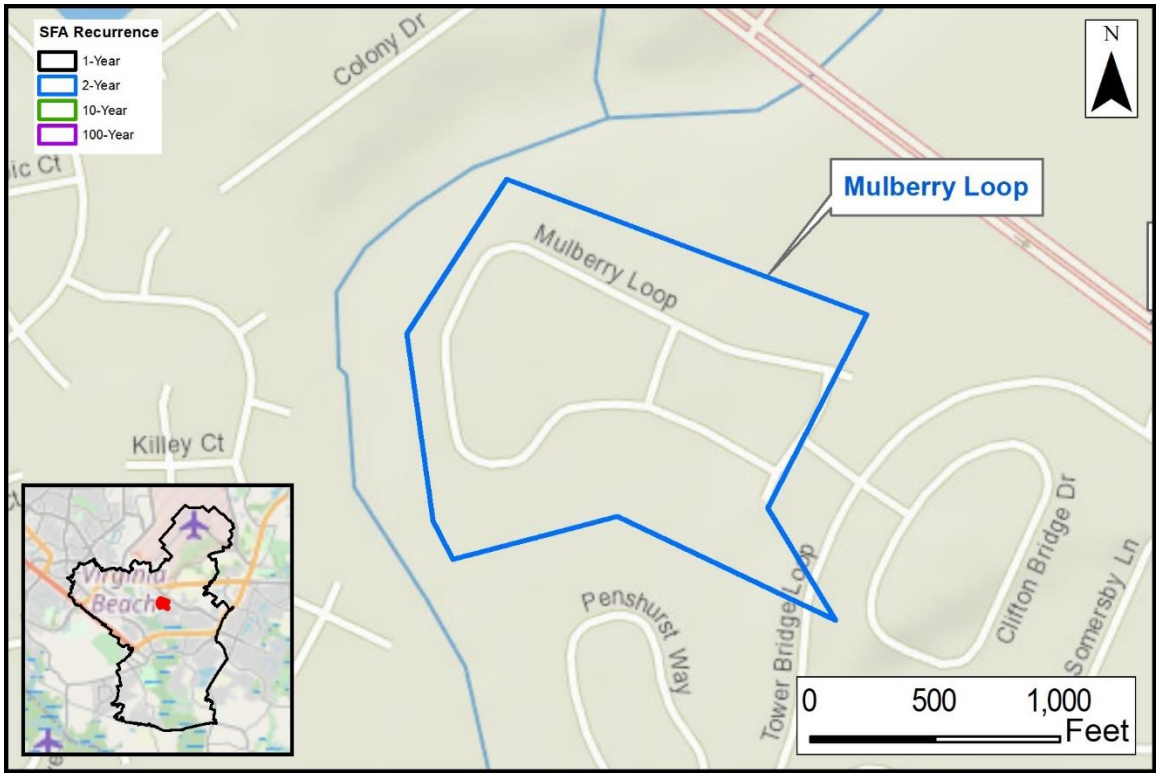


Figure 34. Location Map of Mulberry Loop SFA

3.30.2 Project Description

The downstream tailwater conditions severely limit the options for improvements in this neighborhood. The City will be evaluating this SFA with a Neighborhood Strategy in the future. Refer to Appendix B-30 for the extent of existing flooding in the area.

3.30.3 Project Benefits

While there is no project and there are no benefits, it should be noted that habitable structure flooding does not occur as part of this SFA.

3.30.4 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.30.5 Other Alternatives Not Scored

Given the relative proximity of the lowest elevations of Mulberry Loop and the peak tailwater elevations, backflow prevention for pipe outfalls was considered, but sufficient driving head to activate positive flow from the neighborhood is not available without also flooding the existing

street. Similarly, the existing BMP within the neighborhood is not adjacent to the floodplain, so a stormwater lift station would require significant property acquisition.

This neighborhood would benefit from a neighborhood solution similar to those shown in the SLW Adaptation Strategy Report. This neighborhood can be designed to resolve the flooding issues that occur from a smaller storm event. PW-SWEC will, in the future, have a neighborhood solution created to establish resiliency in this neighborhood.

3.31 Nestlebrook Trail

3.31.1 SFA Descriptions

The Nestlebrook Trail at Indian River Road, Stonewood Drive at Nestlebrook Trail, and Stonewood Drive at West Neck Road SFAs are combined into the Nestlebrook Trail project. Individual SFA locations are shown in Figure 35 and are further described below. All three SFAs are hydraulically connected and can be combined into one project.

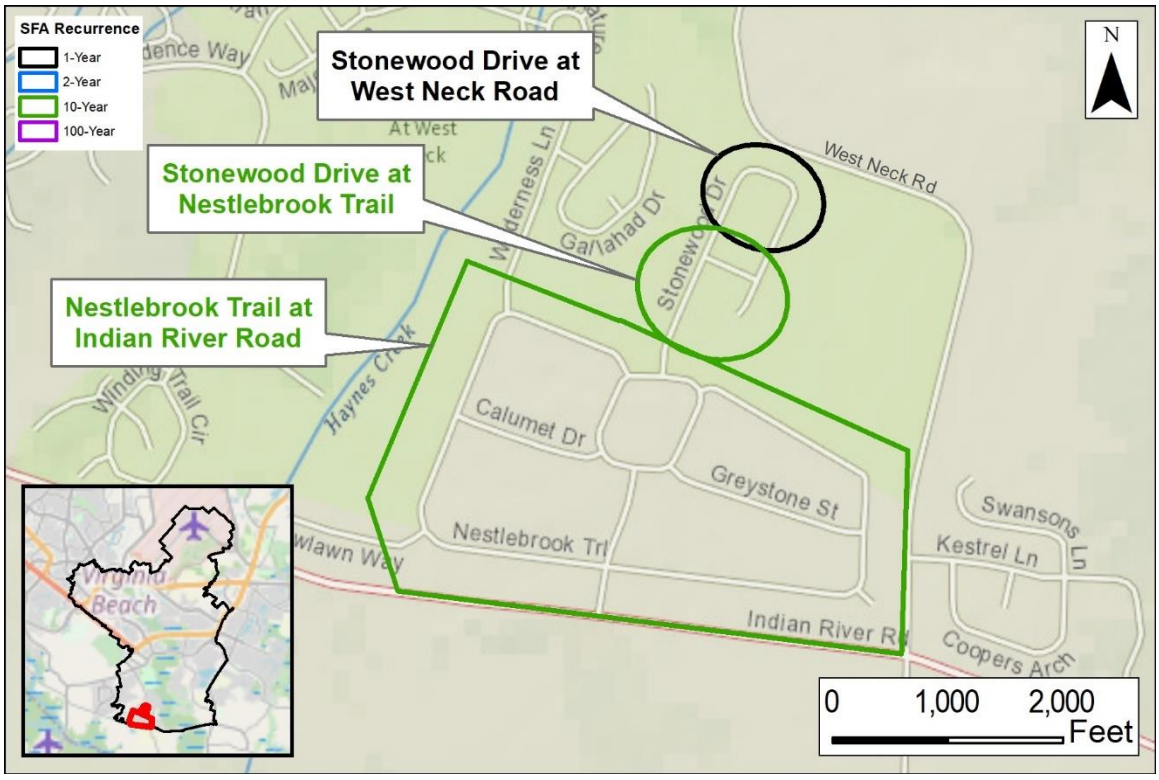


Figure 35. Location Map of Nestlebrook Trail at Indian River Road, Stonewood Drive at Nestlebrook Trail, and Stonewood Drive at West Neck Road SFAs

Nestlebrook Trail at Indian River Road SFA

Nestlebrook Trail at Indian River Road floods due to a lack of conveyance capacity caused by undersized and inverted pipes within an interconnected pond system. The area experiences flooding on neighborhood streets and private property. As shown in Figure 35, the models indicate Nestlebrook Trail at Indian River Road begins to experience flooding in the 10-year storm event.

Stonewood Drive at Nestlebrook Trail SFA

Stonewood Drive at Nestlebrook Trail floods due to a lack of conveyance capacity caused by undersized pipes within an interconnected pond system and a lack of stormwater storage. The area experiences flooding on neighborhood streets and private property. As shown in Figure 35, the models indicate Stonewood Drive at Nestlebrook Trail begins to experience flooding in the 10-year storm event.

Stonewood Drive at West Neck Road SFA

Stonewood Drive at West Neck Road floods due to a lack of conveyance capacity caused by undersized pipes within an interconnected pond system and a lack of stormwater storage. The area experiences flooding on neighborhood streets and private property. As shown in Figure 35, the models indicate Stonewood Drive at West Neck Road begins to experience flooding in the 1-year storm event.

3.31.2 Project Description

This project proposes significant pipe improvements throughout the neighborhood, which includes adding more stormwater infrastructure as well as upsizing existing infrastructure. Multiple pipe inverts are changed to improve conveyance capacity. A BMP is proposed to the east of the site on existing private farmland. Backflow preventers are also added to the neighborhood outlet pipes to prevent tailwater influence within the stormwater system.

3.31.3 Project Benefits

The major benefits of the project include mitigating street flooding within the area, as well as the flooding occurring on surrounding private property. The project also addresses several flood reports that have been documented in the area.

3.31.4 Project Analysis Assumptions

A 50-year LOS is achieved for this project as the peak HGL is higher than the lowest point along Nestlebrook Trail in the most upstream portions of the system. Available storage areas and downstream improvements have been maximized. Flood depths are less than 3 inches above the crown of the road, are summarized on the 100-year flood map, and will require approval for a reduced LOS from the City Engineer.

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. There is a decrease in street flooding in the 100-year storm event, but it is not completely mitigated. Therefore, the project is given a BR of 0.99.

Acquisition of multiple developed residential parcels will be necessary to fit the required stormwater infrastructure between homes. Additionally, the acquisition of an undeveloped parcel currently used as farmland will be necessary to construct the proposed BMP. It is anticipated that moderate maintenance of traffic and utility relocations will be required during the construction of the project. Extensive effort will likely be required to obtain environmental permits due to potential impact to adjacent historic property.

3.31.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.31.6 Other Alternatives Not Scored

One additional alternative was considered but was not scored. The alternative considered the addition of a pump station downstream of the interconnected pond system to minimize the extent of the improvements. This alternative met the PWDSM but was ruled not to be constructible due to a lack of space within the neighborhood. Additionally, more property acquisition was not favorable.

3.31.7 Project Analysis Summary

Table 40 below provides a summary of the Nestlebrook Trail project analysis. Refer to Appendix B-31 for project exhibits and supporting documentation.

Table 40. Nestlebrook Trail Project Summary

SFA Recurrence	1-year (no SLR)
Project LOS	50-year (1.5 feet SLR)
Selected Alternative	Alternative 1
ASC Score	4.45/10
Other ASC Score(s)	N/A
PPC Score	3.64/14.4
BR	0.99
BCR	1.0 (no habitable structure flooding)
Project Cost	$30,815,600

3.32 Nimmo Parkway at Seaboard Road

3.32.1 SFA Description

The Nimmo Parkway at Seaboard Road and Seaboard Road at Smokehouse Road SFAs are combined into one project called Nimmo Parkway at Seaboard Road. Individual SFA locations are shown in Figure 36 and are further described below. Both SFAs are hydraulically connected and can be combined into one project.

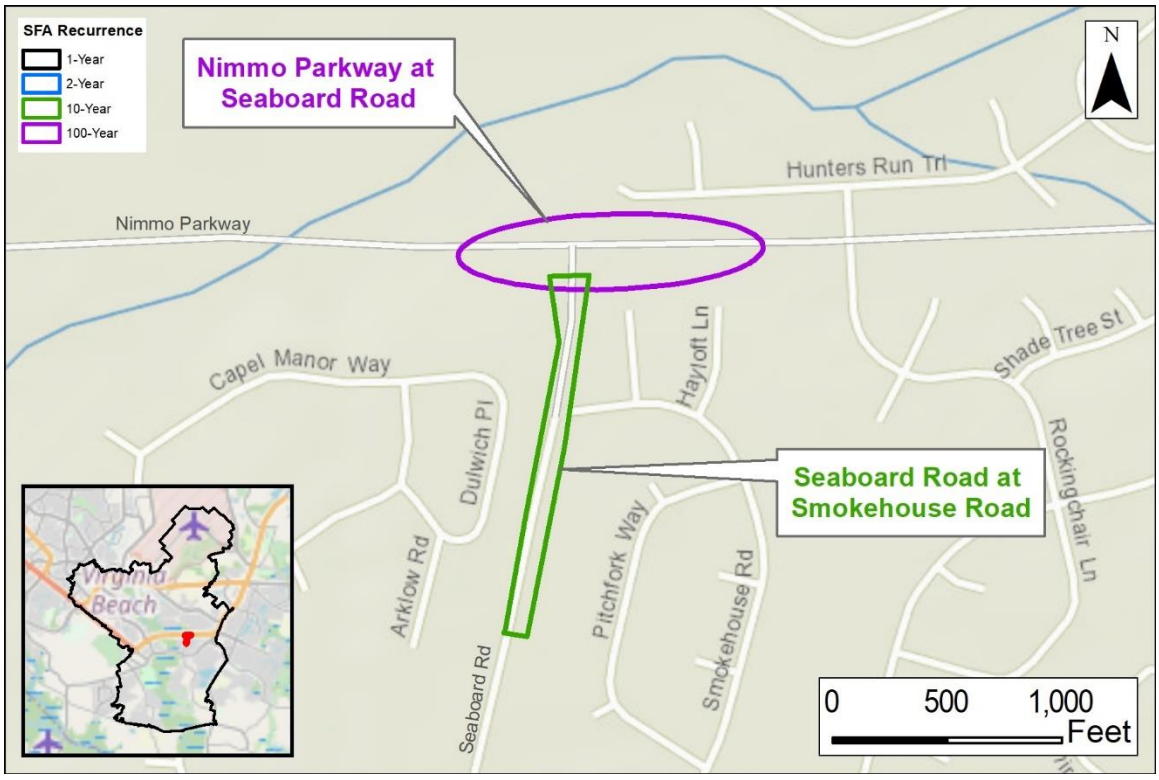


Figure 36. Location Map of Nimmo Parkway at Seaboard Road and Seaboard Road at Smokehouse Road SFAs

Nimmo Parkway at Seaboard Road SFA

The southern lanes of Nimmo Parkway and part of Seaboard Road flood due to undersized pipes and tailwater influence. Nimmo Parkway serves as a secondary evacuation route. As shown in Figure 36, the models indicate Nimmo Parkway begins to experience flooding in the 100-year storm event.

Seaboard Road at Smokehouse Road SFA

Seaboard Road south of Smokehouse Road floods due to undersized pipes along Seaboard Road. As shown in Figure 36, the models indicate Seaboard Road begins to experience flooding in the 10-year storm event.

3.32.2 Project Description

This project creates a new ditch outfall to the west of the Nimmo Parkway and Seaboard Road intersection to the Hunt Club Tributary channel. A box culvert is proposed south of the Nimmo

Parkway intersection on Seaboard Road to divert flow into the new ditch. Pipes are also upsized along Seaboard Road.

3.32.3 Project Benefits

The major benefits of the project include mitigating street flooding on Nimmo Parkway and Seaboard Road.

3.32.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated.

Nimmo Parkway, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and the 100-year storm event with no SLR.

Property acquisition is not required as all the construction will occur within the ROW or City property. It is anticipated that moderate maintenance of traffic and utility relocations will be required during the construction of the project. The proposed ditch will cross a small City sewer force main on City property. Moderate effort will likely be required to obtain environmental permits.

This project and the Princess Anne Woods project are kept separate because the SFAs can be mitigated separately. However, the downstream ditch is the same in both projects. If the Princess Anne Woods project is constructed first, then the downstream ditch improvements as part of this project would not be required. Refer to Section 3.41 for a description of the Princess Anne Woods project.

3.32.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.32.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.32.7 Project Analysis Summary

Table 41 below provides a summary of the Nimmo Parkway at Seaboard Road and Seaboard Road at Smokehouse Road project analysis. Refer to Appendix B-32 for project exhibits and supporting documentation.

Table 41. Nimmo Parkway at Seaboard Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	6.14/10
Other ASC Score(s)	N/A
PPC Score	1.64/14.4
BR	1.0
BCR	1.0 (no habitable structure
Project Cost	$2,240,000

3.33 Penshurst Way

3.33.1 SFA Description

Penshurst Way floods due to tailwater and undersized pipes. As shown in Figure 37, the models indicate Penshurst Way begins to experience flooding in the 2-year storm event.

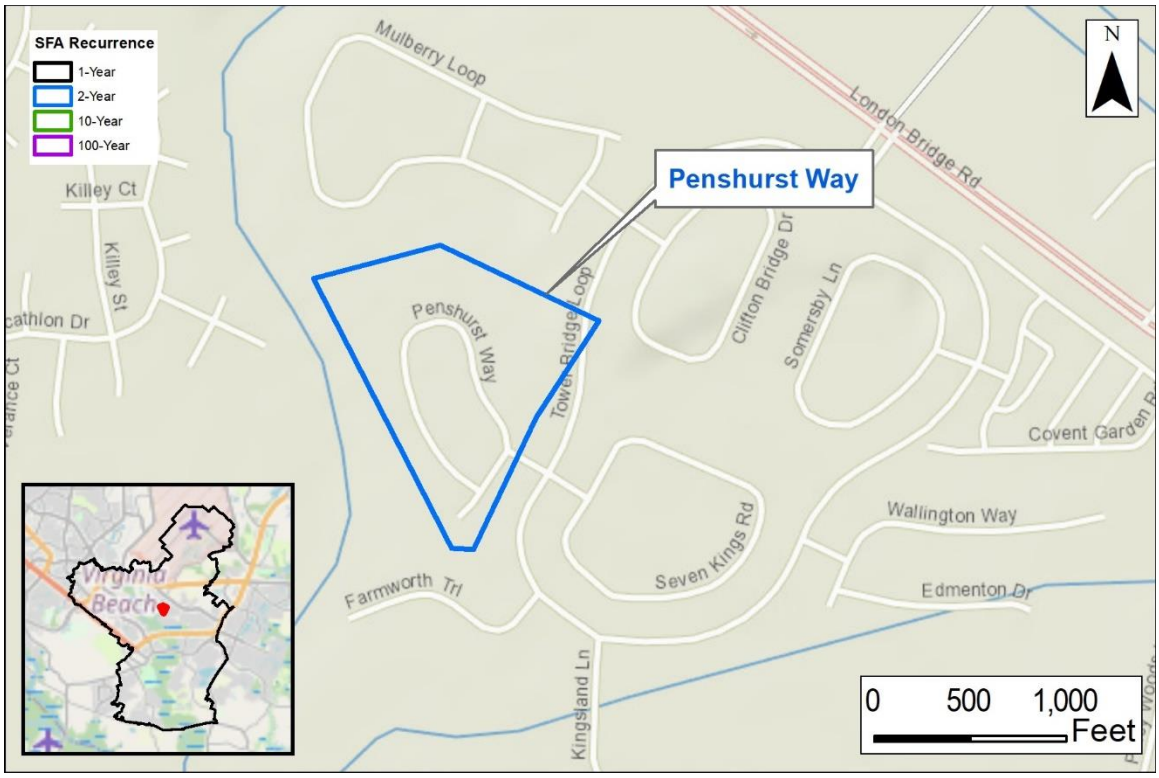


Figure 37. Location Map of Penshurst Way SFA

3.33.2 Project Description

This project will add a backflow preventer to the pipes downstream of the neighborhood BMP. An additional outfall is proposed on the western loop of Penshurst Way to the West Neck Creek floodplain. Pipes in the neighborhood will also be upsized.

3.33.3 Project Benefits

The major benefits of the project include mitigating street flooding on Penshurst Way, as well as the flooding occurring on surrounding private property. The project also addresses flood reports that have been documented in the area.

3.33.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated.

Easement acquisition is required in one location; however, most construction will occur within the ROW or City property. It is anticipated that minimal maintenance of traffic and utility relocations will be required during the construction of the project. It is anticipated that minimal effort will be required to obtain environmental permits.

While runoff is being diverted away from the existing BMP, changes to the original design function are not anticipated as the water quality storm can still be diverted to the BMP. Coordination with the City's VSMP Permit Coordinator is required.

3.33.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.33.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.33.7 Project Analysis Summary

Table 42 below provides a summary of the Penshurst Way project analysis. Refer to Appendix B-33 for project exhibits and supporting documentation.

Table 42. Penshurst Way Project Summary

SFA Recurrence	2-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	5.4/10
Other ASC Score(s)	N/A
PPC Score	2.1/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$1,822,500

3.34 Pine Ridge and Middle Oaks Plantation

Pine View Avenue at London Bridge Road and Breezy Pines Lane at Bartholomews Crossing are combined into one project called Pine Ridge and Middle Oaks Plantation. Individual SFA locations are shown in Figure 38 and are further described below. Meeting the PWDSM requirements for the Breezy Pines Lane at Bartholomews Crossing SFA is dependent on the improvements proposed for the Pine View Avenue at London Bridge Road SFA. A phased project is proposed considering the extent of improvements that are required and to accomplish the objective of the SWMP to develop “standalone” solutions that are not dependent on downstream improvements. Project phases are defined by the individual SFA boundaries and begin with the most downstream improvements. Future refinements to the project phasing proposed may be required. Refer to Appendix B-34-1 through B-34-2 for detailed project phase maps.

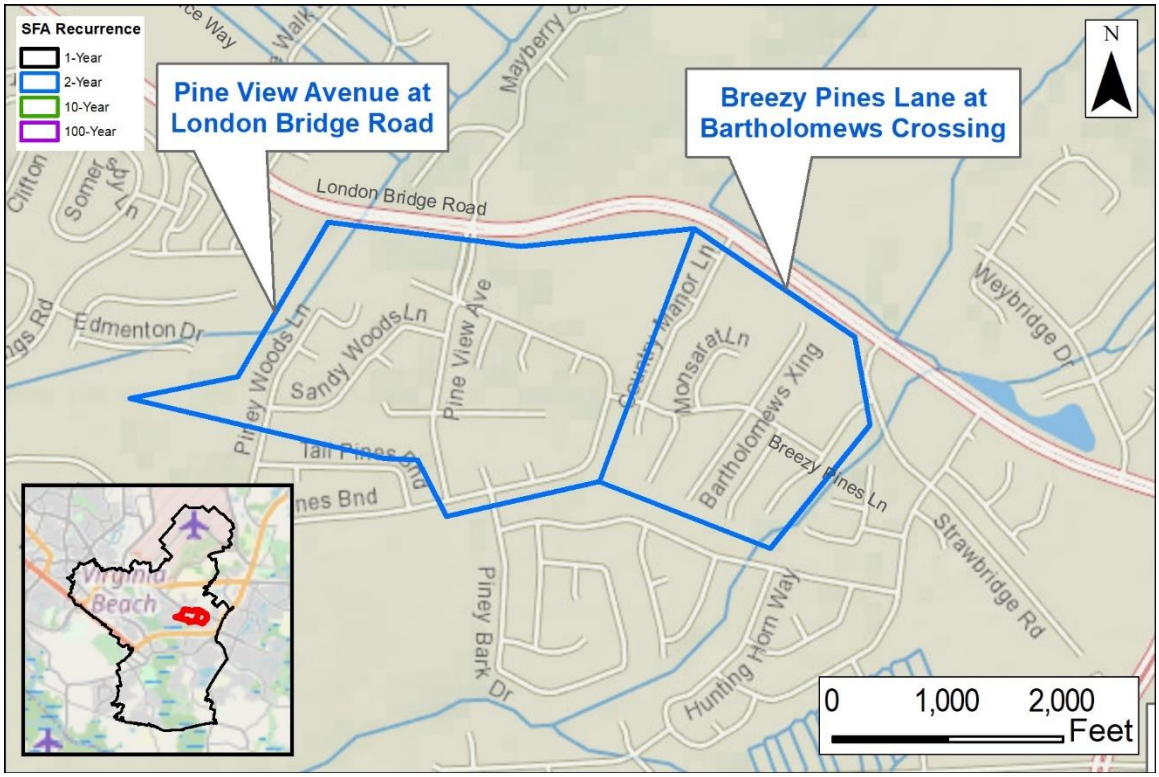


Figure 38. Location Map of Pine View Avenue at London Bridge Road and Breezy Pines Lane at Bartholomews Crossing SFAs

3.34.1 ***Phase 1: Pine View Avenue at London Bridge Road***

3.34.1.1 SFA Description

Pine View Avenue at London Bridge Road experiences flooding due to a lack of conveyance capacity and storage within the existing stormwater system and high tailwater within the tributary that the neighborhood outfalls into. As shown in Figure 38, the models indicate that these areas begin to experience flooding in the 2-year storm event.

3.34.1.2 Project Description

This project includes adding two stormwater BMPs to serve as additional storage for the stormwater flows coming from an undeveloped and residential parcel north of Windy Pines

Bend and south of London Bridge Road, as well as the pipe systems along Windy Pines Bend. The proposed dual 60-inch pipes discharging to the BMPs are intentionally located adjacent to an area known to be confirmed by the USACE as wetlands. This alignment minimizes impacts on the future development potential of the parcel. Some pipes and culverts are upsized or added to the system to improve stormwater conveyance to the outfall. Two ditches are proposed to serve as the outfall for the neighborhood and drain into a tributary of West Neck Creek.

3.34.1.3 Project Benefits

The major benefit of the project is mitigating habitable structure flooding for 26 structures and street flooding within the area. The project also addresses flood reports that have been documented within the neighborhood and have a potential for cost-sharing with DPU for transmission main prioritization along Pine View Avenue.

3.34.1.4 Project Analysis Assumptions

A 50-year LOS is achieved for this project, given the heavy tailwater influence at the neighborhood outfalls. Storage cannot be added to the system without significant impacts on residential properties. The peak HGL is above Wind Branch Circle. Flood depths are less than 3 inches above the crown of the road, are summarized on the 100-year flood map, and will require approval for a reduced LOS from the City Engineer.

HAZUS data is available for the habitable structures along Windy Pines Bend, Shady Lane, and other streets in the area. The structures no longer flood in the 100-year storm event. Based on the BCR methodology, the project BCR is 1.0153. There is a decrease in street flooding in the 100-year storm event, but it is not completely mitigated. Therefore, the project is given a BR of 0.99. Property acquisition is required, as two BMPs will need to be placed to the north of Windy Pines Bend on one undeveloped parcel and one residential parcel to store water before outfalling to the West Neck Creek Tributary. Acquisition of several easements will also be required for the additional pipes added to improve stormwater conveyance.

Pine View Avenue at London Bridge Road and Mayberry Drive at London Bridge Road are kept separate because the Mayberry Drive at London Bridge Road SFA can be mitigated without all the Pine View Avenue at London Bridge Road improvements. However, the ditch widening improvements south of London Bridge Road are the same in both projects. If the Mayberry Drive at London Bridge Road project is constructed first, then the downstream improvements as part of this project would not be required. Refer to Section 3.29 for a description of the Mayberry Drive at London Bridge Road.

To be conservative, it is anticipated that significant effort will be required to obtain environmental permits for the construction of ditch improvements south of London Bridge Road as part of this project. The first 1,300 feet downstream of London Bridge Road (3,400 feet total) are located primarily in uplands. Based on site observations in June 2021, wetlands may be present along the tributary south and west of Edmonton Drive, approximately 30 feet south of the existing top of bank. For this reason, an individual permit will likely be required from both USACE and DEQ to widen the existing tributary.

Additionally, it is also anticipated that moderate utility relocations will be required for water and sewer laterals. Moderate maintenance of traffic will be required to construct neighborhood drainage improvements. Coordination with Dominion Energy will be required to use the existing

120-foot power easement for drainage improvements. It is anticipated that the proposed improvements can maintain minimum clearance from the existing tower structures.

3.34.1.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.34.1.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.34.1.7 Project Analysis Summary

Table 43 below provides a summary of Pine View Avenue at London Bridge Road project analysis. Refer to Appendix B-34-1 for project exhibits and supporting documentation.

Table 43. Pine View Avenue at London Bridge Road Project Summary

SFA Recurrence	2-year (no SLR)
Project LOS	50-year (1.5 feet SLR)
Selected Alternative	Alternative 1
ASC Score	4.75/10
Other ASC Score(s)	N/A
PPC Score	6.27/14.4
BR	0.99
BCR	1.0153
Project Cost	$44,838,100

3.34.2 *Phase 2: Breezy Pines Lane at Bartholomews Crossing*

3.34.2.1 SFA Description

Breezy Pines Lane and other adjacent streets experience flooding due to the lack of storage and conveyance capacity within the downstream stormwater system. The SFA is also highly sensitive to tailwater influence. As shown in Figure 38, the model indicates that this area begins to experience flooding in the 2-year storm event. Habitable structure flooding occurs during the 100-year storm event.

3.34.2.2 Project Description

This project includes adding two underground storage BMPs and one surface BMP to serve as additional storage for the stormwater flows coming from open space areas north and south of Breezy Pines Lane. Many pipes will be upsized or added to the system to improve stormwater conveyance within the neighborhood. Monsarat Lane will be raised to ensure that there are less than 6 inches of flooding above the crown of the road in the 100-year storm event. This project is reliant on downstream improvements from Pine Ridge and Middle Oaks Plantation Phase 1: Pine View Avenue at London Bridge Road project.

3.34.2.3 Project Benefits

The major benefit of the project is mitigating habitable structure flooding for two structures along Tartingers Quay and Kilburton Priory Court, as well as street flooding within the neighborhood. The project also addresses flood reports that have been documented within the neighborhood.

3.34.2.4 Project Analysis Assumptions

Given the tailwater influence on the 100-year design of drainage improvements, a 10-year LOS is achieved for this project. This is necessary as the peak HGL within West Neck Creek is higher than the lowest points of downstream neighborhood streets. This condition makes designing improvements to meet PWDSM requirements not practicable. Flood depths are less than 6 inches above the crown of the road, are summarized on the 100-year flood map, and will require approval from the City Engineer.

HAZUS data is available for the habitable structures along Kilburton Priory Court, Tartingers Quay, and other streets in the area. The structures no longer flood in the 100-year storm event. Based on the BCR methodology, the project BCR is 1.0865. There is a decrease in street flooding in the 100-year storm event, but it is not completely mitigated. Therefore, the project is given a BR of 0.89. Easement acquisition is required for one of the three proposed BMPs, which will be placed south of Middle Oaks Plantation Park. The second BMP will be placed within the park and will not require easement acquisition. Property acquisition will be required for the third BMP as well as the new outfall from Bartholomew's Crossing to the east.

It is anticipated that moderate utility relocations will be required for water and sewer laterals. Minimal maintenance of traffic will be required to construct neighborhood drainage improvements. It is anticipated that minimal effort will be required to obtain environmental permits. Coordination with Dominion Energy will be required to use the existing 120-foot power easement for improvements.

3.34.2.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.34.2.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.34.2.7 Project Analysis Summary

Table 44 below provides a summary of the Breezy Pines Lane at Bartholomews Crossing project analysis. Refer to Appendix B-34-2 for project exhibits and supporting documentation.

Table 44. Breezy Pines Lane at Bartholomews Crossing Project Summary

SFA Recurrence	2-year (no SLR)
Project LOS	10-year (1.5 feet SLR)
Selected Alternative	Alternative 1
ASC Score	5.55/10
Other ASC Score(s)	N/A
PPC Score	5.51/14.4
BR	0.89
BCR	1.0865
Project Cost	$15,840,200

3.34.3 *Pine Ridge and Middle Oaks Plantation Combined Summary*

Table 45 below provides a summary of the Pine Ridge and Middle Oaks Plantation analysis. Refer to Appendix B-34 for project exhibits and supporting documentation.

Table 45. Pine Ridge and Middle Oaks Plantation Summary

	Phase 1: Pine View Avenue at London Bridge Road	Phase 2: Breezy Pines Lane at Bartholomews Crossing
SFA Recurrence	2-year (no SLR)	2-year (no SLR)
Project LOS	50-year (1.5 feet SLR)	10-year (1.5 feet SLR)
Selected Alternative	Alternative 1	Alternative 1
ASC Score	4.75/10	5.55/10
Other ASC Score(s)	N/A	N/A
PPC Score	6.27/14.4	5.51/14.4
BR	0.99	0.89
BCR	1.0153	1.0865
Project Cost	$44,838,100	$15,840,200
Total Project Cost	$60,678,300	

3.35 Prince George Estates

3.35.1 SFA Description

The Prince George Estates and London Bridge at Castleton Commerce Way SFAs are combined into the Prince George Estates project. Individual SFA locations are shown in Figure 39 and are further described below. Both SFAs are hydraulically connected and can be combined into one project.



Figure 39. Location Map of London Bridge Road at Castleton Commerce Way and Prince George Estates SFAs

London Bridge Road at Castleton Commerce Way SFA

London Bridge Road near the intersection of Castleton Commerce Way floods due to undersized pipes and ditches. As shown in Figure 39, the models indicate that London Bridge Road near Castleton Way begins to experience flooding in the 100-year storm event.

Prince George Estates SFA

Prince George Estates neighborhood floods due to undersized pipes. Streets, habitable structures, and private property throughout the neighborhood flood. As shown in Figure 39, the models indicate the Prince George Estates neighborhood begins to experience flooding in the 10-year storm event.

3.35.2 Project Description

This project will redirect runoff from the BMP along London Bridge Road and towards the West Neck Creek tributary adjacent to the neighborhood. New pipes and ditches are proposed throughout and adjacent to the neighborhood to drain water in this direction. Pipes along

London Bridge Road are upsized. Downstream improvements are also proposed to the West Neck Creek tributary to allow for this additional flow from the neighborhood.

3.35.3 Project Benefits

The major benefits of the project include mitigating habitable structure flooding for two structures on Candytuft Court, street flooding throughout the Prince George Estates neighborhood and along London Bridge Road, and flooding occurring on surrounding private property. The project also addresses two flood reports that have been documented in the area. There is a potential cost-sharing opportunity for transmission main prioritization with DPU.

3.35.4 Project Analysis Assumptions

A 50-year LOS is achieved for this project as the peak HGL is higher than the lowest point along multiple neighborhood streets. Modifications to the adjacent areas for storage and conveyance have been maximized, and significant downstream improvements are proposed. Flood depths are less than 3 inches above the crown of the road, are summarized on the 100-year flood map, and will require approval for a reduced LOS from the City Engineer.

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. There is a decrease in street flooding in the 100-year storm event, but it is not completely mitigated. Therefore, the project is given a BR of 0.99. London Bridge Road, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and the 100-year storm event with no SLR.

Several easements are needed for this project, but full property acquisitions are not required. Additionally, it is anticipated that moderate utility relocations will be required due to an existing sanitary sewer pump station, 8-inch gravity sewer main, and 6-inch force main located near the ditch improvements. It is anticipated that moderate maintenance of traffic and utility relocations will be required during the construction of the project in the neighborhood.

Mayberry Drive at London Bridge Road, Pine Ridge and Middle Oaks Plantation, and Prince George Estates are kept separate because the Prince George Estates SFAs can be mitigated without all the Mayberry Drive at London Bridge Road and Pine Ridge and Middle Oaks Plantation improvements. However, the ditch widening improvements south of London Bridge Road are the same in all three projects, and the ditch widening north of London Bridge Road is the same in Mayberry Drive at London Bridge Road and Prince George Estates project. If the Pine Ridge and Middle Oaks Plantation or Mayberry at London Bridge Road projects are constructed first, then the downstream ditch improvements would not need to be constructed as a part of this project. Refer to Section 3.29 for a description of the Mayberry Drive at London Bridge Road and Section 3.34 for a description of the Pine Ridge and Middle Oaks Plantation project.

To be conservative, it is anticipated that significant effort will be required to obtain environmental permits for construction of all ditch improvements, including south of London Bridge Road, as part of this project. However, should the ditch improvements south of London Bridge Road be permitted and constructed first as part of the Pine Ridge and Middle Oaks Plantation project, only minimal effort would be required to permit and construct the ditch improvements north of London Bridge Road. The proposed ditch improvements on the north side of London Bridge Road and the first 1,300 feet downstream of London Bridge Road (3,400 feet total) are located primarily in uplands. Beyond this point, based on site observations in June 2021, wetlands may be present along the ditch approximately 30 feet south of the existing

top of bank. For this reason, an individual permit will likely be required from both USACE and DEQ to widen the existing ditch south of London Bridge Road.

Coordination with the City's VSMP Permit Coordinator is required since flow is being redirected from the BMP south of London Bridge Road (BMP ID: SU2405223201).

3.35.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.35.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.35.7 Project Analysis Summary

Table 46 below provides a summary of the Prince George Estates project analysis. Refer to Appendix B-35 for project exhibits and supporting documentation.

Table 46. Prince George Estates Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	50-year (1.5 feet SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	4.1/10
Other ASC Score(s)	N/A
PPC Score	6.05/14.4
BR	0.99
BCR	1.0 (based on updated model)
Project Cost	$27,797,700

3.36 Princess Anne Place

3.36.1 SFA Description

Princess Anne Place is a small residential area located off Seaboard Road and County Place. The elevations of County Place range from 5 to 5.5 feet, and the elevations of the lots range from 6 to 6.5 feet. The drainage system for this neighborhood is highly sensitive to the 10- and 100-year tailwater elevations due to its proximity to West Neck Creek, which has an HGL of 5.55 and 6.27, respectively, at this location. The current and projected HGL elevations in the downstream channel flood County Place and habitable structures. Significant improvements would need to be made to the West Neck Creek channel. As shown in Figure 40, the models indicate Princess Anne Place begins to experience flooding in the 100-year storm event.

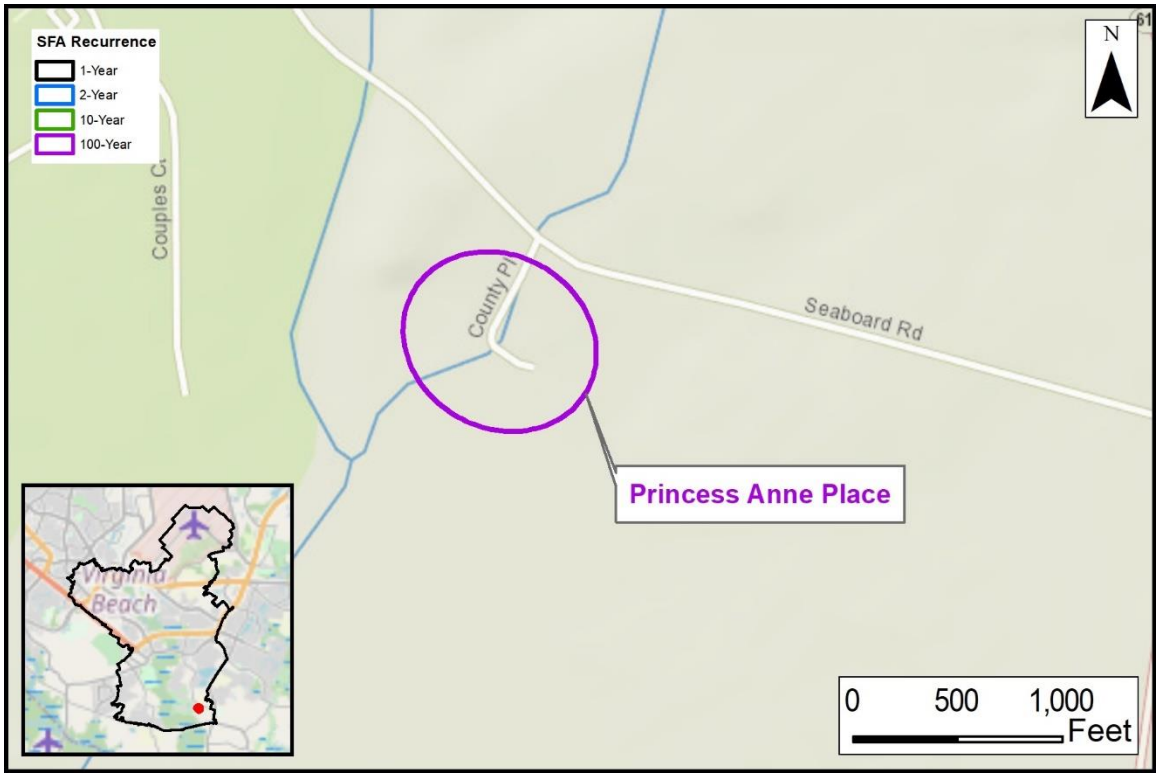


Figure 40. Location Map of Princess Anne Place SFA

3.36.2 Project Description

The downstream tailwater conditions severely limit the options for improvements in this neighborhood. The City will be evaluating this SFA with a Neighborhood Strategy in the future. Refer to Appendix B-36 for the extent of existing flooding in the area.

3.36.3 Project Benefits

There is no project, and there are no benefits.

3.36.4 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.36.5 Other Alternatives Not Scored

This neighborhood would benefit from a neighborhood solution similar to those shown in the SLW Adaptation Strategy Report. This neighborhood can be designed to resolve the flooding issues that occur from a smaller storm event. PW-SWEC will, in the future, have a neighborhood solution created to establish resiliency in this neighborhood.

3.37 Princess Anne Road at Landstown Centre Way

3.37.1 SFA Description

Princess Anne Road, a secondary evacuation route, just south of Dam Neck Road and adjacent to Colonial Grove Memorial Park drains, through a public drainage easement, into a private shopping center (Landstown Commons) and floods due to inadequate pipe sizes and storage. Private property is affected, but no habitable structures. As shown in Figure 41, the models indicate Princess Anne Road at Dam Neck Road begins to experience flooding in the 10-year storm event.

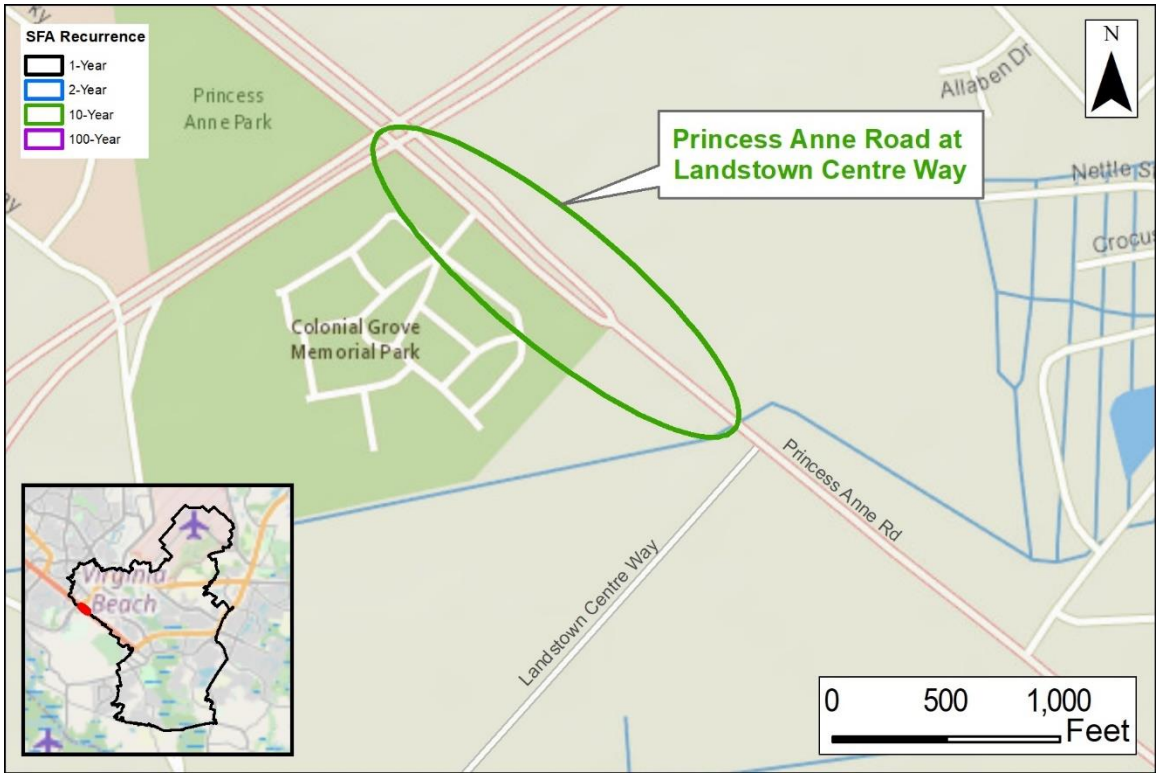


Figure 41. Location Map of Princess Anne Road at Landstown Centre Way SFA

3.37.2 Project Description

This project adds stormwater storage to mitigate flooding. A new BMP is proposed to the southwest of Princess Anne Road on private property (GPIN 14858050780000). Runoff from Princess Anne Road will be redirected into the BMP. The proposed BMP will outfall into the pipe system in the Landstown Commons shopping center.

3.37.3 Project Benefits

The major benefits of the project include mitigating street flooding on Princess Anne Road as well as the flooding occurring on surrounding private property. This project also ensures that Princess Anne Road can effectively serve as a secondary evacuation route.

3.37.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated. Princess

Anne Road, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and the 100-year storm event with no SLR.

Easement acquisition is required for this project. To minimize the amount of property needed, the BMP's size is minimized to meet PWDSM requirements for a passable lane on Princess Anne Road. The BMP will encroach upon the Dominion Energy power easement on the southeastern part of the property. A dry detention basin is assumed to be required as it encroaches within the power easement. Additionally, a 50-foot landscape easement runs in front of the property. According to the plat, the easement is reserved for the owner for landscaping and entrance features. It is assumed that this easement can be used for a stormwater management feature. Coordination with the property owner is required to confirm additional landscaping features that will be installed as part of this project.

It is anticipated that extensive maintenance of traffic will be required during the construction of the project for the construction of pipe along and crossing under Princess Anne Road. Temporary construction access to the cemetery will also be needed for the construction of the BMP. It is anticipated that moderate utility relocations will be required during the construction of the project, and minimal effort will be required to obtain environmental permits. It is assumed that the groundwater elevation is located below the bottom of the BMP based on the apparent water elevations in nearby wet ponds.

3.37.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.37.6 Other Alternatives Not Scored

One additional alternative was considered but not scored. Underground storage was considered under the Landstown Commons shopping center parking lot. However, based on the extent of the construction for this alternative that would be required on private property, it was not modeled or considered any further.

3.37.7 Project Analysis Summary

Table 47 below provides a summary of the Princess Anne Road at Landstown Centre Way project analysis. Refer to Appendix B-37 for project exhibits and supporting documentation.

Table 47. Princess Anne Road at Landstown Centre Way Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	5.6/10
Other ASC Score(s)	N/A
PPC Score	1.54/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$2,850,000

3.38 Princess Anne Road at Mathews Green Road

3.38.1 SFA Description

The Princess Anne Road at General Booth Boulevard and Mathews Green Road at Princess Anne Road SFAs are combined into one project called Princess Anne Road at Mathews Green Road. Individual SFA locations are shown in Figure 42 and are further described below. Both SFAs are hydraulically connected and can be combined into one project.

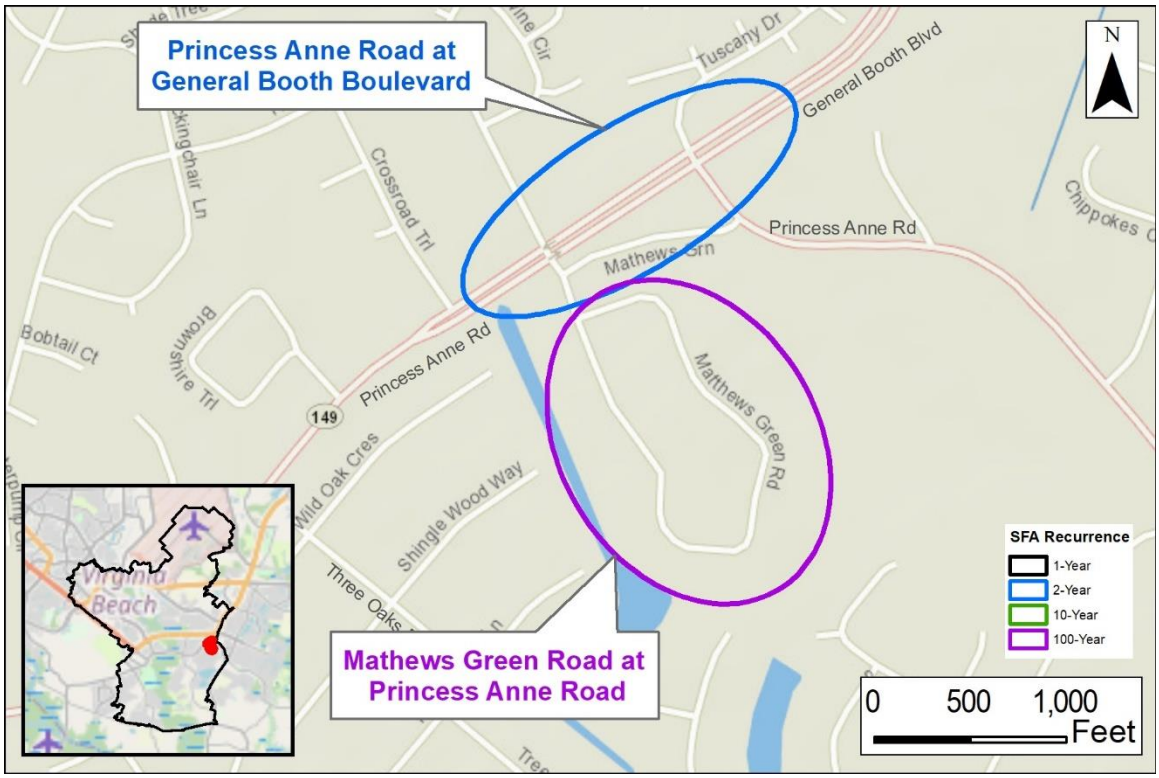


Figure 42. Location Map of Princess Anne Road at General Booth Boulevard and Mathews Green Road at Princess Anne Road SFAs

Mathews Green Road at Princess Anne Road SFA

Mathews Green Road has stormwater infrastructure that currently outfalls through a set of BMPs and then into a downstream channel to the west. The high water elevation in the BMPs minimizes available storage, leading to street flooding in the neighborhood. As shown in Figure 42, the models indicate Mathews Green Road begins to experience flooding in the 100-year storm event.

Princess Anne Road at General Booth Boulevard SFA

Princess Anne Road and General Booth Boulevard experience frequent street flooding due to a lack of storage within the system. Both Princess Anne Road and General Booth Boulevard are secondary evacuation routes. As shown in Figure 42, the models indicate Princess Anne Road and General Booth Boulevard begin to experience flooding in the 2-year storm event.

3.38.2 Project Description

This project will improve the stormwater infrastructure along Princess Anne Road and add stormwater infrastructure along Mathews Green Road to mitigate flooding. Two BMPs will be constructed on City property (Nimmo Park, GPIN 24140530200000) that will outfall to the northern downstream channel. The existing outfall for the BMPs in Mathews Green will be removed, and the pipes' flow direction between the BMPs will be reversed to outfall to the eastern proposed BMP. The downstream condition will be improved by upsizing pipes within Princess Anne Road, Huckleberry Trail, and Rockingchair Lane. These downstream improvements align with the Woodhouse Corner project. Refer to Section 3.63 for a description of the Woodhouse Corner project.

3.38.3 Project Benefits

The major benefits of the project include mitigating street flooding on Mathews Green Road, Princess Anne Road, and General Booth Boulevard, as well as the flooding occurring on surrounding private property. The project also ensures that Princess Anne Road and General Booth Boulevard can effectively serve as secondary evacuation routes. There is a potential cost-sharing opportunity with DPU for a transmission main prioritization.

3.38.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The habitable structure shown as flooding in Appendix B-38 was built in 2016, and the figure was created using LiDAR elevation from 2013. With updated LiDAR elevations from 2018, the structure is no longer flooding. The project is given a BR of 1.0 because all street flooding is mitigated. Princess Anne Road and General Booth Boulevard, as secondary evacuation routes, remain passable in the 10-year storm event with 3.0 feet SLR and the 100-year storm event with no SLR.

Easement acquisition is required from private property to add in proposed pipe connections for the BMPs. The majority of construction and area for the proposed BMPs will occur within the ROW and City property. Moderate maintenance of traffic is anticipated to be required during the construction of the project along Princess Anne Road and General Booth Boulevard. It is anticipated that there will be moderate utility relocations during the construction of the project. Extensive effort will likely be required to obtain environmental permits. USACE and DEQ permits will be required to construct the BMPs in wetlands.

While changes to the original design function of the BMP are not anticipated, coordination with the City’s VSMP Permit Coordinator is required.

This project is not dependent on other projects. However, the downstream culvert improvements on Huckleberry Trail and Rockingchair Lane are consistent with those proposed in the Three Oaks Drive project. Should that project be constructed first, then the downstream culvert improvements would not be required as part of this project. Refer to Section 3.54 for a description of the Three Oaks project.

3.38.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.38.6 Other Alternatives Not Scored

One additional alternative was considered for this project. For Princess Anne Road at General Booth Boulevard, it was considered to upgrade pipes along Princess Anne Road with the

downstream culvert upgrades. This alternative would have limited disturbance to the surrounding natural area. However, it was not considered further since it failed to meet the PWDSM requirements because it did not alleviate flooding on Princess Anne Road and General Booth Boulevard.

3.38.7 Project Analysis Summary

Table 48 below provides a summary of the Princess Anne Road at Mathews Green Road project analysis. Refer to Appendix B-38 for project exhibits and supporting documentation.

Table 48. Princess Anne Road at Mathews Green Road Project Summary

SFA Recurrence	2-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	4.45/10
Other ASC Score(s)	N/A
PPC Score	3.2/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$26,914,000

3.39 Princess Anne Road at North Landing Road

3.39.1 SFA Description

Princess Anne Road and North Landing Road experience flooding due to inadequate pipe sizes and a lack of upstream storage. As shown in Figure 43, the models indicate Princess Anne Road at North Landing Road begins to experience flooding in a 1-year storm event. At least one habitable structure experiences flooding during the 100-year storm event. Princess Anne Road, which is a secondary evacuation route, and North Landing Road also experience flooding.

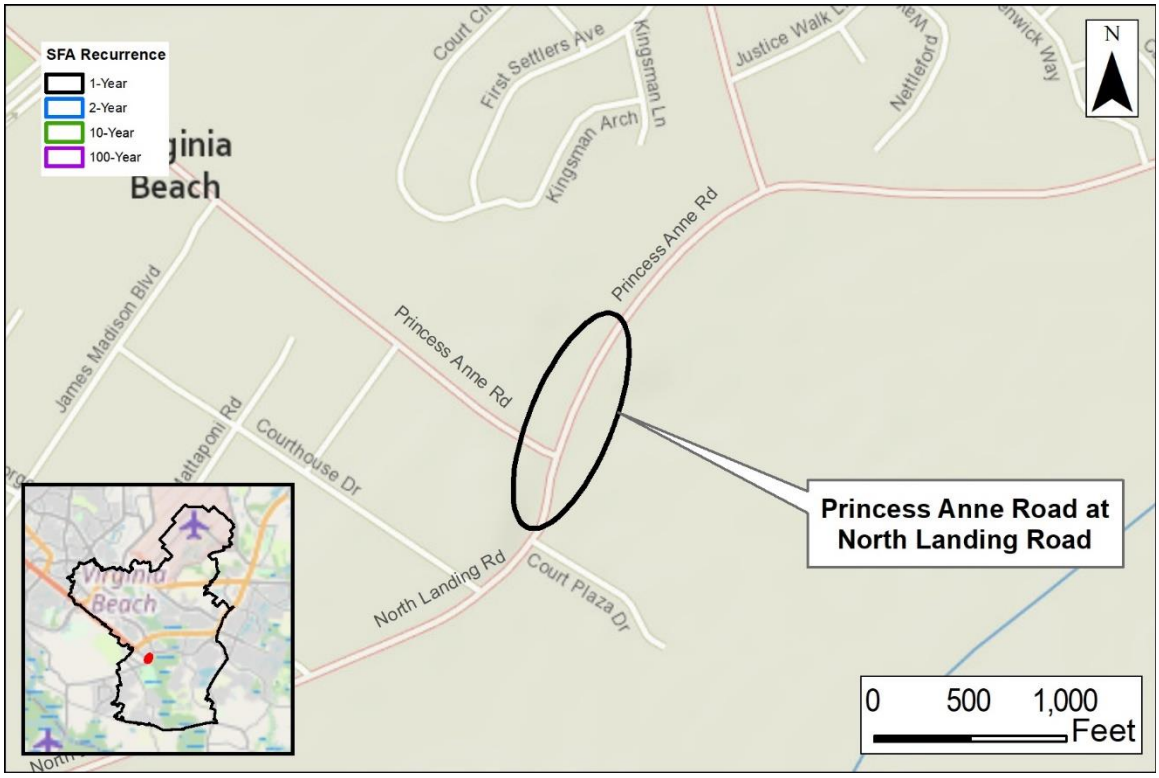


Figure 43. Location Map of Princess Anne Road at North Landing Road SFA

3.39.2 Project Description

This project will add stormwater infrastructure along Princess Anne Road and North Landing Road. A new extended detention BMP will be added at the corner of Princess Anne Road and North Landing Road, which will be constructed on City property (GPIN 14948266580000). The BMP will also provide additional storage for runoff from the Virginia Beach Municipal Center. The pipes crossing Princess Anne Road and North Landing Road will be upsized. The outfall pipe will be removed and replaced with an open channel to allow for additional capacity to West Neck Creek.

3.39.3 Project Benefits

The major benefits of the project include mitigating street flooding on Princess Anne Road and North Landing Road, as well as flooding occurring on the surrounding private property. Flooding is also resolved for one habitable structure. In the proposed condition, both roads will be passable in the 100-year storm event. The project also addresses a flood report in the area.

The project has the highest score of the two alternatives because it requires less extensive land acquisition.

3.39.4 Project Analysis Assumptions

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. The project is given a BR of 1.0 because all street flooding is mitigated. Princess Anne Road, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and the 100-year storm event with no SLR.

An additional property easement is required for this project. The outfall pipe for the system will be replaced with a ditch, and the ditch is within City property. However, a 20-foot-wide maintenance easement is required along both sides of the ditch, which will extend onto the adjoining properties. Additionally, coordination will be required with the adjacent landowner and cellular company to maintain access to the existing cell tower compound. Other options were considered to minimize property acquisition, but they did not relieve flooding on Princess Anne Road, or they required more land acquisition.

The proposed dry storage is on City property that is contained within the Virginia Landmarks Register and the National Register of Historic Places. The location of the dry storage is placed at the low point within City property. It was considered to place the dry storage slightly to the west to limit impacts to trees in the area. However, this location has a higher ground elevation and cannot completely mitigate flooding to meet the PWDSM requirements.

Minor environmental permits are anticipated to extend the channel to Princess Anne Road. There is an abandoned 6-inch force main in the easement where the outfall ditch will be placed. Along Princess Anne Road and North Landing Road, there is an 8-inch sewer line and 16-inch water main. It is anticipated that there will be moderate utility relocations during the construction of the project along Princess Anne Road and North Landing Road.

3.39.5 Other Alternatives Scored

One additional alternative was scored as part of this analysis. Alternative 2 is similar to the selected project since it adds upstream storage and upsizes a pipe crossing North Landing Road. This alternative was explored to minimize upsizing existing pipes and replacing the existing outfall pipe with an open channel. Alternative 2 involves two BMPs on private property in addition to the extended detention BMP collecting runoff from the municipal center proposed in Alternative 1, which would require land acquisition from two separate private landowners.

3.39.6 Other Alternatives Not Scored

One additional alternative was considered but was not scored. To minimize private land acquisition, the alternative considered upsizing the downstream pipes and eliminating one of the BMPs on private property and downstream ditch improvements proposed in Alternative 2. This alternative still included upstream storage on City and private property along with pipe improvements on North Landing Road. This alternative failed to meet the PWDSM requirements since it did not alleviate flooding along North Landing Road. It also was not preferable to have additional land acquisition of private property.

3.39.7 Project Analysis Summary

Table 49 below provides a summary of the Princess Anne Road at North Landing Road project analysis. Refer to Appendix B-39 for project exhibits and supporting documentation.

Table 49. Princess Anne Road at North Landing Road Project Summary

SFA Recurrence	1-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	6.66/10
Other ASC Score(s)	Alternative 2 – 6.13/10
PPC Score	8.4/14.4
BR	1.0
BCR	1.0 (based on updated model)
Project Cost	$1,531,000

3.40 Princess Anne Road at Seaboard Road

3.40.1 SFA Description

Princess Anne Road to the west of the Seaboard Road intersection ranges in elevations from approximately 5 to 5.5 feet. Additionally, Seaboard Road north of the Princess Anne intersection ranges in elevation from 5 to 6 feet. The design tailwater elevation for the 100-year storm event is 5.76 to 5.84 feet in West Neck Creek and floods the streets independent of the existing drainage infrastructure. Additionally, much of this area is located in the FEMA 100-year floodplain. Habitable structures along Princess Anne Road and Seaboard Road also flood. As shown in Figure 44, the models indicate Princess Anne Road at Seaboard Road begins to experience flooding in the 10-year storm event.

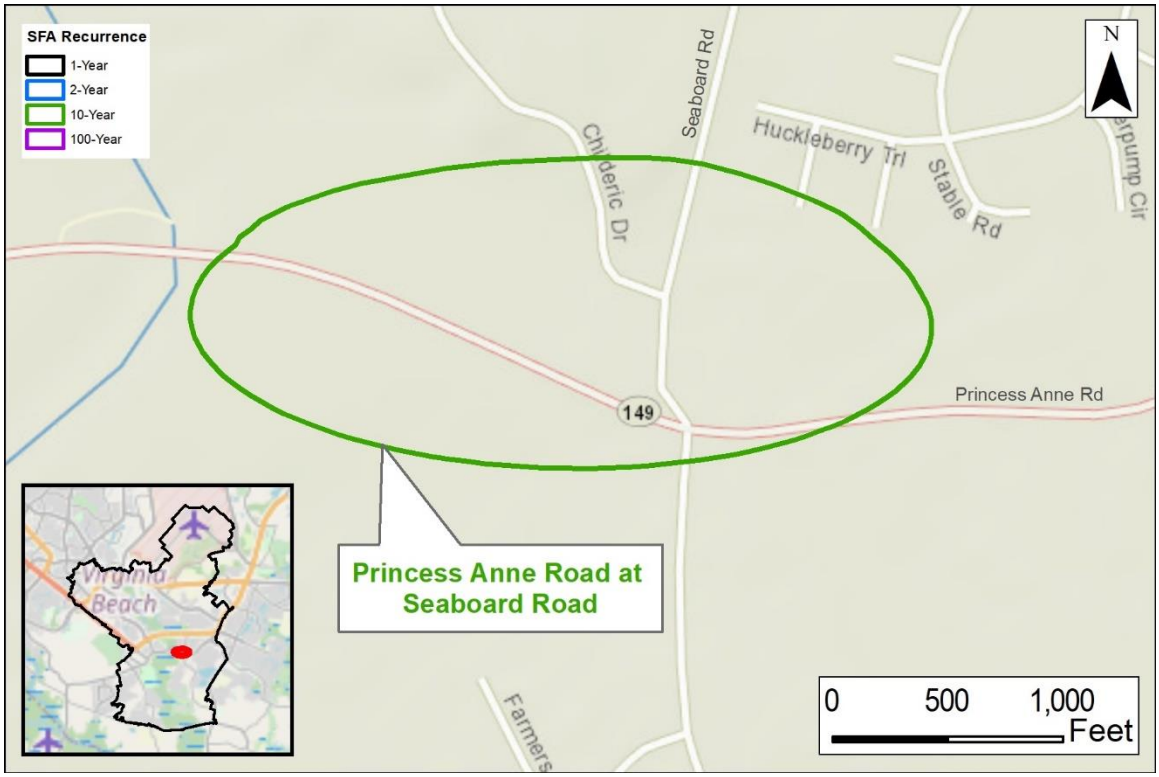


Figure 44. Location Map of Princess Anne Road at Seaboard Road SFA

3.40.2 Project Description

The downstream tailwater conditions severely limit the options for improvements to this neighborhood. The City will be evaluating this SFA with a Neighborhood Strategy in the future. Refer to Appendix B-40 for the extent of existing flooding in the area.

3.40.3 Project Benefits

There is no project, and there are no benefits.

3.40.4 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.40.5 Other Alternatives Not Scored

Elevating Princess Anne Road and Seaboard Road was considered, but this was not considered further as this would still not resolve the adjacent habitable structure flooding.

This SFA would benefit from a neighborhood solution similar to those shown in the SLW Adaptation Strategy Report. This SFA can be designed to resolve the flooding issues that occur from a smaller storm event. PW-SWEC will, in the future, have a neighborhood solution created to establish resiliency in this location.

3.41 Princess Anne Woods

3.41.1 SFA Description

The streets in the Princess Anne Woods neighborhood experience frequent flooding. The NWSE in the BMP in the neighborhood is higher than the invert elevation of the inflow pipes, causing them to be surcharged before the start of the storm event. As shown in Figure 45, the models indicate Princess Anne Woods begins to experience flooding in the 10-year storm event.

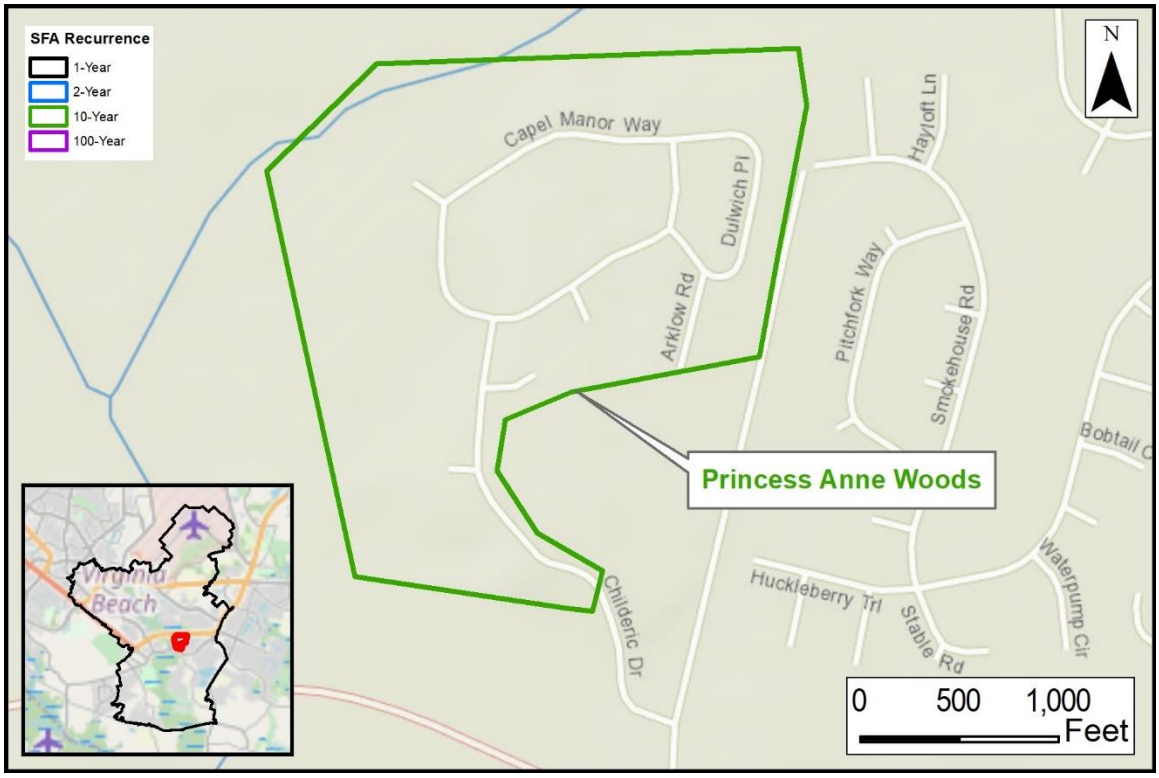


Figure 45. Location Map of Princess Anne Woods SFA

3.41.2 Project Description

This project will improve the existing stormwater infrastructure in Princess Anne Woods and add a new BMP to the neighborhood that will require private property acquisition. The proposed BMP will collect flow from Capel Manor Way, Dulwich Place, and Arklow Road, reducing the flow going to the existing BMP. Two new outfalls will be created. One outfall will be created north of the neighborhood that will outfall into the Hunt Club Tributary floodplain. The second outfall will be created south of the neighborhood along Childeric Road and will outfall into the West Neck Creek floodplain. Pipes that are inadequate throughout the neighborhood will be upsized.

3.41.3 Project Benefits

The major benefits of the project include mitigating street flooding on Capel Manor Way, Dulwich Place, Arklow Road, and Childeric Road. The project also addresses several flood reports that have been documented in the area.

The project has the highest score of the two analyzed alternatives because it does not require the significant operation and maintenance obligations of a stormwater lift station. While private property acquisition is required for the proposed BMP, it does provide additional water quality treatment. This project also required less complex environmental permitting.

3.41.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated.

Princess Anne Woods and Nimmo Parkway at Seaboard Road SFAs are kept separate because the Princess Anne Woods SFA can be mitigated without the Nimmo Parkway at Seaboard Road improvements. However, the downstream ditch is the same in both projects. If the Nimmo Parkway at Seaboard Road project is constructed first, then the downstream improvements as part of this project would not be required. Refer to Section 3.32 for a description of the Nimmo Parkway at Seaboard Road project.

Princess Anne Woods and Seaboard Road at Chloe Lane SFAs are kept separate because the Princess Anne Woods SFA can be mitigated without all the Seaboard Road at Chloe Lane improvements. However, the downstream pipe is the same in both projects. If the Seaboard Road at Chloe Lane project is constructed first, then the downstream improvements as part of this project would not be required. Refer to Section 3.44 for a description of the Seaboard Road and Chloe Lane project.

Multiple property acquisitions will be required for the proposed BMP. The amount of property acquisition is minimized by adding additional outfalls to the system. To reduce the potential conflict with a 4-inch sewer force main, the outfall is piped to the floodplain. It was considered to upsize the current outfall, but this would require expanding the existing drainage easements.

Moderate maintenance of traffic will be required during the construction of the project throughout the neighborhood. It is anticipated that moderate utility relocations will be required during the construction of the project. There are possible conflicts with a 4-inch sewer force main, an 8-inch gravity sewer main, and a 6-inch water main. Minimal effort will likely be required to obtain environmental permits to add outfalls into non-tidal wetlands.

3.41.5 Other Alternatives Scored

One additional alternative was scored as part of this analysis. Alternative 1 is similar to the selected project because it improved the existing infrastructure by upsizing numerous pipes throughout the neighborhood. Instead of a proposed BMP, Alternative 1 created more storage in the system with a 300 cfs stormwater lift station for the existing BMP to lower the elevation of the water during the 100-year storm event. This alternative would require less property acquisition but needs more extensive operation and maintenance activities, would have a higher cost, and more environmental permitting.

3.41.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.41.7 Project Analysis Summary

Table 50 below provides a summary of the Princess Anne Woods project analysis. Refer to Appendix B-41 for project exhibits and supporting documentation.

Table 50. Princess Anne Woods Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 2
ASC Score	4.23/10
Other ASC Score(s)	Alternative 1 – 3.49/10
PPC Score	1.18/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$16,620,000

3.42 Rollingwood

3.42.1 SFA Description

The Rollingwood neighborhood is located northeast of the Holland Road and Nimmo Parkway intersection. Rollingwood floods due to inadequate stormwater storage and undersized pipes throughout the neighborhood. As shown in Figure 46, the models indicate Rollingwood begins to experience flooding in the 1-year storm event.

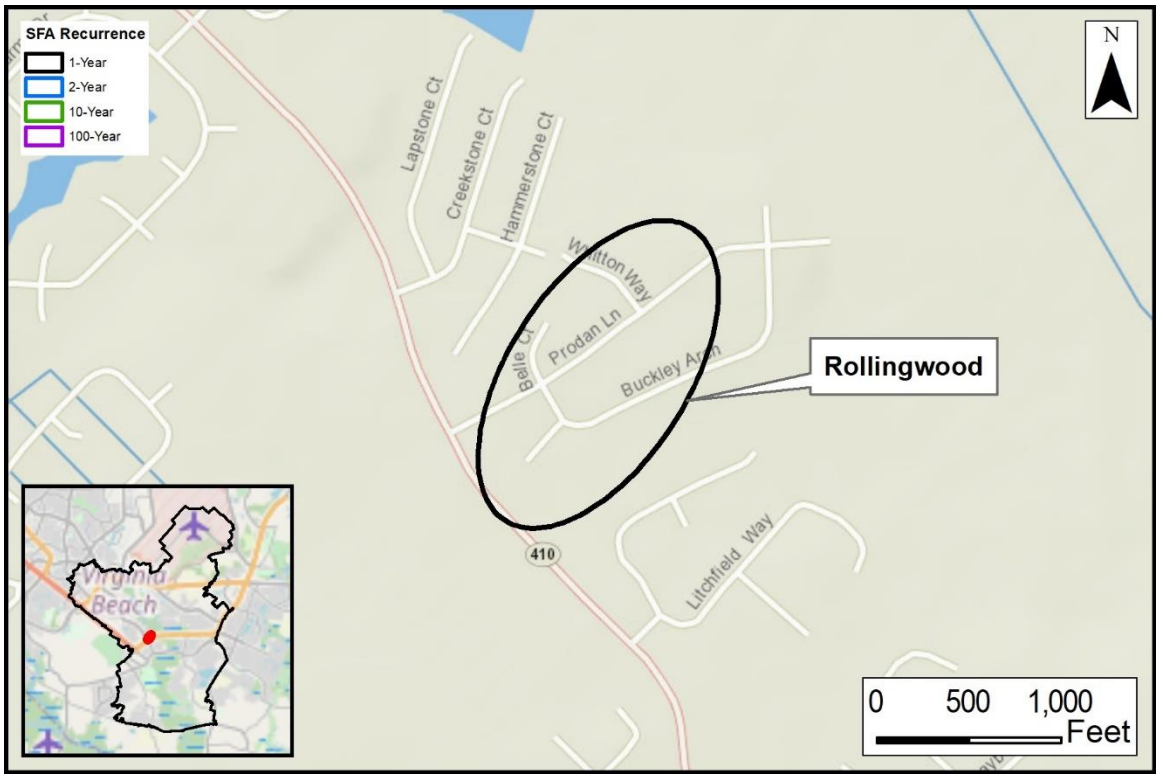


Figure 46. Location Map of Rollingwood SFA

3.42.2 Project Description

This project will add three additional outfalls that will bypass the existing undersized stormwater BMP to relieve flooding throughout the neighborhood. Two new outfalls are proposed north of Whitton Way. Another outfall is proposed east of the corner of Buckley Arch and Griggs Court. The existing outfall on Prodan Lane is upsized to increase capacity, and pipes are proposed to direct runoff away from the pond. A small portion of Riner Court will be raised to provide a passable street.

3.42.3 Project Benefits

The major benefits of the project are mitigating habitable structure flooding on Buckley Arch, Belle Court, and Whitton Way, as well as street flooding throughout the neighborhood. Habitable structure flooding is resolved for 24 structures. The project also addresses several flood reports that have been documented in the area, and there is a potential cost-sharing opportunity with DPU for transmission main prioritization.

3.42.4 Project Analysis Assumptions

HAZUS data is available for the habitable structures along Buckley Arch, Belle Court, and Whitton Way. The structures no longer flood in the 100-year storm event. Based on the BCR methodology, the project BCR is 1.0788. The project is given a BR of 1.0 because all street flooding is mitigated.

New easements are required for this project to create new outfalls. The number of easements is minimized to the extent possible. It is anticipated that moderate utility relocations will be required during the construction of the project, and minimal effort will be required to obtain environmental permits.

While changes to the original design function of the BMP are not anticipated, coordination with the City's VSMP Permit Coordinator is required. Water will be directed away from the original stormwater BMP to new outfalls as part of the design. It is assumed that the water quality storm can still be diverted to the BMP.

Rollingwood and Holland Woods projects are kept separate because the Rollingwood SFA can be mitigated without all of the Holland Woods improvements. However, the 30-inch pipe across Whitton Way is the same in both projects. If the Holland Woods project is constructed first, then the 30-inch pipe across Whitton Way as part of this project would not be required. Refer to Section 3.20 for a description of the Holland Woods project.

3.42.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.42.6 Other Alternatives Not Scored

One additional alternative was considered but was not scored. To minimize the extent of the pipe improvements throughout the neighborhood, expanding the existing stormwater BMP was considered. However, significantly more storage would be required. Based on the proximity of the houses, significant property acquisition would be required, and the alternative did not meet PWDSM standards. The alternative was not considered any further.

3.42.7 Project Analysis Summary

Table 51 below provides a summary of the Rollingwood project analysis. Refer to Appendix B-42 for project exhibits and supporting documentation.

Table 51. Rollingwood Project Summary

SFA Recurrence	1-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	4.4/10
Other ASC Score(s)	N/A
PPC Score	7.2/14.4
BR	1.0
BCR	1.0788
Project Cost	$10,972,000

3.43 Saville Garden Way at Holland Road

3.43.1 SFA Description

The Bernard Farms and Greenwood SFAs are combined into one project called Saville Garden Way at Holland Road. Individual SFA locations are shown in Figure 47 and are further described below. The two SFAs are hydraulically connected and can be combined into one project.

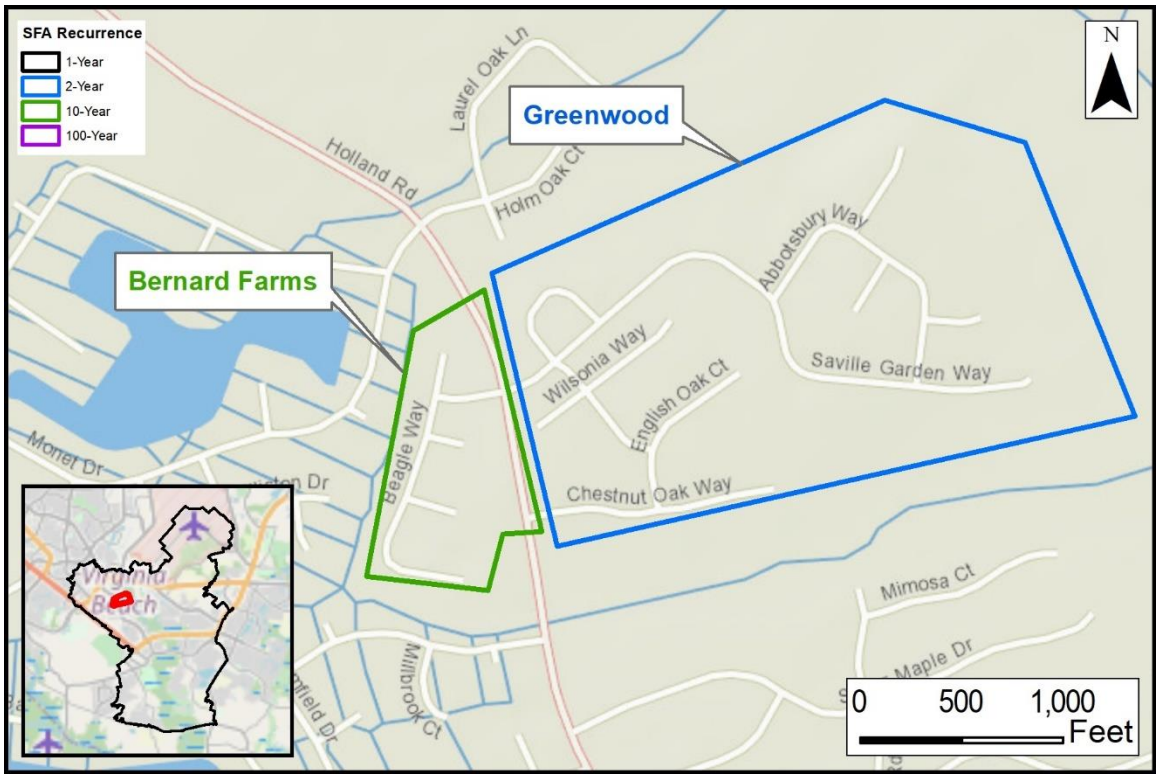


Figure 47. Location Map of Bernard Farms and Greenwood SFAs

Bernard Farms SFA

Habitable structures, private property, and streets within the Bernard Farms neighborhood experience flooding due to a lack of storage and inadequate pipes. The low point within the neighborhood is at the same elevation as the HGL downstream in West Neck Creek. As shown in Figure 47, the models indicate Bernard Farms begins to experience flooding in the 10-year storm event.

Greenwood SFA

Streets and private property experience flooding in the Greenwood neighborhood due to a lack of storage, and the existing stormwater infrastructure is inadequate. The FEMA 100-year floodplain surrounds the neighborhood to the north, east, and south. As shown in Figure 47, the models indicate Greenwood begins to experience flooding in the 2-year storm event.

3.43.2 Project Description

This project will add a new BMP to provide more storage to the system. A new outfall will be created for the proposed BMP to provide more immediate relief for Bernard Farms. Inadequate pipes throughout both neighborhoods will be upsized. Additionally, flow from Saville Garden Way will be diverted to an upsized ditch in the northeast corner of the neighborhood. Runoff will be directed to the southern ditch with proposed pipe outfalls along Chestnut Oak Way and Saville Garden Way.

3.43.3 Project Benefits

The major benefits of the project include mitigating habitable structure flooding in the 100-year storm. There are 7 habitable structures on May Court and 2 habitable structures along Beagle Way that experience flooding in existing conditions, which is mitigated in the proposed conditions. Additionally, street flooding and private property flooding along Beagle Way, Saville Garden Way, Wilsonia Way, English Oak Court, and Chestnut Oak Way are reduced in the 100-year and resolved in the 10-year storm event. The project also addresses several flood reports that have been documented in the area.

3.43.4 Project Analysis Assumptions

Given the proximity of the neighborhood to the 100-year floodplain as described above and the associated tailwater influence on the 100-year design of drainage improvements, a 10-year LOS is achieved for this project. This is necessary as the peak HGL within West Neck Creek is higher than the lowest point of some neighborhood streets. Flood depths are less than 6 inches above the crown of the road, are summarized on the 100-year flood map, and will require approval for a reduced LOS from the City Engineer.

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. There is a decrease in street flooding in the 100-year storm event, but it is not completely mitigated. Therefore, the project is given a BR of 0.91.

Property acquisition will be required from multiple private landowners to add a BMP. Easement acquisition will be required for pipe and ditch improvements. It is anticipated that moderate maintenance of traffic will be required during the construction of the project along Holland Road and the residential streets. Moderate utility relocations are anticipated to be required during the construction of the project. In Bernard Farms, conflicts are likely with 8-inch and 16-inch waterlines, 8-inch sewer force main, and 8-inch gravity sewer line. In Greenwood, utility conflicts are anticipated with 10-inch water lines and 8-inch gravity sewer and force mains. It is anticipated that moderate effort will be required to obtain environmental permits to expand a ditch through non-tidal wetlands.

Runoff is required to be diverted away from existing BMPs to meet PWDSM requirements. It is assumed that the additional BMP will offset changes to the original design function of the existing BMPs. Coordination with the City's VSMP Permit Coordinator is required.

3.43.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.43.6 Other Alternatives Not Scored

One additional alternative was considered to improve the LOS but was not scored. In addition to the improvements proposed, this alternative would create floodplains along the outfall channels north and south of Greenwood to add additional storage to the system. The proposed

floodplains would be utilized by maintaining the existing channel while reducing the top of bank elevation from approximately 6 feet to 2 feet. This reduces the HGL within the outfall channels but failed to meet the PWDSM requirements since there was still street flooding in the 100-year storm event. It also would require extensive environmental permitting to create floodplains in nontidal wetlands. Due to these reasons, the alternative was not considered further.

3.43.7 Project Analysis Summary

Table 52 below provides a summary of the Saville Garden Way at Holland Road project analysis. Refer to Appendix B-43 for project exhibits and supporting documentation.

Table 52. Saville Garden Way at Holland Road Project Summary

SFA Recurrence	2-year (no SLR)
Project LOS	10-year (1.5 feet SLR)
Selected Alternative	Alternative 1
ASC Score	4.43/10
Other ASC Score(s)	N/A
PPC Score	6.01/14.4
BR	0.91
BCR	1.0 (based on updated model)
Project Cost	$12,272,700

3.44 Seaboard Road and Chloe Lane

3.44.1 SFA Description

The Chloe Lane at Childeric Road and Seaboard Road at Huckleberry Trail SFAs are combined into one project called Seaboard Road and Chloe Lane. Individual SFA locations are shown in Figure 48 and are further described below. The two SFAs are hydraulically connected and can be combined into one project.

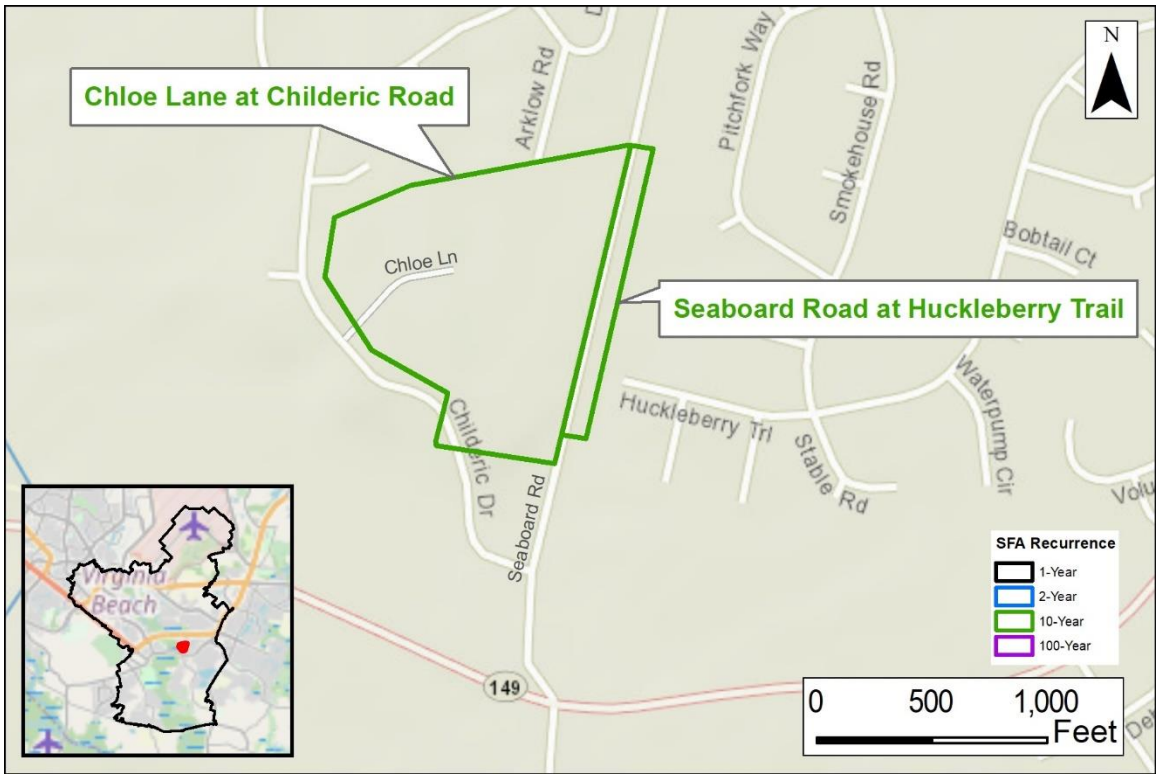


Figure 48. Location Map of Chloe Lane at Childeric Road and Seaboard Road at Huckleberry Trail SFAs

Chloe Lane at Childeric Road SFA

Chloe Lane at Childeric Road experiences street flooding and private property flooding due to an inverted outfall pipe on the BMP and not enough storage upstream. As shown in Figure 48, the models indicate Chloe Lane begins to experience flooding in the 10-year storm event.

Seaboard Road at Huckleberry Trail SFA

Seaboard Road at Huckleberry Trail experiences street flooding and private property flooding due to a lack of upstream storage. As shown in Figure 48, the models indicate Seaboard Road begins to experience flooding in the 10-year storm event.

3.44.2 Project Description

This project will expand the existing BMP behind Childeric Road and Chloe Lane from a 0.2-acre BMP to a 1.4-acre BMP. Some of the drainage from Seaboard Road will be diverted into the expanded BMP. An additional inflow pipe is created from Chloe Lane into the expanded

BMP to allow more flow into the BMP. A second outfall is also created that discharges into the floodplain south of Childeric Road to minimize disturbance to residential parcels.

3.44.3 Project Benefits

The major benefits of the project include mitigating street flooding on Chloe Lane and Seaboard Road, as well as the flooding occurring on surrounding private property and one habitable structure. The project also addresses several flood reports that have been documented in the area.

3.44.4 Project Analysis Assumptions

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. The project is given a BR of 1.0 because all street flooding is mitigated.

Seaboard Road at Chloe Lane and Princess Anne Woods are kept separate because the Seaboard Road at Chloe Lane SFA can be mitigated without all the Princess Anne Woods improvements. However, the downstream pipe is the same in both projects. If the Princess Anne Woods project is constructed first, then the downstream improvements as part of this project would not be required. Refer to Section 3.41 for a description of the Princess Anne Woods project.

Easement acquisition will be required to expand the existing BMP and pipe improvements. The pipes and the expanded BMP locations avoid conflicts with habitable structures and the cemetery on Childeric Road. It is anticipated that minimal maintenance of traffic will be required during the construction of the project along Seaboard Road. Moderate utility relocations will be required during the construction of the project, likely including the 8-inch gravity sewer line and 8-inch water line along Childeric Road. Additionally, along Seaboard Road, a 12-inch water line, 8-inch gravity sewer line, and 10-inch sewer force main. Minimal effort will likely be required to obtain environmental permits to add an outfall into nontidal wetlands.

3.44.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.44.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.44.7 Project Analysis Summary

Table 53 below provides a summary of the Seaboard Road and Chloe Lane project analysis. Refer to Appendix B-44 for project exhibits and supporting documentation.

Table 53. Seaboard Road and Chloe Lane Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	5.74/10
Other ASC Score(s)	N/A
PPC Score	5.88/14.4
BR	1.0
BCR	1.0 (based on updated model)
Project Cost	$5,458,800

3.45 Seaboard Road at County Place

3.45.1 SFA Description

Seaboard Road experiences flooding due to a lack of storage upstream and inadequate pipes downstream. As shown in Figure 49, the models indicate Seaboard Road at County Place begins to experience flooding in the 10-year storm event.

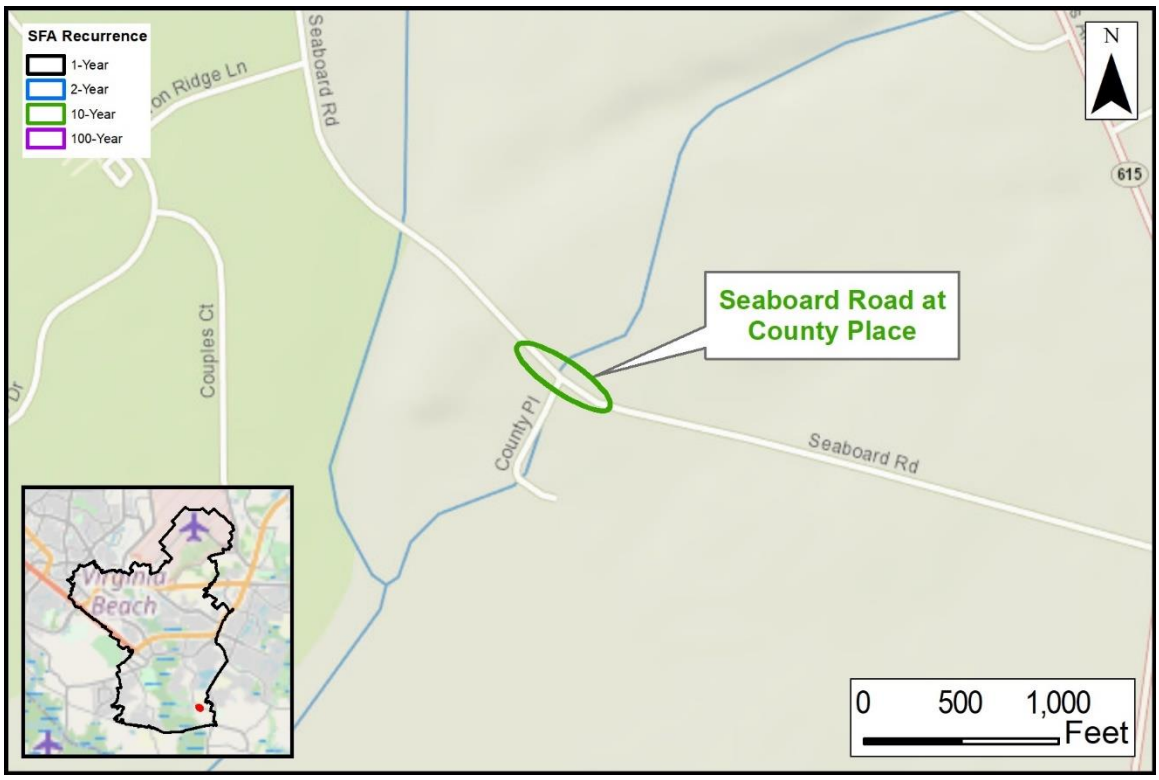


Figure 49. Location Map of Seaboard Road at County Place SFA

3.45.2 Project Description

This project will improve the existing stormwater infrastructure along Seaboard Road and County Place. The ditch along Seaboard Road will be expanded, and the downstream pipes along County Place will be upsized.

3.45.3 Project Benefits

The major benefit of the project is mitigating street flooding on Seaboard Road.

3.45.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated.

Easement acquisition will be required to expand the ditch along Seaboard Road. To minimize the amount of easement acquisition, the downstream pipe system will be improved. It is anticipated that minimal maintenance of traffic will be required for the construction of the project along Seaboard Road and County Place. Environmental permitting is not anticipated.

3.45.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.45.6 Other Alternatives Not Scored

One alternative considered sending water northwest with pipe or ditch improvements along Seaboard Road to the tributary stream for West Neck Creek. Based on the vertical profile along Seaboard Road, ditch improvements are not recommended as the required depth and width needed to tie into the tributary stream for West Neck Creek would require significant easement acquisition from the adjacent properties. A proposed pipe system would be more feasible, but parallel pipes would likely be required to convey the required flow given the vertical constraints. These improvements would be much more extensive than those currently proposed along County Place. As the proposed ditch improvements for Seaboard Road provide enough upstream storage to reduce the HGL along County Place, more extensive improvements along Seaboard Road were not considered further.

Another alternative was considered to raise Seaboard Road at this location. However, County Place is already over 4 feet lower in grade than Seaboard Road. To resolve the flooding along Seaboard Road, the road would need to be raised an additional foot, which was not desirable for the County Place neighborhood, so this alternative was not considered further.

3.45.7 Project Analysis Summary

Table 54 below provides a summary of the Seaboard Road at County Place project analysis. Refer to Appendix B-45 for project exhibits and supporting documentation.

Table 54. Seaboard Road at County Place Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	5.01/10
Other ASC Score(s)	N/A
PPC Score	1.18/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$1,447,500

3.46 Seaboard Road at Heron Ridge Lane

3.46.1 SFA Description

The Seaboard Road at Heron Ridge Golf Club and Seaboard Road at Golfwatch Lane SFAs are combined into one project called Seaboard Road at Heron Ridge Lane. The individual SFA locations are shown in Figure 50 and are further described below. After scoring the individual SFAs, it was determined the projects could be combined since they included similar solutions and are located near each other.

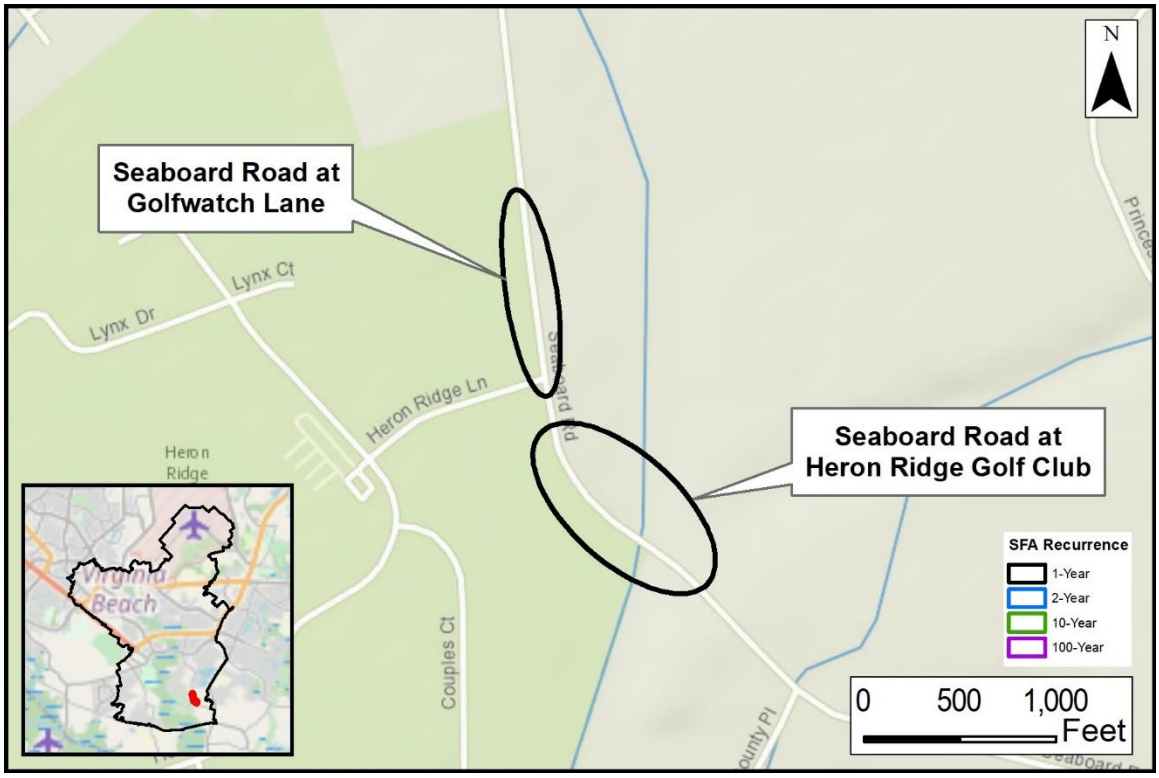


Figure 50. Location Map of Seaboard Road at Heron Ridge Golf Club and Seaboard Road at Golfwatch Lane SFAs

Seaboard Road at Heron Ridge Golf Club SFA

Seaboard Road frequently floods where a tributary stream for West Neck Creek flows under the road. The current culverts are inadequate, causing the road to overtop and habitable structures to flood upstream of the culvert. As shown in Figure 50, the models indicate Seaboard Road begins to experience flooding in the 1-year storm event.

Seaboard Road at Golfwatch Lane SFA

As shown in Figure 50, Seaboard Road floods from Golfwatch Lane south to the tributary stream crossing during the 1-year storm event. The pipes and ditches along Seaboard Road are inadequate. At the north end of the SFA, there is a lack of stormwater infrastructure.

3.46.2 Project Description

This project will add stormwater infrastructure along Seaboard Road to mitigate flooding. A proposed pipe will cross Seaboard Road at the intersection of Golfwatch Lane and connect with

a proposed ditch that will outfall into the tributary channel. Pipes at the intersection of Heron Ridge Lane and Seaboard Road will be upsized, and the ditch along Seaboard Road will be widened. The culverts at the South end of the SFA, where the tributary crosses Seaboard Road, will be replaced with dual 8-foot by 4-foot box culverts.

3.46.3 Project Benefits

The major benefits of the project include mitigating street flooding on Seaboard Road, as well as the flooding occurring on surrounding private property. The flooding of two habitable structures is resolved.

3.46.4 Project Analysis Assumptions

Seaboard Road at Heron Ridge Golf Club SFA and Seaboard Road at Golfwatch Lane SFA were both considered separately before ultimately being combined into one project. The one alternative considered for Seaboard Road at Heron Ridge Golf Club requires ditch improvements along Seaboard Road. The alternative for Seaboard Road at Golfwatch Lane with the higher ASC score also requires ditch improvements along Seaboard Road. Since both alternatives include the same ditch improvements, they are combined into one project, Seaboard Road at Heron Ridge Lane.

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. The project is given a BR of 1.0 because all street flooding is mitigated.

One easement will be required in-between residential structures at the north end of the SFA. Also, the ditch improvements along Seaboard Road will require the acquisition of an easement since the proposed ditch and required maintenance access will encroach outside the existing ROW.

There are utility conflicts at the north end of the project at the intersection of Golfwatch Lane and Seaboard Road. Along Seaboard Road, there is a 10-inch water main and a 2.5-inch sewer force main. There is also a 10-inch water main line along Heron Ridge Lane.

It is anticipated that moderate effort will be required to obtain environmental permits from DEQ and USACE to modify the culvert and ditch. Moderate maintenance of traffic will need to be provided for Seaboard Road and Heron Ridge Lane.

3.46.5 Other Alternatives Scored

One additional alternative was scored as part of this analysis for Seaboard Road at Golfwatch Lane. This alternative included two culverts crossing Seaboard Road and then flowing east into proposed ditches before reaching the tributary stream for West Neck Creek. This alternative would have minimized pipe and ditch improvements along Seaboard Road. However, there would be more property acquisition from private landowners, which is why this alternative scores lower than the selected alternative.

3.46.6 Other Alternatives Not Scored

An additional alternative was considered but was not scored. A BMP was added north of Golf Watch Lane on private property. The proposed BMP outfalls to a 30-inch pipe to the downstream system. The existing 12-inch and 15-inch pipes at the intersection of Heron Ridge Lane and Seaboard Road were upsized to 30-inch pipes, which would require minor roadside

ditch improvements to meet the proposed pipe inverts. However, this alternative failed to meet the PWDSM requirements as Seaboard Road was still flooding.

3.46.7 Project Analysis Summary

Table 55 below provides a summary of the Seaboard Road at Heron Ridge Lane project analysis. Refer to Appendix B-46 for project exhibits and supporting documentation.

Table 55. Seaboard Road at Heron Ridge Lane Project Summary

SFA Recurrence	1-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	4.8/10
Other ASC Score(s)	Alternative 2- 4.66/10
PPC Score	7.3/14.4
BR	1.0
BCR	1.0 (based on updated model)
Project Cost	$1,486,300

3.47 Signature Circle

3.47.1 SFA Description

The Einstein Drive and Willowlawn Way and Signature Drive at Wilderness Lane SFAs are combined into the Signature Circle project. Individual SFA locations are shown in Figure 51 and are further described below. Both SFAs are hydraulically connected and can be combined into one project.

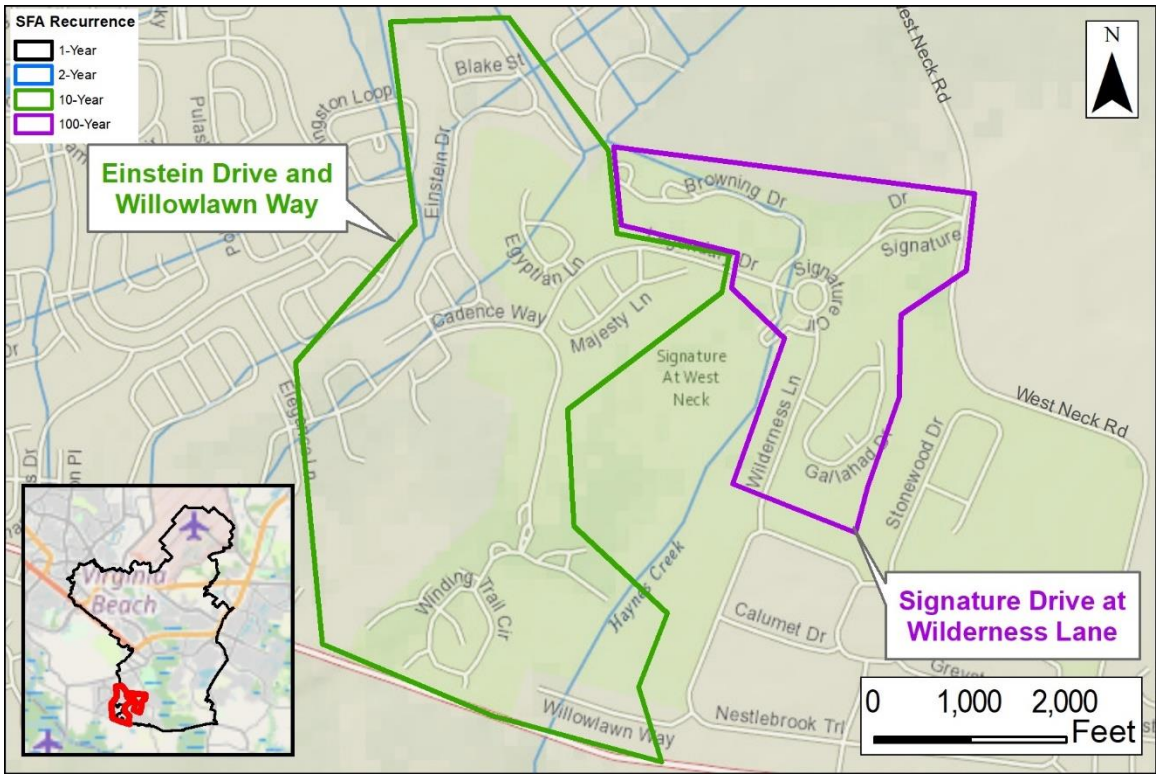


Figure 51. Location Map of Einstein Drive and Willowlawn Way and Signature Drive at Wilderness Lane SFAs

Einstein Drive and Willowlawn Way SFA

Einstein Drive and Willowlawn Way flood due to a lack of conveyance capacity due to undersized outlet pipes from an interconnected pond system. The area experiences flooding on neighborhood streets and private property. As shown in Figure 51, the models indicate Einstein Drive and Willowlawn Way begins to experience flooding in the 10-year storm event.

Signature Drive at Wilderness Lane SFA

Signature Drive at Wilderness Lane floods due to a lack of conveyance capacity due to undersized pipes within an interconnected pond system and a lack of stormwater storage. The area experiences flooding on neighborhood streets, private property, and two habitable structures. As shown in Figure 51, the models indicate Signature Drive at Wilderness Lane begins to experience flooding in a 100-year storm event.

3.47.2 Project Description

This project proposes to increase conveyance capacity by improving outlet structures and adding conveyance ditches between ponds to allow more stormwater conveyance from the system. An existing BMP will be expanded, and a new BMP is proposed to add stormwater storage. The addition of more stormwater infrastructure is proposed throughout the neighborhood to improve conveyance from the streets and into the stormwater system.

3.47.3 Project Benefits

The major benefits of this project include mitigating street flooding within the area, as well as the flooding occurring on surrounding private property. Another benefit includes mitigating habitable structure flooding on Egyptian Lane and Longworth Court for two structures. The project also addresses several flood reports that have been documented in the area.

3.47.4 Project Analysis Assumptions

A 50-year LOS is achieved for this project as the available storage areas, and downstream improvements have been maximized within the constraints of preserving the existing golf course. Flood depths are less than 3 inches above the crown of the road, are summarized on the 100-year flood map, and will require approval for a reduced LOS from the City Engineer.

HAZUS data is available for the habitable structures along Egyptian Lane and Longworth Court. The structures no longer flood in the 100-year storm event. Based on the BCR methodology, the project BCR is 1.0081. There is a decrease in street flooding in the 100-year storm event, but it is not completely mitigated. Therefore, the project is given a BR of 0.95.

Easement acquisition is required to expand an existing BMP and to construct a proposed BMP. Multiple easements are required for upsized or new stormwater infrastructure. It is anticipated that moderate maintenance of traffic and utility relocations will be required during the construction of the project. It is anticipated that minimal effort will be required to obtain environmental permits.

3.47.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.47.6 Other Alternatives Not Scored

One additional alternative was considered but was not scored. The alternative considered converting sections of the existing golf course into areas that could provide more stormwater storage. This alternative was not preferable because it removed sections of a golf course that could be functional in the future.

3.47.7 Project Analysis Summary

Table 56 below provides a summary of the Signature Circle project analysis. Refer to Appendix B-47 for project exhibits and supporting documentation.

Table 56. Signature Circle Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	50-year (1.5 feet SLR)
Selected Alternative	Alternative 1
ASC Score	5.05/10
Other ASC Score(s)	N/A
PPC Score	5.75/14.4
BR	0.95
BCR	1.0081
Project Cost	$44,313,700

3.48 South Rosemont Road at Buckner Boulevard

3.48.1 SFA Description

South Rosemont Road is a secondary evacuation route that experiences flooding due to inadequate storage in the area. As shown in Figure 52, the models indicate South Rosemont Road at Buckner Boulevard begins to experience flooding in the 100-year storm event.

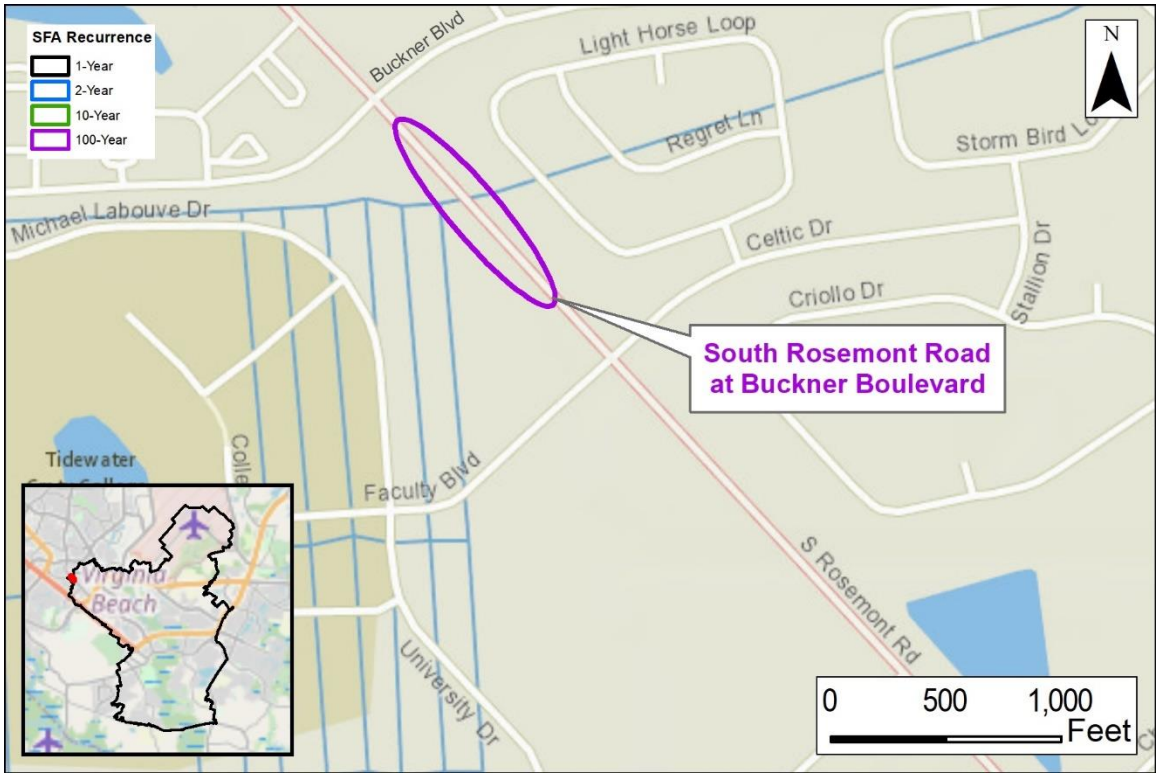


Figure 52. Location Map of South Rosemont Road at Buckner Boulevard SFA

3.48.2 Project Description

This project will raise South Rosemont Road above the 100-year flood elevation. The road will be raised approximately 1 foot to resolve the flooding.

3.48.3 Project Benefits

The major benefits of the project include mitigating flooding on South Rosemont Road and ensuring that South Rosemont Road can effectively serve as a secondary evacuation route. There is a potential cost-sharing opportunity as CIP 2-038 (South Rosemont Road Phase V) improvements are proposed in this area.

3.48.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated. South Rosemont Road, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and 100-year storm event with no SLR.

In accordance with the methodology documented in Section 2, the potential future improvements associated with South Rosemont Road Phase V were not considered in the

development of the alternatives. Coordination is recommended to determine if the improvements recommended as part of this project can be incorporated into the South Rosemont Phase V improvements.

Property acquisition is not required as all the construction will occur within the ROW or City property. It is anticipated that moderate maintenance of traffic will be required during the construction of the project along South Rosemont Road.

While the project is not dependent on any other projects, the extent of the roadway improvements could be reduced if the Buckner Farms Phase 2A: Light Horse Loop and Storm Bird Loop phase of the Buckner Farms project is completed. These improvements would decrease the amount the road needs to be raised by approximately 6 inches.

3.48.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.48.6 Other Alternatives Not Scored

It was also considered to add additional storage along South Rosemont Road. Since South Rosemont Road is being improved, it was not preferred to redesign the roadway and drainage, so this was not considered further.

3.48.7 Project Analysis Summary

Table 57 below provides a summary of the South Rosemont Road at Buckner Boulevard project analysis. Refer to Appendix B-48 for project exhibits and supporting documentation.

Table 57. South Rosemont Road at Buckner Boulevard Project Summary

SFA Recurrence	100-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	7.65/10
Other ASC Score(s)	N/A
PPC Score	0.1/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$1,873,100

3.49 South Rosemont Road at Concert Drive

3.49.1 SFA Description

All lanes of Concert Drive are flooding at the intersection of South Rosemont Road. There is a raised grassed median in the middle of the road that is clear during the 100-year storm event. As shown in Figure 53, the models indicate South Rosemont Road at Concert Drive begins to experience flooding in the 100-year storm event.

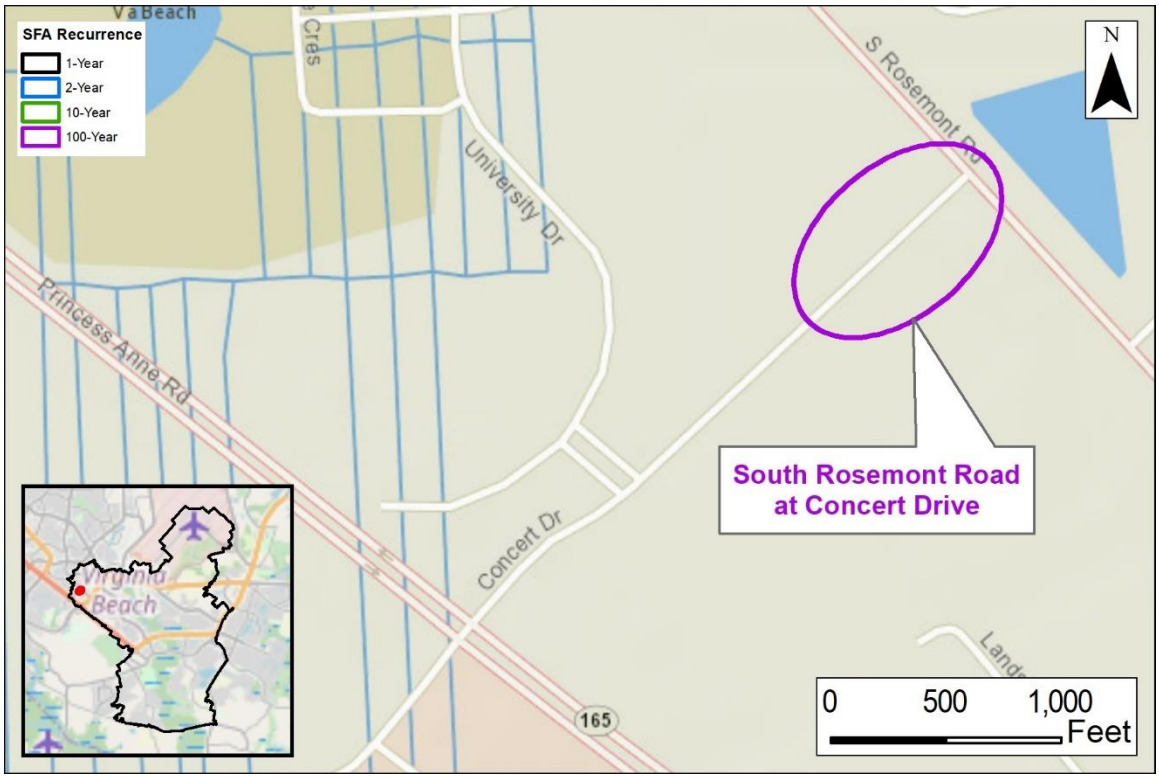


Figure 53. Location Map of South Rosemont Road at Concert Drive SFA

3.49.2 Project Description

This project will remove the raised grass median on Concert Drive for the length of the southwest turn lane. The raised median will be replaced with a striped median to allow for a passable lane without further improvements.

3.49.3 Project Benefits

The major benefits of the project include mitigating street flooding on Concert Drive and minimizing disturbance to the area. There is a potential cost-sharing opportunity with Rosemont Road Phase V and DPU for transmission main prioritization.

3.49.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated. Property acquisition is not required as all the construction will occur within City ROW. It is anticipated that moderate maintenance of traffic will be required during the construction of the project, and no utility relocations will be required during the construction of the project. Environmental permitting will not be required.

3.49.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.49.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.49.7 Project Analysis Summary

Table 58 below provides a summary of the South Rosemont Road at Concert Drive project analysis. Refer to Appendix B-49 for project exhibits and supporting documentation.

Table 58. South Rosemont Road at Concert Drive Project Summary

SFA Recurrence	100-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	7.27/10
Other ASC Score(s)	N/A
PPC Score	0.07/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$155,000

3.50 Springhaven Drive at Windy Pines Bend

3.50.1 SFA Description

The southern end of the Castleton neighborhood, defined by Farmworth Trail, Springhaven Drive, Wallington Way, and Edmonton Drive is low-lying, with road elevations ranging from 5 to 6 feet along Springhaven Drive to 8 to 9 feet along Wallington Way. The design tailwater elevation for the 100-year storm event is 6.19 feet in West Neck Creek near Springhaven Drive and 8.5 to 9 feet near Wallington Way. Much of this area is located adjacent to or within the FEMA 100-year floodplain. The tailwater elevations, independent of the existing drainage infrastructure, flood the streets. As shown in Figure 54, the models indicate streets begin to experience flooding in the 10-year storm event.

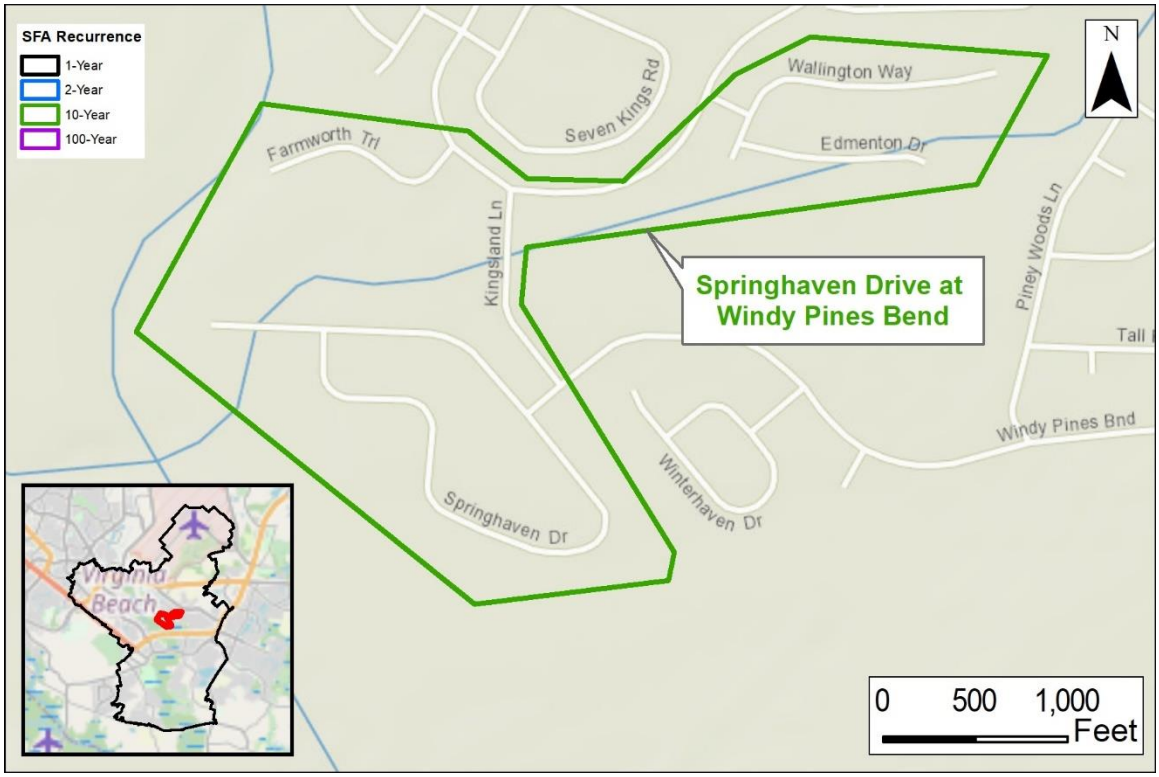


Figure 54. Location Map of Springhaven Drive at Windy Pines Bend SFA

3.50.2 Project Description

The downstream tailwater conditions severely limit the options for improvements in this neighborhood. The City will be evaluating this SFA with a Neighborhood Strategy in the future. Refer to Appendix B-50 for the extent of existing flooding in the area.

3.50.3 Project Benefits

There is no project, and there are no benefits.

3.50.4 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.50.5 Other Alternatives Not Scored

Dredging of West Neck Creek in this area was considered in other projects. However, the HGLs in this area were not lowered enough to relieve the tailwater flooding.

This area would benefit from a neighborhood solution similar to those shown in the SLW Adaptation Strategy Report. This area can be designed to resolve the flooding issues that occur from a smaller storm event. PW-SWEC will, in the future, have a neighborhood solution created to establish resiliency in this area.

3.51 Strawbridge Park

3.51.1 SFA Description

Strawbridge Road, Norchester Crescent, and Winchester Glen Drive experience flooding due to a lack of capacity in the stormwater system. As shown in Figure 55, the models indicate that these areas begin to experience flooding in the 100-year storm event.

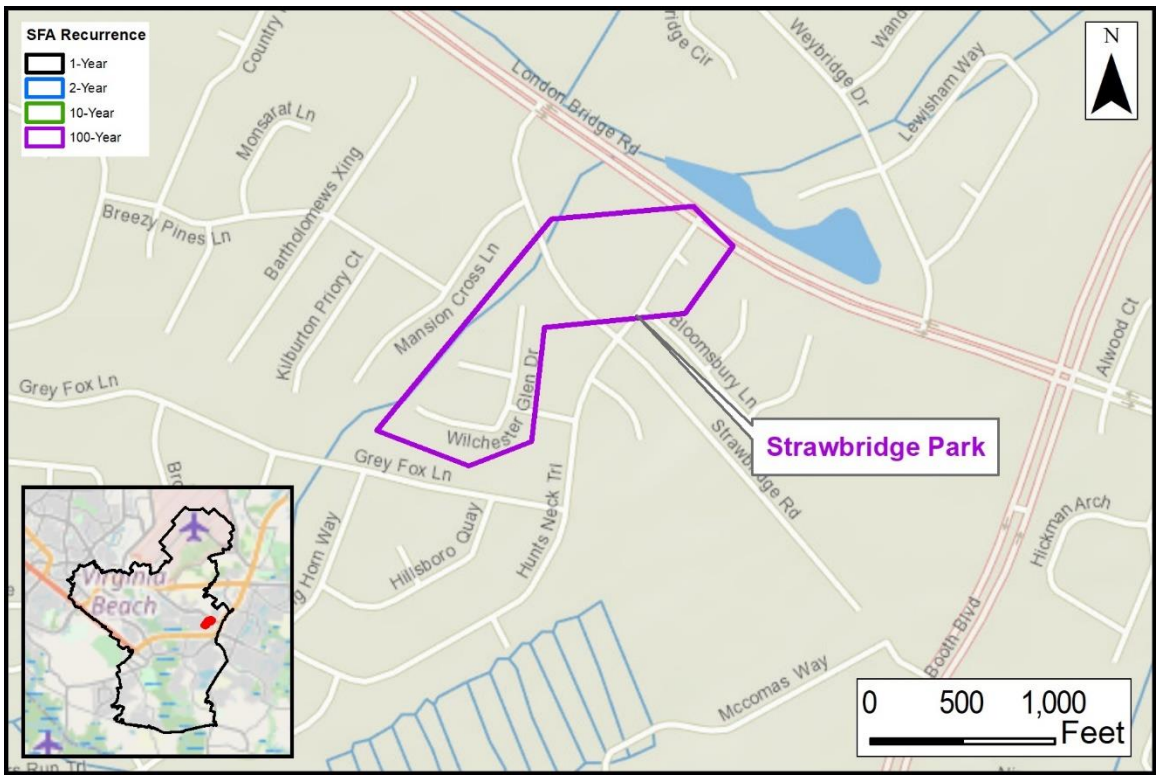


Figure 55. Location Map of Strawbridge Park SFA

3.51.2 Project Description

This project will upsize existing pipes in three separate locations. The first is along the east side of Strawbridge Road, which outfalls into the Southgate Ditch (GPIN 24049934150000). The second is at the cul-de-sac of Norchester Crescent (GPIN 24048879140000), and the third is at the cul-de-sac of Winchester Glen Drive (GPIN 24048847950000).

3.51.3 Project Benefits

The major benefit of the project is mitigating street flooding along Strawbridge Road, Norchester Crescent, and Winchester Glen Drive.

3.51.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated. Minimal easement acquisition of private property is required, as most of the construction will occur within the ROW, City property, or City easements. It is anticipated that minimal effort will be required to obtain environmental permits. Minimal utility relocations and maintenance of traffic will be required during the construction of the project.

3.51.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.51.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.51.7 Project Analysis Summary

Table 59 below provides a summary of the Strawbridge Park project analysis. Refer to Appendix B-51 for project exhibits and supporting documentation.

Table 59. Strawbridge Park Project Summary

SFA Recurrence	100-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	5.31/10
Other ASC Score(s)	N/A
PPC Score	0.47/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$598,500

3.52 Strawbridge Park North

3.52.1 SFA Description

Strawbridge Park North experiences significant flooding due to inadequate stormwater infrastructure and a lack of storage. Streets, private property, and habitable structures experience flooding. As shown in Figure 56, the models indicate Strawbridge Park North begins to experience flooding in the 10-year storm event.

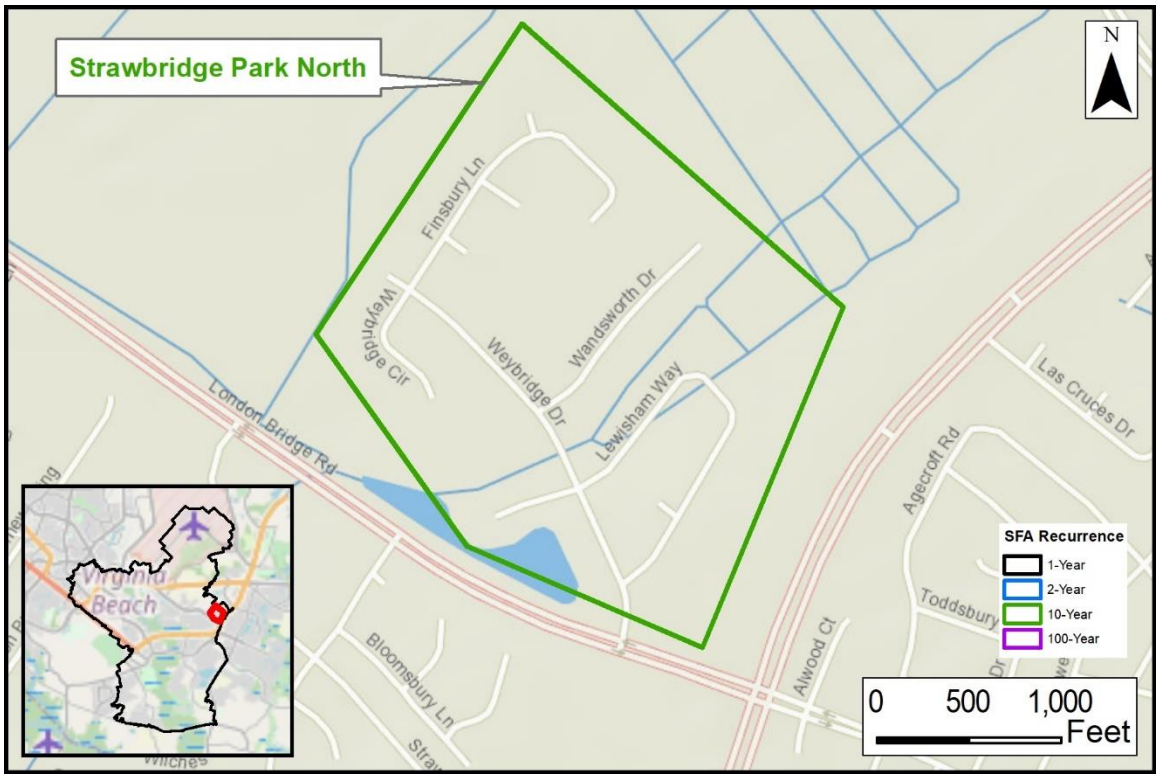


Figure 56. Location Map of Strawbridge Park North SFA

3.52.2 Project Description

This project will add BMPs, upsize inadequate pipes, and add additional pipes throughout the neighborhood. An 18-cfs lift station will be added to the pond placed within Strawbridge Park North to draw down the water elevation in the ponds before the start of the 100-year storm event. The outfall of the existing BMP will be removed, and a new outfall will be added that will outfall to the proposed BMP at Strawbridge Park North.

3.52.3 Project Benefits

The major benefits of the project include mitigating flooding for a total of 23 habitable structures. Flooding is mitigated for one structure along Finsbury Circle, one on Finsbury Lane, one on Bromley Court, seven on Weybridge Circle, five on Wandsworth Drive, and eight on Lewisham Way. The project also mitigates street flooding on Finsbury Lane, Wandsworth Drive, Weybridge Drive, Lewisham Way, and surrounding streets. The project ensures that London Bridge Road can effectively serve as a secondary evacuation route. The project addresses several documented flood reports in the area. The project will also provide a BMP that can be utilized with the future development of Corporate Landing Business Park.

3.52.4 Project Analysis Assumptions

HAZUS data is available for the habitable structures along Finsbury Lane, Finsbury Circle, Bromley Court, Weybridge Circle, Wandsworth Circle, and Lewisham Way. The structures no longer flood in the 100-year storm event. Based on the BCR methodology, the project BCR is 1.1392. There is a decrease in street flooding in the 100-year storm event, but it is not completely mitigated. Therefore, the project is given a BR of 0.84. The flooding on Finsbury Lane caused by private drainage is under review by the City. London Bridge Road, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and the 100-year storm event with no SLR.

Property and easement acquisitions are required for this project. Property acquisition will be required to expand an existing easement along Finsbury Circle and Bromley Court and for pipe improvements. Property acquisition is limited by constructing BMPs on city property and maintaining pipe improvements with the ROW. Coordination will be required with Dominion Energy for improvements within their easement.

Extensive maintenance of traffic will be required during the construction of the project along London Bridge Road and for the neighborhood drainage improvements. It is anticipated that moderate utility relocations will be required during the construction of the project with 4-inch and 8-inch gravity sewer lines and 6-inch, 8-inch, and 10-inch water lines within the neighborhood. Conflicts are expected with 10-inch water lines along London Bridge Road and Strawbridge Road.

While changes to the original design function of the existing BMP are not anticipated, coordination with the City's VSMP Permit Coordinator is required. A net water quality benefit is anticipated with the addition of multiple BMPs as part of this project.

Strawbridge Park North and London Bridge Road at Hunt Club Farm projects are kept separate because the Strawbridge Park North SFA can be mitigated without all the London Bridge Road at Hunt Club Farm improvements. However, the pond and pipe improvements south of London Bridge Road are the same in both projects. If the London Bridge at Hunt Club Farm project is constructed first, then the downstream improvements as part of this project would not be required. Refer to Section 3.27 for a description of the London Bridge at Hunt Club Farm project.

Strawbridge Park North and General Booth Boulevard at Corporate Landing projects are kept separate because the Strawbridge Park North SFA can be mitigated without all the General Booth Boulevard at Corporate Landing improvements. However, the BMP located on City property at Corporate Landing Business Park is the same in both projects. If the General Booth Boulevard at Corporate Landing project is constructed first, then the downstream improvements as part of this project would not be required. Refer to Section 3.16 for a description of the General Booth Boulevard at Corporate Landing project.

3.52.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.52.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.52.7 Project Analysis Summary

Table 60 below provides a summary of the Strawbridge Park North project analysis. Refer to Appendix B-52 for project exhibits and supporting documentation.

Table 60. Strawbridge Park North Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	5.54/10
Other ASC Score(s)	N/A
PPC Score	6.24/14.4
BR	0.84
BCR	1.1392
Project Cost	$27,131,100

3.53 Taylor Farm Road at Aviator Drive

3.53.1 SFA Description

The Taylor Farm Road at Encounter Court and Taylor Farms Road at Engagement Court SFAs are combined into one project called Taylor Farm Road at Aviator Drive. Individual SFA locations are shown in Figure 57 and are further described below. The two SFAs are hydraulically connected and can be combined into one project.

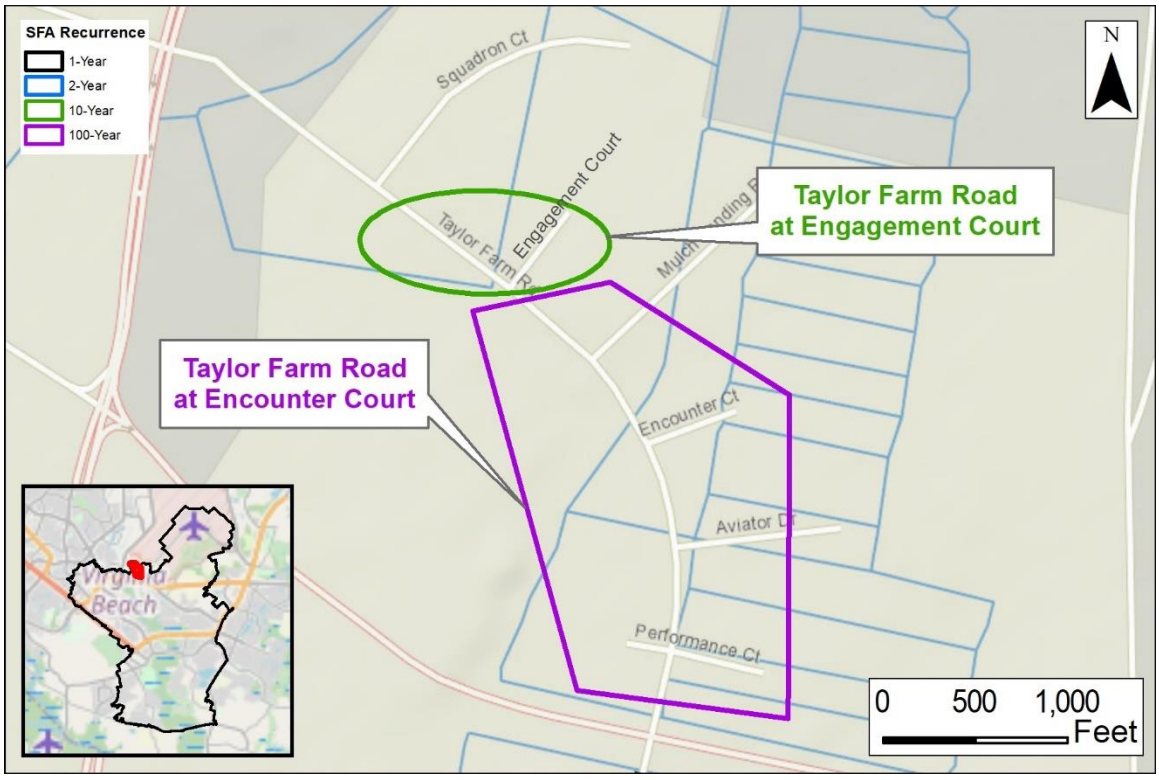


Figure 57. Location Map of Taylor Farm Road at Encounter Court and Taylor Farm Road at Engagement Court SFAs

Taylor Farm Road at Encounter Court SFA

Taylor Farm Road and the surrounding streets are in an industrial area. There is not enough storage in the area leading to street flooding. As shown in Figure 57, the models indicate Taylor Farm Road, Performance Court, Aviator Drive, Encounter Court, and Mulch Landing Road begin to experience flooding in the 100-year storm event.

Taylor Farm Road at Engagement Court SFA

Taylor Farm Road, Engagement Court, and private property experience flooding. The pipes in the area are inadequate, and there is not enough storage. As shown in Figure 57, the models indicate Taylor Farm Road and Engagement Court begin to experience flooding in the 10-year storm event.

3.53.2 Project Description

This project will increase the existing BMP's size and add a lift station to draw down the initial elevation before a 100-year storm event allowing for more storage in the system. Upstream

pipes will be upsized to allow for more conveyance capacity in the system and alleviate street flooding. An additional inflow pipe will be added to the expanded BMP footprint to relieve street flooding on Taylor Farm Road. To connect the proposed pipe to the current system, one pipe along Taylor Farm Road will be reversed to allow more direct flow into the expanded BMP.

3.53.3 Project Benefits

The project's major benefits include mitigating street flooding on Taylor Farm Road, Performance Court, Aviator Drive, Encounter Court, Mulch Landing Road, Engagement Court, and the flooding occurring on surrounding private property.

3.53.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated.

Property and easement acquisition from two private landowners will be required to expand the BMP, add the additional outfall, and add a lift station. It is anticipated that moderate maintenance of traffic will be required during the construction of the project at the intersection of Taylor Farm Road and Engagement Court for the pipe improvements. Moderate utility relocations will be required during the project's construction near the same intersection. There is a 10-inch water main, a 12-inch water main, and an 8-inch sewer line at the Taylor Farm Road and Engagement Court intersection.

3.53.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.53.6 Other Alternatives Not Scored

One additional alternative was considered but was not scored since it did not meet the PWDSM requirements. This alternative more than doubled the BMP’s size to include the entire private parcel to the west of the BMP in an attempt to eliminate the need for a lift station. The flooding was reduced to 10-40 minutes on the streets by increasing the system's storage but did not completely alleviate flooding. Additionally, pipes were increased upstream of the BMP, and underground storage was added near the Taylor Farm Road and Engagement Court intersection. These improvements also did not meet the PWDSM requirements.

3.53.7 Project Analysis Summary

Table 61 below provides a summary of the Taylor Farm Road at Aviator Drive project analysis. Refer to Appendix B-53 for project exhibits and supporting documentation.

Table 61. Taylor Farm Road at Aviator Drive Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	5.22/10
Other ASC Score(s)	N/A
PPC Score	1.68/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$10,250,000

3.54 Three Oaks

3.54.1 SFA Description

Three Oaks Drive, Wild Oaks Crescent, Shingle Wood Way, and Russet Leaf Lane experience frequent street flooding. The downstream channel is connected to inadequate culverts, and the stormwater infrastructure within the neighborhood is inadequate and lacks upstream storage. As shown in Figure 58, the models indicate Three Oaks begins to experience flooding in the 10-year storm event.

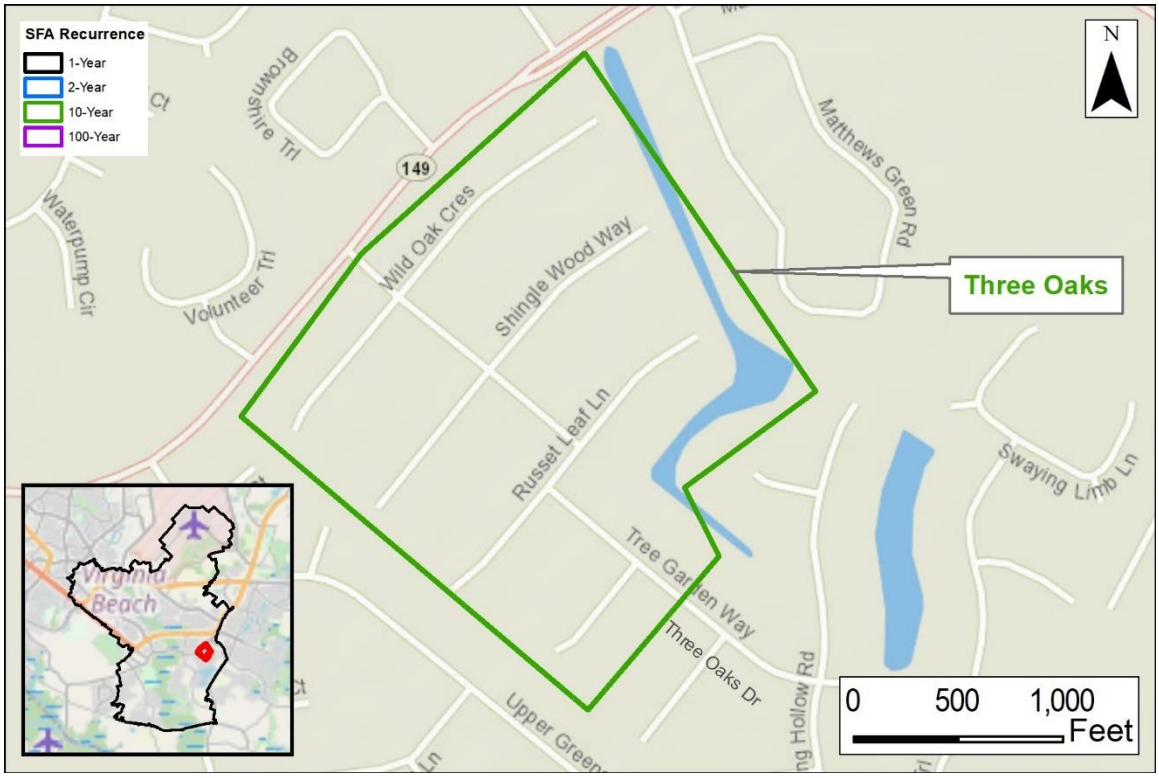


Figure 58. Location Map of Three Oaks SFA

3.54.2 Project Description

This project will mitigate flooding by upsizing pipes within the neighborhood, adding an upstream underground storage system, and improving the downstream condition with upsized culverts. Property acquired for the underground storage facility could be used as a neighborhood park.

3.54.3 Project Benefits

The major benefits of the project include mitigating street flooding on Three Oaks Drive, Wild Oaks Crescent, Shingle Wood Way, Russet Leaf Lane, and Brushwood Terrace. The project also addresses several flood reports that have been documented in the area.

3.54.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated.

Property acquisition will be required for the underground storage. Underground storage has been selected to provide a potential location for a neighborhood park above the storage, instead of a surface BMP. Downstream improvements are proposed to limit the size of the underground storage.

It is anticipated that moderate maintenance of traffic and utility relocations will be required during the construction of the project along Princess Anne Road. Minimal effort will likely be required to obtain environmental permits to upsize outfalls into non-tidal wetlands.

This project is not dependent on other projects. However, the downstream culvert improvements on Huckleberry Trail and Rockingchair Lane are consistent with those proposed in the Princess Anne Road at Mathews Green Road project. Should that project be constructed first, then the downstream culvert improvements would not be required as part of this project. Refer to Section 3.38 for a description of the Princess Anne Road at Mathews Green Road project.

3.54.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.54.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.54.7 Project Analysis Summary

Table 62 below provides a summary of the Three Oaks project analysis. Refer to Appendix B-54 for project exhibits and supporting documentation.

Table 62. Three Oaks Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	4/10
Other ASC Score(s)	N/A
PPC Score	1.68/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$14,607,800

3.55 Tower Bridge Loop North

3.55.1 SFA Description

The northwest corner of Tower Bridge Loop North floods due to inadequate pipe capacity. The other flooding noted is located within the Camden Village development on the northeast corner of Tower Bridge Loop and south of London Bridge Road, is related to a private drainage system and is not considered further. As shown in Figure 59, the models indicate Tower Bridge Loop begins to experience flooding in the 10-year storm event.

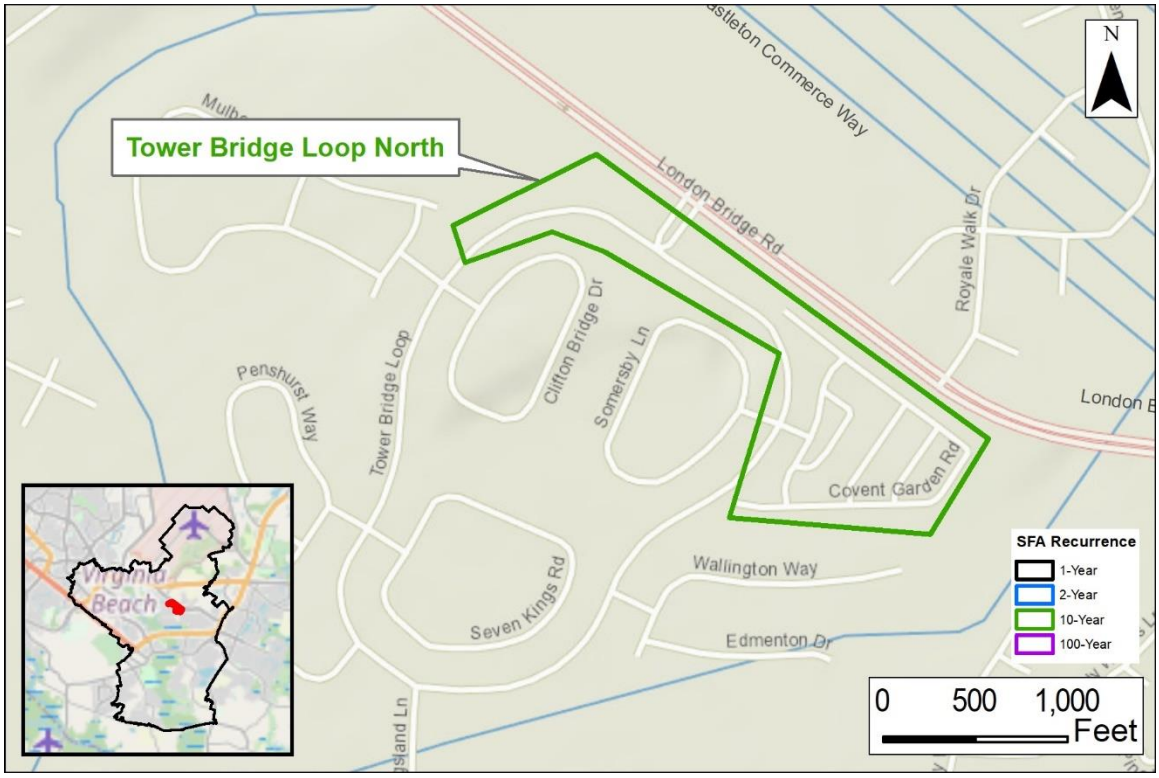


Figure 59. Location Map of Tower Bridge Loop North SFA

3.55.2 Project Description

This project adds additional pipe capacity along the roadway. The proposed trunkline will be located on the north side of the road and outfalls to a proposed trapezoidal ditch. The proposed trapezoidal ditch outfalls through the floodplain to the main West Neck Creek channel. Pipes are also upsized, leading into the northernmost BMP in between Clifton Bridge Drive and Somersby Lane.

3.55.3 Project Benefits

The major benefits of the project include mitigating street flooding in the northwest corner of Tower Bridge Loop, as well as the flooding occurring on surrounding private property.

3.55.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated.

Minimal easement acquisition will be required for this project. It is anticipated that moderate maintenance of traffic and utility relocation will be required during the construction of the project. Extensive effort will likely be required to obtain environmental permits for the ditch outfall.

While runoff is being diverted away from the existing BMPs, changes to the original design function are not anticipated as the water quality storm can still be diverted to the BMP. Coordination with the City's VSMP Permit Coordinator is required.

This project and the Castleton project are kept separate because the SFAs can be mitigated separately. However, the downstream ditch is the same in both projects. If the Castleton project is constructed first, then the downstream ditch improvements as part of this project would not be required. Refer to Section 3.4 for a description of the Castleton project.

3.55.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.55.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.55.7 Project Analysis Summary

Table 63 below provides a summary of the Tower Bridge Loop North project analysis. Refer to Appendix B-55 for project exhibits and supporting documentation.

Table 63. Tower Bridge Loop North Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	4.38/10
Other ASC Score(s)	N/A
PPC Score	1.18/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$5,076,100

3.56 Tower Bridge Loop at Seven Kings Road

3.56.1 SFA Description

Tower Bridge Loop at Seven Kings Road is a residential road that serves several neighborhoods. The portion of Tower Bridge Loop near the Seven Kings Road intersection ranges in elevations between 4.5 to 6 feet. The design tailwater elevation for the 100-year storm event is 6.4 feet in West Neck Creek. The road is also located in the 100-year floodplain. The tailwater elevation, independent of the existing drainage infrastructure, floods the street. As shown in Figure 60, the models indicate Tower Bridge Loop at Seven Kings Road begins to experience flooding in the 2-year storm event.

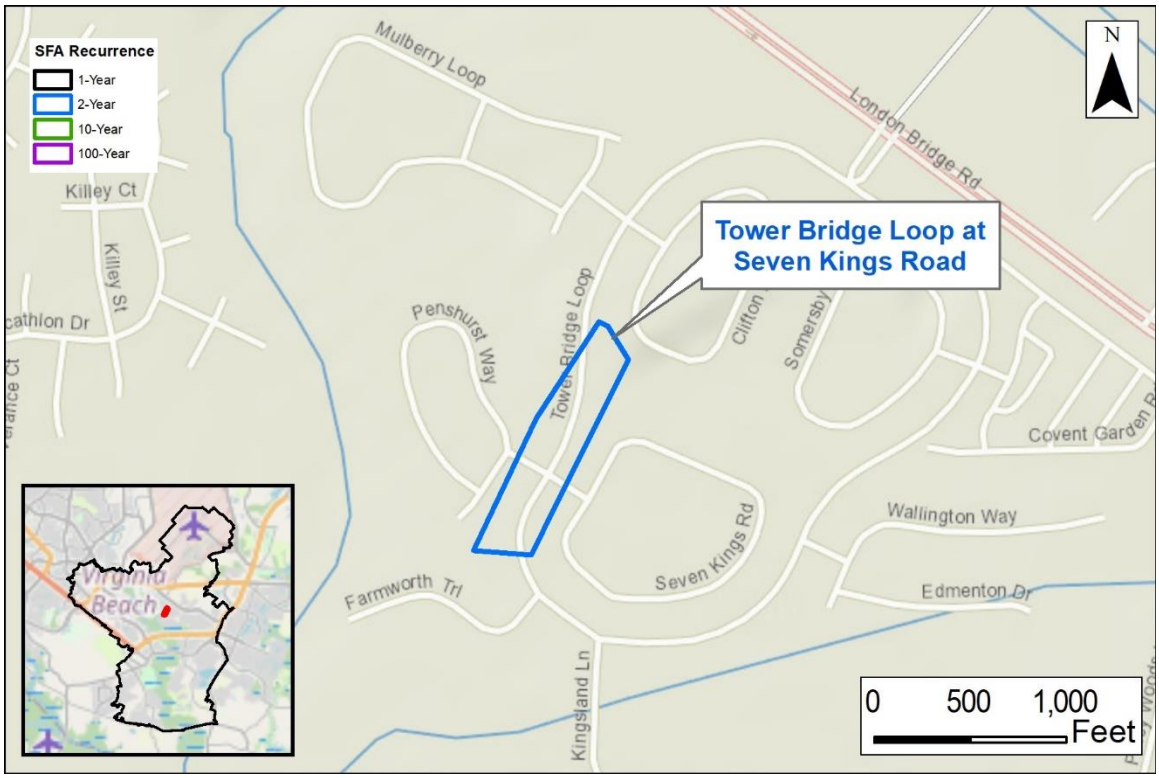


Figure 60. Location Map of Tower Bridge Loop at Seven Kings Road SFA

3.56.2 Project Description

The downstream tailwater conditions severely limit the options for improvements in this neighborhood. The City will be evaluating this SFA with a Neighborhood Strategy in the future. Refer to Appendix B-56 for the extent of existing flooding in the area.

3.56.3 Project Benefits

There is no project, and there are no benefits.

3.56.4 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.56.5 Other Alternatives Not Scored

This neighborhood would benefit from a neighborhood solution similar to those shown in the SLW Adaptation Strategy Report. This neighborhood can be designed to resolve the flooding

issues that occur from a smaller storm event. PW-SWEC will, in the future, have a neighborhood solution created to establish resiliency in this neighborhood.

3.57 Tree Garden Way at Kindling Hollow Road

3.57.1 SFA Description

Tree Garden Way at Kindling Hollow Road experiences flooding due to a lack of storage in the system, inadequate pipes, and an inadequate outfall for the BMP. Streets, private property, and habitable structures experience flooding. As shown in Figure 61, the models indicate Tree Garden Way at Kindling Hollow Road begins to experience flooding in the 10-year storm event.

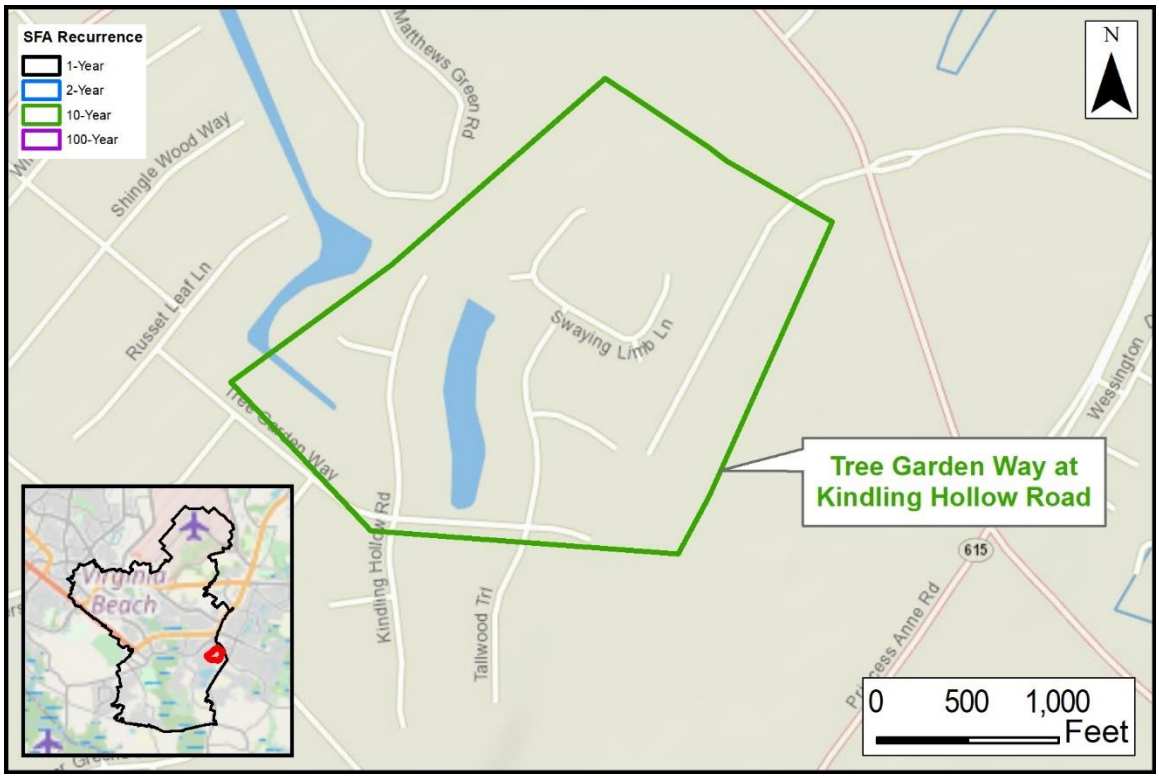


Figure 61. Location Map of Tree Garden Way at Kindling Hollow Road SFA

3.57.2 Project Description

This project will add additional storage downstream with a proposed BMP on City property (Three Oaks Park, GPIN 24141202230000) and to expand the existing BMP at Three Oaks Elementary School into Three Oaks Park. The existing outfall for the BMP within the neighborhood will be removed, and the stormwater system will outfall to the proposed BMP with upsized pipes and additional proposed pipes. The proposed BMP will outfall into an expanded ditch and upsized culvert into Sherwood Lakes.

3.57.3 Project Benefits

The major benefits of the project include mitigating three habitable structures flooding on Kindling Hollow Road, one habitable structure flooding on Colonial Acres Court, and one habitable structure on Tallwood Trail (five total). Street flooding is mitigated along Kindling Hollow Road, Little Acorn Court, Seedling Grove Court, Tallwood Trail, Colonial Acres Court, and Swaying Limb Lane. The project also addresses several flood reports that have been documented in the area.

3.57.4 Project Analysis Assumptions

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. The project is given a BR of 1.0 because all street flooding is mitigated.

Easement acquisition will be required for this project. To limit the amount of easement acquisition, BMPs will be constructed on City property (Three Oaks Elementary School and Three Oaks Park), and proposed pipes are added in the ROW. Coordination will be required with the City of Virginia Beach Public Schools and Parks and Recreation for the proposed BMPs on City property. The proposed BMP on Three Oaks Park will require 30 ac-ft of storage. The project figure shows the total volume needed. However, it can be constructed as a large water feature, multiple water features throughout the park, or as another amenity in the park. The placement and design of the storage can be considered during the redevelopment of Three Oaks Park. The BMPs in Three Oaks Park and Three Oaks Elementary School could also be combined.

It is anticipated that moderate maintenance of traffic will be required within the neighborhood during the construction of the project. Moderate utility relocations will likely be required during the construction of the project for 8-inch gravity sewer and water lines.

Some runoff is being diverted away from the existing BMP within the neighborhood. However, this diversion can potentially be offset by the water quality benefits provided by the proposed BMP. Coordination with the City's VSMP Permit Coordinator is required.

3.57.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.57.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.57.7 Project Analysis Summary

Table 64 below provides a summary of the Tree Garden Way at Kindling Hollow Road project analysis. Refer to Appendix B-57 for project exhibits and supporting documentation.

Table 64. Tree Garden Way at Kindling Hollow Road Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	6.33/10
Other ASC Score(s)	N/A
PPC Score	5.38/14.4
BR	1.0
BCR	1.0 (based on updated model)
Project Cost	$27,033,100

3.58 Victoria Park

3.58.1 SFA Description

The Bombay Landing at Wilhelm Drive and West Neck Road at Kellam High School SFAs are combined into the Victoria Park project. Individual SFA locations are shown in Figure 62 and are further described below. The two SFAs are hydraulically connected and can be combined into one project.

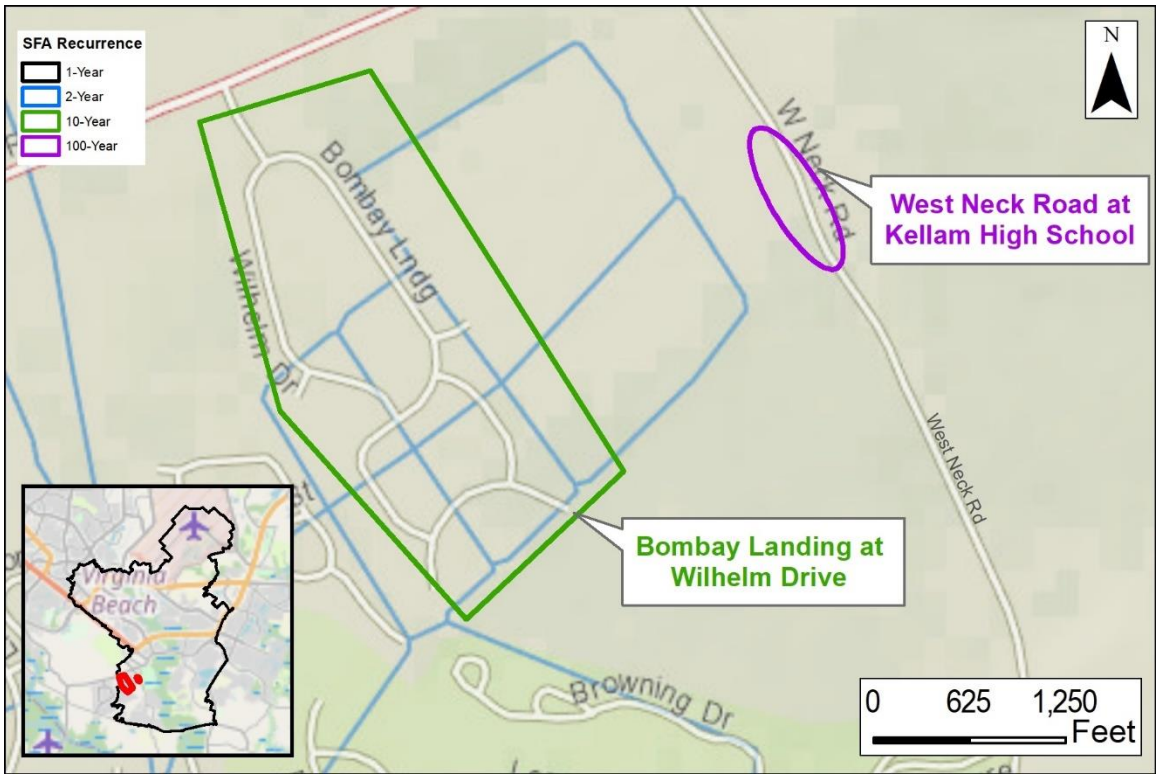


Figure 62. Location Map of Bombay Landing at Wilhelm Drive and West Neck Road at Kellam High School SFA

Bombay Landing at Wilhelm Drive SFA

Bombay Landing at Wilhelm Drive experiences frequent flooding. The current system outfalls to Kellam High School through pipes 5 feet higher than the stormwater system within Bombay Landing at Wilhelm Drive, causing street flooding within the neighborhood. Additionally, the pipes within Bombay Landing at Wilhelm Drive are inadequate. As shown in Figure 62, the models indicate Bombay Landing at Wilhelm Drive begins to experience flooding in the 10-year storm event.

West Neck Road at Kellam High School SFA

West Neck Road, as well as the Kellam High School entrance, floods due to the lack of storage capacity upstream of the BMP located on the south end of the school property. As shown in Figure 62, the models indicate West Neck Road and the Kellam High School entrance begin to experience flooding in the 100-year storm event. West Neck Road serves as a secondary evacuation route. Kellam High School is considered a critical infrastructure as an emergency

shelter. The project is surrounded by residential areas and the school property, which has several BMPs that are connected to the roadway drainage system on West Neck Road.

3.58.2 Project Description

The current outfall, into the Kellam High School storm system, will be removed. Numerous pipes will be reversed to change the direction of flow to the proposed ditch south of the neighborhood, and additional stormwater infrastructure will be added. To account for an increase in flow to the downstream ditch, it will be widened and lowered. The downstream culvert crossing at West Neck Road will be upsized. West Neck Road serves as a secondary evacuation route, and Kellam High School is designated as an emergency shelter.

3.58.3 Project Benefits

The major benefits of the project include mitigating street flooding on Bombay Landing, Wilhelm Drive, Copperhawke Drive, Bending Birch Trail, and West Neck Road, as well as the flooding occurring on surrounding private property. The project also addresses a flood report that has been documented in the area. This project ensures that West Neck Road can effectively serve as a secondary evacuation route and provide access to Kellam High School, an emergency shelter.

3.58.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated. West Neck Road, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and the 100-year storm event with no SLR. This also meets the design requirement for critical infrastructure.

A small amount of easement acquisition is required for this project, but most of the construction will occur within the ROW or City property. It is anticipated that moderate maintenance of traffic will be required along West Neck Road during the construction of the project. Moderate utility relocations will be required during the construction of the project. It is anticipated that moderate effort will be required to obtain environmental permits to modify the outfall ditch.

3.58.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.58.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.58.7 Project Analysis Summary

Table 65 below provides a summary of the Victoria Park project analysis. Refer to Appendix B-58 for project exhibits and supporting documentation.

Table 65. Victoria Park Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	4.46/10
PPC Score	3.82/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$9,203,700

3.59 West Neck Road at North Landing Road

3.59.1 SFA Description

West Neck Road, a secondary evacuation route, and North Landing Road experience street flooding. As shown in Figure 63, the models indicate West Neck Road at North Landing Road begins to experience flooding in the 100-year storm event.



Figure 63. Location Map of West Neck Road at North Landing Road SFA

3.59.2 Project Description

This project will expand the existing BMP at the corner of West Neck Road and North Landing Road on City property (GPIN 14946271010000). An additional outfall will be added for the BMP that will outfall along West Neck Road to North Landing Road. This project will also improve existing infrastructure along West Neck Road.

3.59.3 Project Benefits

The major benefits of the project include mitigating street flooding on West Neck Road. This project also ensures that West Neck Road can effectively serve as a secondary evacuation route. There is also a potential cost-sharing opportunity with DPU for transmission line prioritization.

3.59.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated. West Neck Road and North Landing Road, as secondary evacuation routes, remain passable in the 10-year storm event with 3.0 feet SLR and the 100-year storm event with no SLR.

Property and easement acquisition is not required as all the construction will occur within the ROW or City property. It is anticipated that moderate maintenance of traffic will be required during the construction of the project along North Landing Road and West Neck Road. Extensive utility relocations will likely be required during the construction of the project, including a 4-inch and 16-inch sewer force main, 8-inch sewer gravity main, and 16-inch water main on North Landing Road. Coordination will also be required with Dominion Energy to relocate the electrical utilities.

While changes to the original design function of the BMP are not anticipated, coordination with the City's VSMP Permit Coordinator is required.

3.59.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.59.6 Other Alternatives Not Scored

One additional alternative was considered to improve the downstream condition. The culvert crossing North Landing Road and the downstream ditch would be lowered by 1 foot. Additionally, the downstream ditch would be widened by 30 feet to increase the downstream conveyance. By improving the downstream ditch, the existing BMP would not be required to be expanded to resolve the flooding. However, this alternative would require the acquisition of one private property that has already been developed, so it was not considered further.

3.59.7 Project Analysis Summary

Table 66 below provides a summary of the West Neck Road at North Landing Road project analysis. Refer to Appendix B-59 for project exhibits and supporting documentation.

Table 66. West Neck Road at North Landing Road Project Summary

SFA Recurrence	100-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	6.7/10
Other ASC Score(s)	N/A
PPC Score	0.1/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$5,089,000

3.60 West Neck Road at Signature Drive

3.60.1 SFA Description

West Neck Road floods near Signature Drive due to an undersized culvert underneath West Neck Road. West Neck Road serves as a secondary evacuation route. As shown in Figure 64, the models indicate West Neck Road begins to experience flooding in the 10-year storm event.

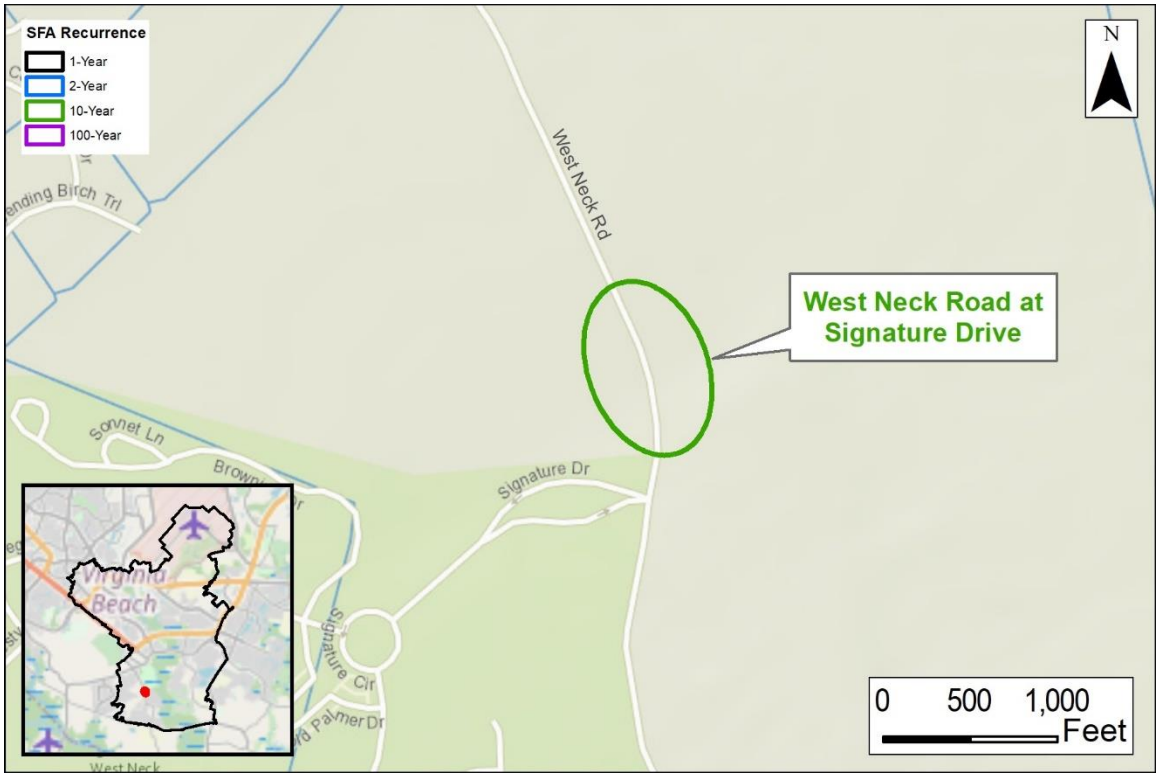


Figure 64. Location Map of West Neck Road at Signature Drive SFA

3.60.2 Project Description

This project will replace the existing 42-inch culvert with dual 8-foot by 4-foot box culverts. Additionally, the ditches upstream and downstream will be excavated to properly align with the proposed culvert.

3.60.3 Project Benefits

The major benefits of the project include mitigating street flooding along West Neck Road, as well as the flooding occurring on surrounding private property. This project addresses flood reports that have been documented in the area, and the project has potential cost-sharing opportunities, as CIP 2-088 (West Neck Road Phase IV) improvements are proposed in the area.

3.60.4 Project Analysis Assumptions

City GIS information identifies the existing culvert as dual 24-inch pipes. Field measurements confirmed the existing culvert is a single 42-inch pipe. The project assumes the proposed culvert is the same length as the existing conditions. In accordance with the methodology documented in Section 2, the potential future improvements associated with West Neck Road

Phase IV were not considered in the development of the alternatives. The cost estimate is based on the improvements required for the existing site conditions.

Property and easement acquisition are not required as all the construction will occur within the ROW or City property. All ditch widening will be located within an existing easement or City ROW.

When comparing the existing site conditions to the proposed project conditions, the HGL downstream of the culvert increases by 0.3 feet. However, the increase is within the FEMA floodplain of West Neck Creek, which is defined as a major waterbody by the PWDSM. It is assumed that no further downstream improvements are required.

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated. West Neck Road, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and 100-year storm event with no SLR. It is anticipated that moderate utility relocations and maintenance of traffic will be required during the construction of the project. Additionally, moderate effort will likely be required to obtain environmental permits.

3.60.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.60.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.60.7 Project Analysis Summary

Table 67 below provides a summary of the West Neck Road at Signature Drive project analysis. Refer to Appendix B-60 for project exhibits and supporting documentation.

Table 67. West Neck Road at Signature Drive Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	7.11/10
Other ASC Score(s)	N/A
PPC Score	1.94/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$825,000

3.61 Windy Pines Bend at Piney Woods Lane

3.61.1 SFA Description

The southeastern corner of the Castleton neighborhood and the southwestern corner of the Pine Ridge neighborhood, near Windy Pines Bend at Piney Woods Lane, ranges in elevations from approximately 5 to 6 feet. The residential lots reach up to elevation 8 feet in some locations. The design tailwater elevation for the 100-year storm event is 6.19 feet in West Neck Creek. The tailwater elevation, independent of the existing drainage infrastructure, floods the street. As shown in Figure 65, the models indicate Woody Pines Bend begins to experience flooding in the 2-year storm event.

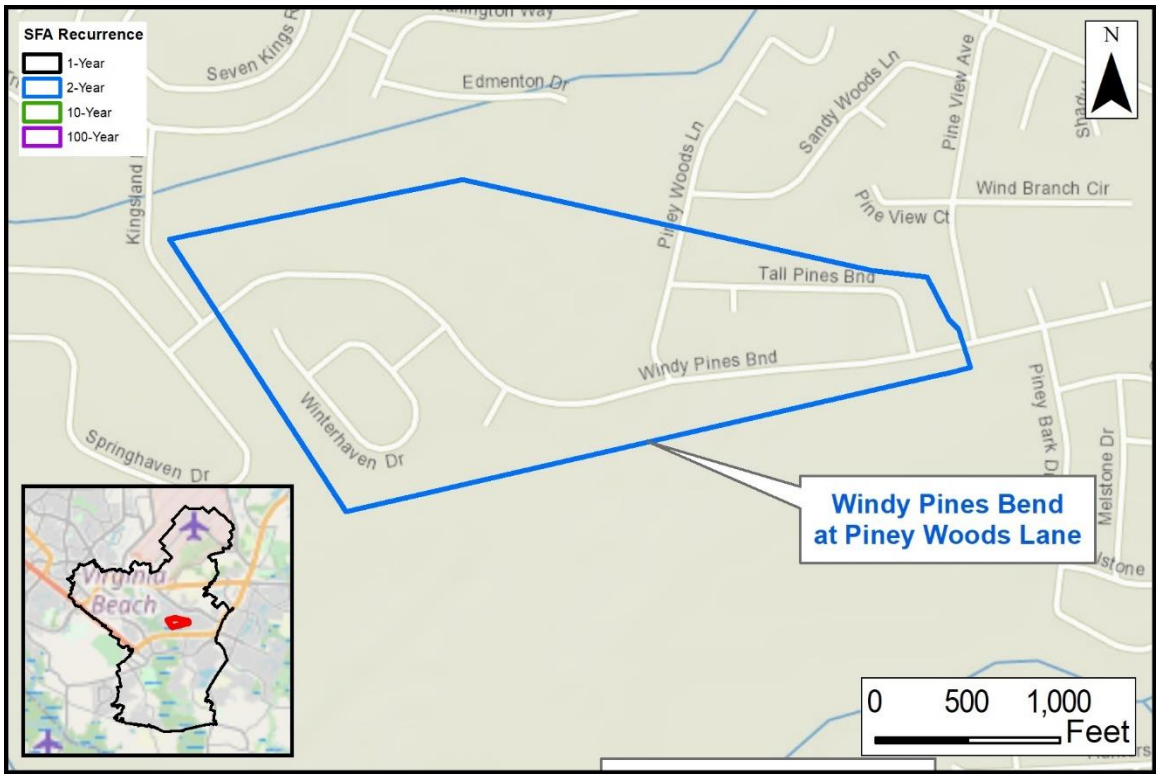


Figure 65. Location Map of Windy Pines Bend at Piney Woods Lane SFA

3.61.2 Project Description

The downstream tailwater conditions severely limit the options for improvements in this neighborhood. The City will be evaluating this SFA with a Neighborhood Strategy in the future. Refer to Appendix B-61 for the extent of existing flooding in the area.

3.61.3 Project Benefits

There is no project, and there are no benefits.

3.61.4 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.61.5 Other Alternatives Not Scored

This neighborhood would benefit from a neighborhood solution similar to those shown in the SLW Adaptation Strategy Report. This neighborhood can be designed to resolve the flooding

issues that occur from a smaller storm event. PW-SWEC will, in the future, have a neighborhood solution created to establish resiliency in this neighborhood.

3.62 Windy Willow Court

3.62.1 SFA Description

Windy Willow Court is a small street to the northeast of the Dam Neck Road and Holland Road intersection. It floods due to a lack of stormwater infrastructure along the roadway and tailwater influenced by undersized infrastructure along Dam Neck Road. As shown in Figure 66, the models indicate Windy Willow Court begins to experience flooding in the 2-year storm event.

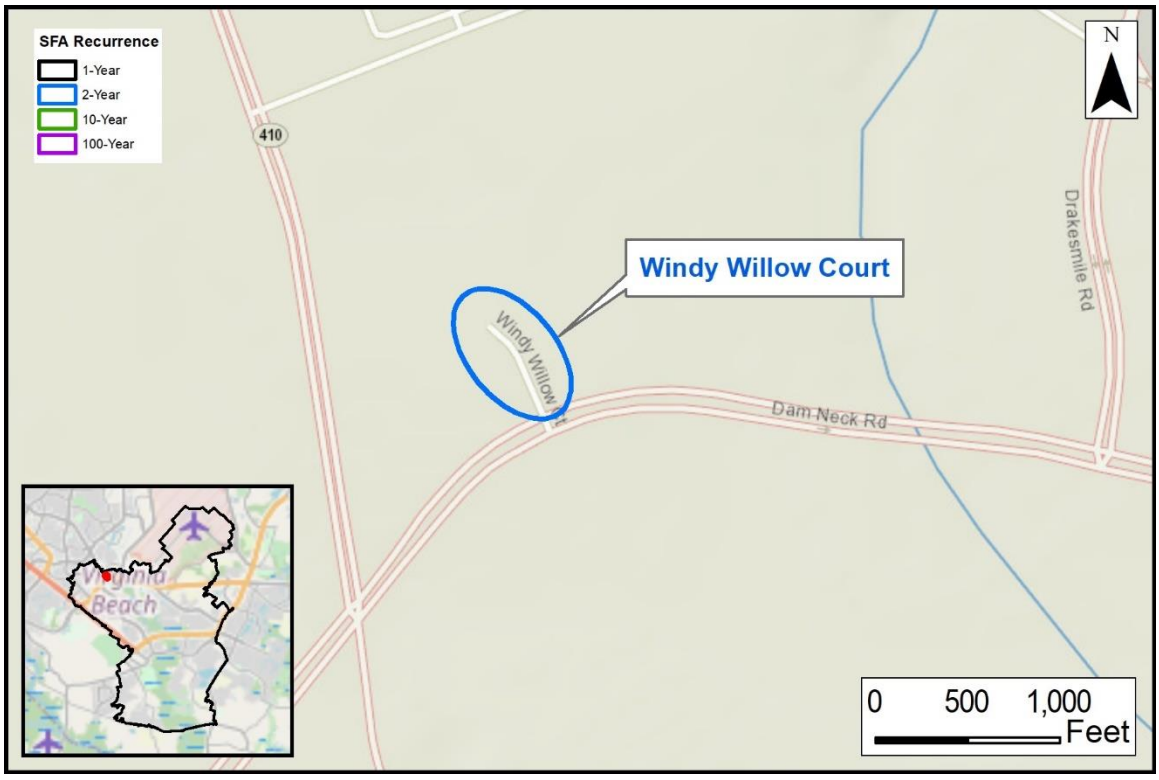


Figure 66. Location Map of Windy Willow Court SFA

3.62.2 Project Description

This project will raise approximately 300 feet of Windy Willow Court by 1.5 feet to meet the PWDSM requirements.

3.62.3 Project Benefits

The major benefit of the project is mitigating street flooding on Windy Willow Court.

3.62.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated.

Property acquisition is not required as all the construction will occur within the ROW or City property. It is anticipated that minimal maintenance of traffic and utility relocations will be required during the construction of the project.

3.62.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.62.6 Other Alternatives Not Scored

One additional alternative was considered, but not scored. A new outfall crossing Dam Neck Road was considered. The new outfall would drain to the existing ditch east of the existing Dominion Energy power easement and mitigate flooding on the north side of Dam Neck Road. Due to the isolated nature of this flooding along a short residential road, the required disruptions to Dam Neck Road are not justified compared to the selected alternative. Additionally, the alternative failed to meet PWDSM standards.

3.62.7 Project Analysis Summary

Table 68 below provides a summary of the Windy Willow Court project analysis. Refer to Appendix B-62 for project exhibits and supporting documentation.

Table 68. Windy Willow Court Project Summary

SFA Recurrence	2-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	5.92/10
Other ASC Score(s)	N/A
PPC Score	1.3/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$1,170,000

3.63 Woodhouse Corner

Individual SFA locations, shown below in Figure 67 and further described below, are combined into the Woodhouse Corner project. Meeting the PWDSM requirements for the upstream SFAs is dependent on the improvements proposed for the downstream SFAs. A phased project is proposed considering the extent of improvements that are required and to accomplish the objective of the SWMP to develop "standalone" solutions that are not dependent on downstream improvements. Project phases are defined by the individual SFA boundaries and begin with the most downstream improvements. Future refinements to the project phasing proposed may be required. Refer to Appendix B-63-1 through B-63-8 for detailed project phase maps.

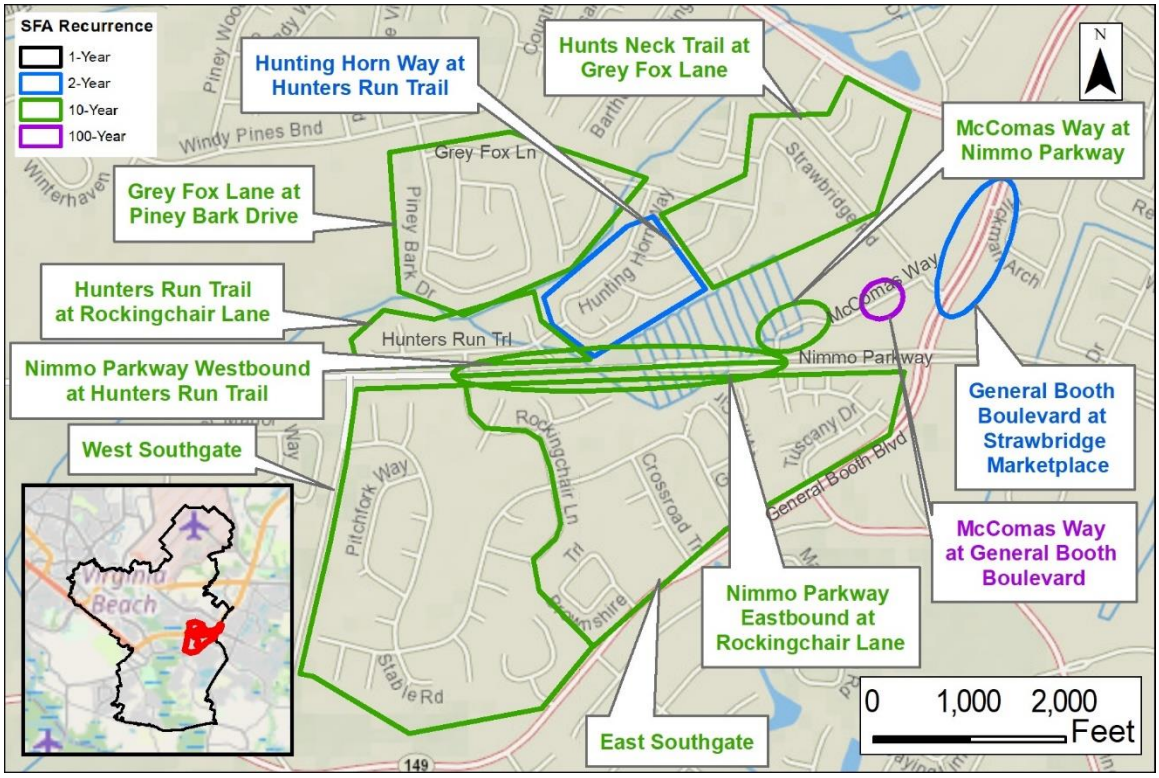


Figure 67. Location Map of Hunters Run Trail at Rockingchair Lane, West Southgate, Grey Fox Lane at Piney Bark Drive, Hunting Horn Way at Hunters Run Trail, Hunts Neck Trail at Grey Fox Lane, Nimmo Parkway Westbound at Hunters Run Trail, East Southgate, Nimmo Parkway Eastbound at Rockingchair Lane, McComas Way at General Booth Boulevard, McComas Way at Nimmo Parkway, and General Booth Boulevard at Strawbridge Marketplace SFAs

3.63.1 ***Phase 1: Hunters Run Trail at Rockingchair Lane***

3.63.1.1 SFA Description

Hunters Run Trail experiences flooding due to a lack of conveyance capacity within the existing stormwater system and high tailwater within the interconnected BMP system. Approximately 1,100 acres drain to the existing 2.17-acre BMP. As shown in Figure 67, the models indicate that these areas begin to experience flooding in the 10-year storm event.

3.63.1.2 Project Description

This project will upsize the existing stormwater infrastructure along Hunters Run Trail, Dry Creek Court, and Trapshooter Court to increase stormwater conveyance through the system and into the BMP. The improvements will follow the same drainage patterns as in the existing condition. Additionally, an 800-cfs lift station is required in the BMP to maintain the HGL within the BMP during storm events at an elevation low enough that prevents stormwater from filling up the upstream pipes. A flood gate is required at the BMP outfall that will allow smaller storm events to pass through the outfall when the lift station is not operating and prevent drainage from the Hunt Club Tributary from backing into the BMP during larger storm events when the lift station is operating. Additionally, the existing ditch crossing Hunters Run Trail will be lowered by approximately 2 feet.

3.63.1.3 Project Benefits

The major benefits of the project include mitigating street flooding along Hunters Run Trail and habitable structure flooding on Hunters Run Trail, Trapshooter Court, and Silver Oaks Court. Habitable structure flooding is resolved for thirty structures; the project also addresses several flood reports that have been documented in the area. There is a potential cost-sharing opportunity with DPU for transmission main prioritization near Silver Oaks Court.

3.63.1.4 Project Analysis Assumptions

The project indicates structural flooding is resolved; however, the structural flooding is not reflected in the BCR. The project is given a BR of 1.0 because all street flooding is mitigated.

Property acquisition of multiple parcels is required to install the lift station and flood gate. It is anticipated that minimal maintenance of traffic and moderate utility relocations will be required during the construction of the project.

Moderate effort to obtain environmental permits is anticipated for the project. The direct wetland impacts will be from the intake and outfall from the pump station. Direct impact from the pump station construction will be minimized during design. However, given the elevation in the area, it is anticipated that an individual permit will be required. The project will not sever the hydrologic connection from the pond and the downstream ditch because the floodgate will only be closed when the pump station is operating during large storm events. Since the hydrologic connection will be maintained after construction, the project is not considered to have a severe permitting risk.

This alternative also includes a flood gate at the downstream end of the existing BMP that will allow the BMP to operate in normal conditions and prevent recirculation during lift station operation. Riprap and a concrete pad will be necessary at the downstream end of the lift station to prevent degradation of the existing channel.

At the time of this report, the Nimmo Quay subdivision is being designed and permitted. The subdivision proposes a bridge crossing over West Neck Creek. The analysis of this alternative does not consider those improvements. These downstream improvements will need to be considered, if constructed, during detailed design.

3.63.1.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.63.1.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.63.1.7 Project Analysis Summary

Table 69 below provides a summary of the SFA project analysis. Refer to Appendix B-63-1 for project exhibits and supporting documentation.

Table 69. Hunters Run Trail at Rockingchair Lane Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	2.98/10
Other ASC Score(s)	N/A
PPC Score	5.88/14.4
BR	1.0
BCR	1.0 (based on updated model)
Project Cost	$87,776,300

3.63.2 *Phase 2A: West Southgate*

3.63.2.1 SFA Description

West Southgate experiences flooding due to a lack of conveyance capacity within the existing stormwater system and high tailwater within the interconnected BMP system. As shown in Figure 67, the models indicate that these areas begin to experience flooding in the 10-year storm event.

3.63.2.2 Project Description

This project will upsize the existing stormwater infrastructure along Huckleberry Trail and Smokehouse Road to increase stormwater conveyance through the system and into the BMP. The improvements will follow the same drainage patterns as in the existing condition. Additionally, a 200-cfs lift station will be added to the BMP to lower the HGL and prevent stormwater from filling the upstream pipes. The pumps will pull stormwater from the existing BMP and outfall through the existing culverts under Nimmo Parkway. Volunteer Trail and Cully Farm Road will be raised a maximum of 0.75 feet to prevent stormwater from ponding on the road. Woodhouse Corner Phase 2A: West Southgate is dependent on Woodhouse Corner Phase 1: Hunters Run Trail at Rockingchair Lane improvements.

3.63.2.3 Project Benefits

The major benefits of the project include mitigating street flooding along Smokehouse Road, Huckleberry Trail, Volunteer Trail, and others. The project also addresses several flood reports that have been documented in the area. There is a potential cost-sharing opportunity with DPU for transmission main prioritization near Cully Farm Road.

3.63.2.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated. Property acquisition will be required to install the lift station. Easement acquisition will be necessary to extend one existing drainage easement. It is anticipated that moderate maintenance of traffic

and utility relocations will be required during the construction of the project. Also, minimal effort to obtain environmental permits is anticipated for the project. This alternative is reliant on the improvements from the Woodhouse Corner Phase 1: Hunters Run Trail at Rockingchair Lane Project.

No recirculation is expected at the proposed lift station due to the proposed improvements in Woodhouse Corner Phase 1: Hunters Run Trail at Rockingchair Lane project. Cured in place pipe (CIPP) lining will be necessary at the culverts crossing Nimmo Road to account for the additional flow from the proposed lift station. Enhancing existing outfall protection downstream of the lined pipes will be needed to prevent scour.

3.63.2.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.63.2.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.63.2.7 Project Analysis Summary

Table 70 below provides a summary of the SFA project analysis. Refer to Appendix B-63-2 for project exhibits and supporting documentation.

Table 70. West Southgate Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	3.63/10
Other ASC Score(s)	N/A
PPC Score	1.68/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$29,654,000

3.63.3 *Phase 2B: Hunt Club Forest*

3.63.3.1 SFA Description

Grey Fox Lane at Piney Bark Drive, Hunting Horn Way at Hunters Run Trail, Hunts Neck Trail at Grey Fox Lane, and Nimmo Parkway Westbound at Hunters Run Trail SFAs are combined into one project called Hunt Club Forest. Individual SFA locations are shown in Figure 67 and are further described below. All SFAs are hydraulically connected and can be combined into one project.

Grey Fox Lane at Piney Bark Drive SFA

Grey Fox Lane, adjacent streets, and habitable structures experience flooding due to a lack of upstream storage and conveyance capacity within the existing stormwater system. As shown in Figure 67, the models indicate that these areas begin to experience flooding in a 10-year storm event.

Hunting Horn Way at Hunters Run Trail SFA

Hunting Horn Way, Hunts Neck Trail, and Hillsboro Quay, and adjacent habitable structures experience flooding due to a lack of upstream storage and conveyance capacity within the existing stormwater system. As shown in Figure 67, the models indicate that these areas begin to experience flooding in a 2-year storm event.

Hunts Neck Trail at Grey Fox Lane SFA

Hunts Neck Trail, other adjacent streets, and habitable structures experience flooding due to a lack of storage and conveyance capacity within the existing stormwater system. As shown in Figure 67, the models indicate that these areas begin to experience flooding in the 10-year storm event.

Nimmo Parkway Westbound at Hunters Run Trail SFA

Nimmo Parkway experiences flooding due to a lack of conveyance capacity within the existing stormwater system and high tailwater within the BMP where the system outfalls. As shown in Figure 67, the models indicate that these areas begin to experience flooding in the 10-year storm event. Nimmo Parkway serves as a secondary evacuation route, and Fire Station 21 is a critical infrastructure.

3.63.3.2 Project Description

This project includes the addition of new pipes, upsized pipes, upsized/improved ditches, and multiple new BMPs to increase stormwater conveyance capacity and storage within the area. Underground storage facilities will be constructed on City property within Hunt Club Park, Hunt Club Forest Park, and Strawbridge Park (GPINs 24047808120000, 24049729650000, and 24049934150000, respectively) while maintaining the current functionality of the parks in proposed conditions. A new ditch is proposed along the west property line of Hunters Run Park, and the existing ditch that crosses Hunters Run Trail will be enlarged to carry more flow from the residential area to the Hunt Club Tributary. Debris will be removed from the most downstream section of the Hunt Club Tributary. Woodhouse Corner Phase 2B: Hunt Club Forest is dependent on Woodhouse Corner Phase 1: Hunters Run Trail at Rockingchair Lane improvements.

3.63.3.3 Project Benefits

The major benefits of the project include mitigating street and habitable structure flooding at 27 residential properties along Hunting Horn Way and Hunts Neck Trail. The project mitigates flooding on Nimmo Parkway which is a secondary evacuation route and provides access to Fire Station 21. This project also addresses several flood reports that have been documented in the area. There is a potential cost-sharing opportunity with DPU for transmission main prioritization between Nimmo Parkway and Hunters Run Trail.

3.63.3.4 Project Analysis Assumptions

HAZUS data is available for the habitable structures along Hunting Horn Way and Hunts Neck Trail. The structures no longer flood in the 100-year storm event. Based on the BCR methodology, the project BCR is 1.0682. The project is given a BR of 1.0 because all street flooding is mitigated. Nimmo Parkway, as a secondary evacuation route, remains passable in

the 10-year storm event with 3.0 feet SLR and 100-year storm event with no SLR. This also meets the design requirement for critical infrastructure.

Easement acquisition is required for multiple proposed pipes between residential properties, and property acquisition is required for the ditch improvements west of Hunting Horn Way. One property acquisition required on Piney Bark Drive is already considered in the Woodhouse Corner Phase 1: Hunters Run Trail at Rockingchair Lane project and is assumed to be acquired before the construction of this project. It is anticipated that extensive maintenance of traffic and utility relocations will be required during construction of the project. Also, minimal effort to obtain environmental permits is anticipated for the project.

3.63.3.5 Other Alternatives Scored

One additional alternative was scored. This alternative included a proposed wet pond to store water within the loop formed by Hunting Horn Way and Hunts Neck Trail before discharging into the Hunt Club Tributary. This alternative had a lower score because it requires significantly more property acquisition than Alternative 2.

3.63.3.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.63.3.7 Project Analysis Summary

Table 71 below provides a summary of the Hunt Club Forest project analysis. Refer to Appendix B-63-3 for project exhibits and supporting documentation.

Table 71. Hunt Club Forest Project Summary

SFA Recurrence	2-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 2
ASC Score	4.68/10
Other ASC Score(s)	Alternative 1 – 4.53/10
PPC Score	9.3/14.4
BR	1.0
BCR	1.0682
Project Cost	$31,671,000

3.63.4 ***Phase 3: East Southgate***

3.63.4.1 SFA Description

Huckleberry Trail and other adjacent streets experience flooding due to a lack of conveyance capacity within the existing stormwater system and high tailwater within the interconnected BMP system. As shown in Figure 67, the models indicate that these areas begin to experience flooding in the 10-year storm event.

3.63.4.2 Project Description

This project will upsize existing pipes and add new pipes to increase stormwater conveyance capacity along Huckleberry Trail, Grapevine Court, and Crossroad Trail. Culverts will be upsized to allow more conveyance through the system. All pipe networks will drain to the

existing interconnected BMP system. Woodhouse Corner Phase 3: East Southgate is dependent on Woodhouse Corner Phase 2A: West Southgate improvements.

3.63.4.3 Project Benefits

The major benefits of the project include mitigating street flooding along Huckleberry Trail and surrounding streets. This project also addresses several flood reports that have been documented in the area. There is a potential cost-sharing opportunity with DPU for transmission main prioritization near Huckleberry Trail and Crossroad Trail.

3.63.4.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated.

Easement acquisition is required to upsize one pipe between residential properties. It is anticipated that moderate maintenance of traffic and utility relocations will be required during the construction of the project. Also, minimal effort to obtain environmental permits is anticipated for the project.

This project, Princess Anne Road at Mathews Green Road, and Three Oaks, are kept separate because the SFAs can be mitigated separately. However, the downstream culverts are the same in all three projects. If the Princess Anne Road at Mathews Green project or the Three Oaks project is constructed first, then the downstream culvert improvements as part of this project would not be required. Refer to Section 3.38 for a description of the Princess Anne Road at Mathews Green Road project and Section 3.54 for a description of the Three Oaks project.

Habitable structure flooding can be seen along Princess Anne Road at two residential properties (GPIN 24047498800000 and 24047486970000). Since the flooding in these parcels is caused by the lack of storage and conveyance capacity within a private drainage system (GPIN 24047581610000), these areas were not addressed.

3.63.4.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.63.4.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.63.4.7 Project Analysis Summary

Table 72 below provides a summary of the East Southgate project analysis. Refer to Appendix B-63-4 for project exhibits and supporting documentation.

Table 72. East Southgate Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	5.41/10
Other ASC Score(s)	N/A
PPC Score	1.68/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$13,595,000

3.63.5 ***Phase 4A: Nimmo Parkway Eastbound at Rockingchair Lane***

3.63.5.1 SFA Description

Nimmo Parkway experiences flooding due to a lack of conveyance capacity within the existing stormwater system, causing runoff to overtop Nimmo Parkway from the existing BMP and outfall ditch. Nimmo Parkway is a secondary evacuation route, and Fire Station 21 is a critical infrastructure. As shown in Figure 67, the models indicate that these areas begin to experience flooding in the 10-year storm event.

3.63.5.2 Project Description

This project proposes removing the connection between the Nimmo Parkway drainage system and the adjacent BMP to the south of Nimmo Parkway Eastbound. Instead, the connecting pipe and ditch will be removed, and the existing outfall of the BMP will be upsized and redirected southwest to the interconnected BMP system. The drainage system along Nimmo Parkway will be diverted to outfall into the four culverts discharging into the Hunter's Run BMP, instead of to the BMP on the north side of Nimmo Parkway as it does in the existing condition. Woodhouse Corner Phase 4A: Nimmo Parkway Eastbound at Rockingchair Lane is dependent on Woodhouse Corner Phase 3: East Southgate improvements.

3.63.5.3 Project Benefits

The major benefits of the project include ensuring that Nimmo Parkway provides access to Fire Station 21 and can effectively serve as a secondary evacuation route. This project also reduces flooding on private property and addresses several flood reports that have been documented in the area. There is a potential cost-sharing opportunity with DPU for transmission main prioritization at the intersection of Rockingchair Lane and Nimmo Parkway.

3.63.5.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated. Nimmo Parkway, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and the 100-year storm event with no SLR. This also meets the design requirement for critical infrastructure.

Property acquisition is not required as all the construction will occur within the ROW and City property. It is anticipated that moderate maintenance of traffic and utility relocations will be

required during the construction of the project. Also, minimal effort to obtain environmental permits is anticipated for the project.

Some runoff is being diverted away from the existing BMP on the north side of Nimmo Parkway. However, this diversion can potentially be offset by the water quality benefits provided by the Hunter's Run BMP. Coordination with the City's VSMP Permit Coordinator is required.

3.63.5.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.63.5.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.63.5.7 Project Analysis Summary

Table 73 below provides a summary of the Nimmo Parkway Eastbound at Rockingchair Lane project analysis. Refer to Appendix B-63-5 for project exhibits and supporting documentation.

Table 73. Nimmo Parkway Eastbound at Rockingchair Lane Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	5.79/10
Other ASC Score(s)	N/A
PPC Score	3.32/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$3,520,000

3.63.6 ***Phase 4B: McComas Way at General Booth Boulevard***

3.63.6.1 SFA Description

This area experiences flooding due to a lack of conveyance capacity within the existing stormwater system. In the existing condition, McComas Way and the adjacent parking lot at 2100 McComas Way experiences flooding. As shown in Figure 67, the models indicate that these areas begin to experience flooding in the 100-year storm event.

3.63.6.2 Project Description

This project will replace the existing 24-inch pipe with a 36-inch pipe along the north side of McComas Way, and the downstream 36-inch pipe will be replaced with a 48-inch pipe. The proposed improvements are adjacent to the private property at 2100 McComas Way (GPIN 24140726370000). Woodhouse Corner Phase 4B: McComas Way at General Booth Boulevard is dependent on Woodhouse Corner Phase 3: East Southgate improvements.

3.63.6.3 Project Benefits

The major benefits of the project include mitigating street flooding along McComas Way. This project addresses flood reports that have been documented in the area.

3.63.6.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated. Easement acquisition is required since the pipe being replaced is not fully within the ROW. It is anticipated that minimal utility relocations, maintenance of traffic, and effort to obtain environmental permits will be required.

3.63.6.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.63.6.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.63.6.7 Project Analysis Summary

Table 74 below provides a summary of the McComas Way at General Booth Boulevard project analysis. Refer to Appendix B-63-6 for project exhibits and supporting documentation.

Table 74. McComas Way at General Booth Boulevard Project Summary

SFA Recurrence	100-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	5.81/10
Other ASC Score(s)	N/A
PPC Score	0.87/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$1,108,800

3.63.7 *Phase 5A: McComas Way at Nimmo Parkway*

3.63.7.1 SFA Description

Nimmo Parkway experiences flooding due to a lack of storage capacity within the existing stormwater system along McComas Way. This system collects onsite drainage coming from the Princess Anne Recreation Center. As shown in Figure 67, the models indicate that these areas begin to experience flooding in the 10-year storm event.

3.63.7.2 Project Description

This project will add underground detention in the parking lot of the Princess Anne Recreation Center. Inlets will be added within the recreation center parking lot, and existing pipes from the recreation center will be connected to the underground storage to collect and store stormwater runoff. The proposed storage will outfall into the existing drainage system crossing Nimmo Parkway. Woodhouse Corner Phase 5A: McComas Way at Nimmo Parkway is dependent on Woodhouse Corner Phase 4A: Nimmo Parkway Eastbound at Rockingchair Lane improvements.

3.63.7.3 Project Benefits

The major benefits of this project include mitigating street flooding on McComas Way, as well as the flooding occurring on surrounding private property. This project also addresses several flood reports that have been documented in the area.

3.63.7.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated.

Property acquisition is not required as all the construction will occur within the ROW and City property. It is anticipated that minimal maintenance of traffic, utility relocations, and effort to obtain environmental permits will be required.

3.63.7.5 Other Alternatives Scored

No additional alternatives were evaluated for this SFA.

3.63.7.6 Other Alternatives Not Scored

No additional alternatives were evaluated for this SFA.

3.63.7.7 Project Analysis Summary

Table 75 below provides a summary of the McComas Way at Nimmo Parkway project analysis. Refer to Appendix B-63-7 for project exhibits and supporting documentation.

Table 75. McComas Way at Nimmo Parkway Project Summary

SFA Recurrence	10-year (no SLR)
Project LOS	100-year (no SLR)
Selected Alternative	Alternative 1
ASC Score	5.57/10
Other ASC Score(s)	N/A
PPC Score	2.08/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$1,760,000

3.63.8 *Phase 5B: General Booth Boulevard at Strawbridge Marketplace*

3.63.8.1 SFA Description

General Booth Boulevard experiences frequent street flooding and flooding on private property due to a lack of storage in the system. General Booth Boulevard serves as a secondary evacuation route. As shown in Figure 67, the models indicate General Booth Boulevard at Strawbridge Marketplace begins to experience flooding in the 2-year storm event.

3.63.8.2 Project Description

This project will add underground storage at the Strawbridge Elementary School parking lot to relieve the flooding on General Booth Boulevard. The project also includes upsizing pipes to the north and south of Strawbridge Marketplace. The proposed pipe system will drain stormwater runoff from General Booth Boulevard and Strawbridge Marketplace to the proposed BMP. The road will be raised 0.75 feet to mitigate the street flooding along General Booth

Boulevard. Woodhouse Corner Phase 5B: General Booth Boulevard at Strawbridge Marketplace is dependent on Woodhouse Corner Phase 4B: McComas Way at General Booth Boulevard improvements.

3.63.8.3 Project Benefits

The major benefits of this project include mitigating street flooding on General Booth Boulevard, as well as the flooding occurring on surrounding private property. The project also ensures that General Booth Boulevard can effectively serve as a secondary evacuation route. There is a potential cost-sharing opportunity with DPU for the transmission main prioritization along General Booth Boulevard and McComas Way.

3.63.8.4 Project Analysis Assumptions

No habitable structures are impacted in the 100-year storm event, so the project is given a BCR value of 1.0. The project is given a BR of 1.0 because all street flooding is mitigated. General Booth Boulevard, as a secondary evacuation route, remains passable in the 10-year storm event with 3.0 feet SLR and the 100-year storm event with no SLR.

Easement acquisition will be required for this project. Improvements are made in the ROW or on City property where possible to limit the amount of easement acquisition. It is anticipated that moderate maintenance of traffic will be required during the construction of the project along General Booth Boulevard and London Bridge Boulevard. Moderate utility relocations will be required during the construction of the project, likely including the 16-inch water main along General Booth Boulevard, the 8-inch and 10-inch water lines along McComas Way, and an 8-inch gravity sewer line in Strawbridge Marketplace. Along London Bridge Road, conflicts are also anticipated with an 8-inch gravity sewer line, 10-inch waterline, and 8-inch sewer force.

3.63.8.5 Other Alternatives Scored

Other alternatives, as described below, were considered, but were not scored.

3.63.8.6 Other Alternatives Not Scored

One additional alternative was considered that would place the underground storage at Strawbridge Marketplace instead of at Strawbridge Elementary School. This alternative did resolve the flooding along General Booth Boulevard without requiring General Booth Boulevard to be raised since it provided more direct storage to the system. However, it was preferred to place the underground storage on City property as opposed to the private developed property, so this alternative was not considered further.

A second alternative was considered that would place a BMP in the Corporate Landing Park and more extensive pipe improvements along General Booth Boulevard. This alternative would also avoid placing underground storage on the private developed property. However, this alternative failed to meet the PWDSM requirements and did not alleviate flooding along General Booth Boulevard, so it was not considered further.

3.63.8.7 Project Analysis Summary

Table 76 below provides a summary of the General Booth Boulevard at Strawbridge Marketplace project analysis. Refer to Appendix B-63-8 for project exhibits and supporting documentation.

Table 76. General Booth Boulevard at Strawbridge Marketplace Project Summary

SFA Recurrence	2-year (no SLR)
Project LOS	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1
ASC Score	5.37/10
Other ASC Score(s)	N/A
PPC Score	2.3/14.4
BR	1.0
BCR	1.0 (no habitable structure flooding)
Project Cost	$8,637,000

3.63.9 *Woodhouse Corner Combined Summary*

Table 77 below provides a summary of the Woodhouse Corner analysis. Refer to Appendix B-63 for project exhibits and supporting documentation.

Table 77. Woodhouse Corner Combined Project Summary

	Phase 1: Hunters Run Trail at Rockingchair Lane	Phase 2A: West Southgate	Phase 2B: Hunt Club Forest	Phase 3: East Southgate	Phase 4A: Nimmo Parkway Eastbound at Rockingchair Lane	Phase 4B: McComas Way at General Booth Boulevard	Phase 5A: McComas Way at Nimmo Parkway	Phase 5B: General Booth Boulevard at Strawbridge Marketplace
SFA Recurrence	10-year (no SLR)	10-year (no SLR)	2-year (no SLR)	10-year (no SLR)	10-year (no SLR)	100-year (no SLR)	10-year (no SLR)	2-year (no SLR)
Project LOS	100-year (no SLR)	100-year (no SLR)	100-year (no SLR) 10-year (3.0 feet SLR)	100-year (no SLR)	100-year (no SLR) 10-year (3.0 feet SLR)	100-year (no SLR)	100-year (no SLR)	100-year (no SLR) 10-year (3.0 feet SLR)
Selected Alternative	Alternative 1	Alternative 1	Alternative 2	Alternative 1	Alternative 1	Alternative 1	Alternative 1	Alternative 1
ASC Score	2.98/10	3.63/10	4.68/10	5.41/10	5.79/10	5.81/10	5.57/10	5.37/10
Other ASC Score(s)	N/A	N/A	Alternative 1 – 4.53	N/A	N/A	N/A	N/A	N/A
PPC Score	5.88/14.4	1.68/14.4	9.3/14.4	1.68/14.4	3.32/14.4	0.87/14.4	2.08/14.4	2.3/14.4
BR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
BCR	1.0 (based on updated model)	1.0 (no habitable structure flooding)	1.0682	1.0 (no habitable structure flooding)	1.0 (no habitable structure flooding)	1.0 (no habitable structure flooding)	1.0 (no habitable structure flooding)	1.0 (no habitable structure flooding)
Individual Project Cost	$87,776,300	$29,654,000	$31,671,000	$13,595,000	$3,520,000	$1,108,800	$1,760,000	$8,637,000
Total Project Cost	$177,722,100							

Conclusion


WEST NECK
A PLAQUE DISPLAYING ALL BENEFACTORS AND MEMORIAMS IS LOCATED IN THE WEST NECK VILLAGE HALL

4 Conclusion

The Upper West Neck Creek Drainage Basin is highly susceptible to tailwater influences. It is also a hub of new construction with ongoing roadway improvements and new housing developments. These characteristics presented a different set of challenges from the first SWMP developed for Linkhorn Bay. While the overall approach remained the same for the 100-year storm event, early analysis of the Upper West Neck Creek SWMP showed that many SFAs could not be resolved due to SLR influence on the tailwater conditions. When SLR is applied to the basin outfall, several SFAs experience a starting tailwater that exceeds road and property elevations. In order to evaluate these SFAs and provide a project, PW-SWEC made the decision to include the West Neck Creek City-Wide Alignment for evaluating SFA alternatives for the 100-year storm event, eliminating SLR influence on the design tailwater elevation. While the City-wide solution will eliminate SLR influence for the 100-year storm event, it will not be closed for more frequent storms. Full solutions were still conceptualized for the 10-year storm event with SLR for each SFA, except as noted below.

Upper West Neck Creek projects identified for the SFAs can generally be placed into two categories:

1) SFAs that are not driven by tailwater influences.

i) Fifty-six projects meet the PWDSM requirements.

ii) Of the projects that meet the PWDSM requirements, 24 projects are phased projects. A phased project is proposed considering the extent of improvements that are required and to accomplish the objective of the SWMP to develop “standalone” solutions that are not dependent on downstream improvements. Project phases are defined by the individual SFA boundaries and beginning with the most downstream improvements. Future refinements to the project phasing proposed may be required.

2) SFAs that are highly sensitive to tailwater.

i) Three projects have a reduced 10-year LOS (Breezy Pines Lane at Bartholomews Crossing, Landstown Meadows and Landstown Lake, and Saville Garden Way at Holland Road).

   i) Given the proximity of the neighborhoods to the 100-year floodplain and the associated tailwater influence on the 100-year design of drainage improvements, a 10-year LOS was considered for these projects.

   ii) The BRs for these projects range from 0.89 to 0.91.

   iii) The 10-year LOS maintains the HGL in the system in the 10-year storm event with 1.5 feet of SLR and resolves any habitable structure flooding with less than 6” of flooding above the crown of the road in the 100-year storm event with no SLR. Approval of a reduced LOS by the City Engineer will be required for these projects.

ii) Twelve projects have a reduced 50-year LOS.

   i) Generally, these projects are not located as close to the 100-year floodplain as the 10-year LOS projects, but are still sensitive to tailwater influences. Typically, site constraints prohibit additional storage or conveyance improvements to achieve the 100-year LOS.

   ii) The BRs for these projects range from 0.73 to 0.99.

   iii) A 50-year LOS maintains the HGL in the system for the 10-year storm event with 1.5 feet of SLR and resolves any habitable structure flooding with less than 3” of flooding

above the crown of the road in the 100-year storm event with no SLR. Approval of a reduced LOS by the City Engineer will be required for these projects.

iii) Nine projects were set aside as it was determined that only neighborhood and/or City-wide solutions would mitigate the flooding. Seven of these SFAs are within the FEMA Floodplain AE.
    i) These are areas that would benefit from a neighborhood solution, similar to those shown in the SLW Adaptation Strategy Report. These neighborhoods can be designed to resolve the flooding issues that occur from a smaller storm event. PW-SWEC will, in the future, have a neighborhood solution created to establish resiliency in these neighborhoods.

Twelve projects included a BCR greater than 1.0 using available HAZUS AAL data. As stated earlier, some projects indicated that structural flooding was resolved, but the structural flooding was not reflected in the BCR. The models used to create the flood-depth rasters were prepared in January 2021, while the HAZUS data was created from models prepared in May 2021. The BCR values reflect the most accurate information at this time.

Project Tiers

The combined ranking score calculated for each project will provide guidance to the City in the future as projects are prioritized for implementation. The project's combined ranking score is the product of the selected ASC, PPC, BCR, and BR. Based on the results, the projects were separated into two tiers, as can be seen below. The highest scoring projects were placed in Tier 1, while the lower scoring projects were placed in Tier 2, as shown in Figure 68.

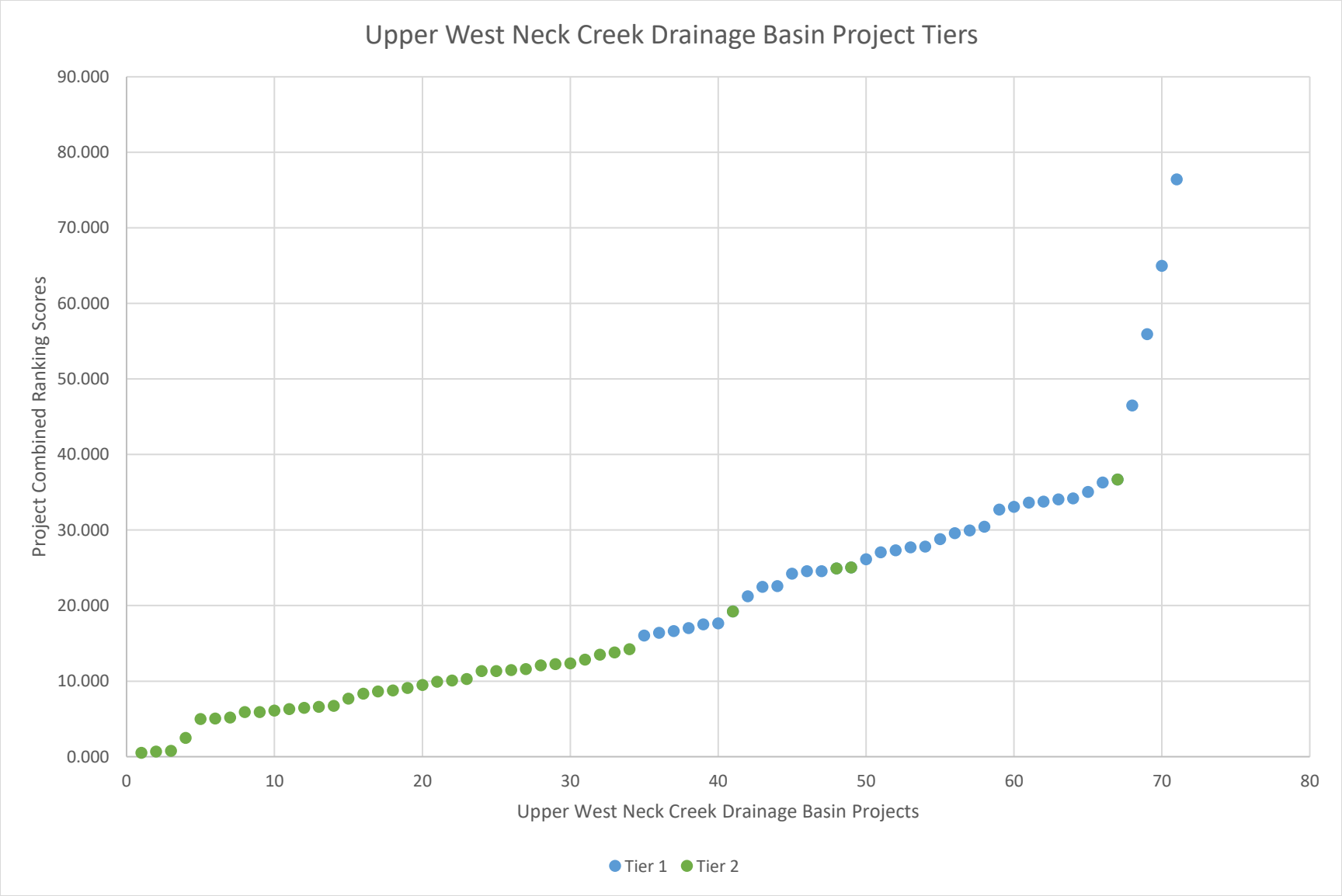


Figure 68. Upper West Neck Creek Tier 1 and 2 Projects

It is to be noted that the combined ranking score is necessary to separate projects into their respective tiers. It is not recommended that this score be used to determine the priority for project implementation. For this reason, projects are listed alphabetically in their respective tiers instead of descending order of the combined ranking score. Tier 1 consists of the 33 highest scoring projects. Four additional projects have a Tier 1 score, but they are phased projects contingent on the completion of a Tier 2 project, and are therefore included in Tier 2. These four projects are shown as Tier 2 in the graph and included in the Tier 2 table below. A total of 38 projects are placed in Tier 2. Tier 1 and Tier 2 projects are summarized in Table 78 and Table 79, respectively.

Table 78. Upper West Neck Creek Tier 1 Projects

Project Name	Drainage Basin	Council District (Voting District)	Cost (in 2021 dollars)
Buckner Farms Phase 1 - Dam Neck Road at Holland Road	Upper West Neck Creek	Rose Hall (3)	$16,095,000
Buyrn Farm	Upper West Neck Creek	Princess Anne (7)	$3,081,000
Castleton	Upper West Neck Creek	Rose Hall (3)	$4,880,500
Christopher Farms Phase 1 - Princess Anne Crossing	Upper West Neck Creek	Princess Anne (7)	$42,646,600
Court House Forest	Upper West Neck Creek	Princess Anne (7)	$17,466,200
Courthouse Drive at James Madison Boulevard	Upper West Neck Creek	Princess Anne (7)	$18,020,000
Dam Neck Road and Harpers Road Phase 1 - London Bridge Road at Harpers Road	Upper West Neck Creek	Rose Hall (3) / Princess Anne (7)	$37,763,000
Dam Neck Road and Harpers Road Phase 2 - Dam Neck Road at Harpers Road	Upper West Neck Creek	Beach (6) / Princess Anne (7)	$36,367,500
Dam Neck Road at Princess Anne Road	Upper West Neck Creek	Centerville (1) / Princess Anne (7)	$18,038,000
Foxfire	Upper West Neck Creek	Princess Anne (7)	$60,782,800
Heron Ridge Estates	Upper West Neck Creek	Princess Anne (7)	$43,360,000
Holland Woods	Upper West Neck Creek	Princess Anne (7)	$2,773,200
Landstown Meadows and Landstown Lake	Upper West Neck Creek	Princess Anne (7)	$93,238,200
Laurel Oak Lane at Holland Road	Upper West Neck Creek	Princess Anne (7)	$3,441,600

Project Name	Drainage Basin	Council District (Voting District)	Cost (in 2021 dollars)
Litchfield Manor, Highcourt and Princess Anne Quarter	Upper West Neck Creek	Princess Anne (7)	$59,960,300
London Bridge Road at Hunt Club Farm	Upper West Neck Creek	Princess Anne (7)	$3,566,250
Maple Shade Drive at Wild Cherry Court	Upper West Neck Creek	Princess Anne (7)	$6,967,700
Mayberry Drive at London Bridge Road	Upper West Neck Creek	Rose Hall (3) / Princess Anne (7)	$12,476,800
Nestlebrook Trail	Upper West Neck Creek	Princess Anne (7)	$30,815,600
Pine Ridge and Middle Oaks Plantation Phase 1 - Pine View Avenue at London Bridge Road	Upper West Neck Creek	Princess Anne (7)	$44,838,100
Pine Ridge and Middle Oaks Plantation Phase 2 - Breezy Pines Lane at Bartholomews Crossing	Upper West Neck Creek	Rose Hall (3) / Princess Anne (7)	$15,840,200
Prince George Estates	Upper West Neck Creek	Rose Hall (3) / Princess Anne (7)	$27,797,700
Princess Anne Road at North Landing Road	Upper West Neck Creek	Princess Anne (7)	$1,531,000
Rollingwood	Upper West Neck Creek	Princess Anne (7)	$10,972,000
Saville Garden Way at Holland Road	Upper West Neck Creek	Princess Anne (7)	$12,272,700
Seaboard Road and Chloe Lane	Upper West Neck Creek	Princess Anne (7)	$5,458,800
Seaboard Road at Heron Ridge Lane	Upper West Neck Creek	Princess Anne (7)	$1,486,300
Signature Circle	Upper West Neck Creek	Princess Anne (7)	$44,313,700
Strawbridge Park North	Upper West Neck Creek	Princess Anne (7)	$27,131,100
Tree Garden Way at Kindling Hollow Road	Upper West Neck Creek	Princess Anne (7)	$27,033,100
Victoria Park	Upper West Neck Creek	Princess Anne (7)	$9,203,700
Woodhouse Corner Phase 1 - Hunters Run Trail at Rockingchair Lane	Upper West Neck Creek	Princess Anne (7)	$87,776,300
Woodhouse Corner Phase 2B - Hunt Club Forest	Upper West Neck Creek	Princess Anne (7)	$31,671,000

Table 79. Upper West Neck Creek Tier 2 Projects

Project Name	Drainage Basin	Council District (Voting District)	Cost (in 2021 dollars)
Buckner Farms Phase 2A - Holland Road at Shipps Corner Road	Upper West Neck Creek	Rose Hall (3)	$6,846,000
Buckner Farms Phase 2B - Light Horse Loop and Storm Bird Loop	Upper West Neck Creek	Rose Hall (3)	$42,340,600
Buckner Farms Phase 3A - Criollo Drive	Upper West Neck Creek	Rose Hall (3)	$11,163,600
Buckner Farms Phase 3B - Buckner Boulevard at Crofts Pride Drive	Upper West Neck Creek	Rose Hall (3)	$5,123,750
Buckner Farms Phase 4A - Brigands Way at Dam Neck Road	Upper West Neck Creek	Rose Hall (3)	$10,383,500
Buckner Farms Phase 4B - Grassland Farms	Upper West Neck Creek	Rose Hall (3)	$37,300,600
Buckner Farms Phase 4C - Buckner Farms North	Upper West Neck Creek	Rose Hall (3)	$8,065,200
Christopher Farms Phase 2 - North Christopher Farms	Upper West Neck Creek	Princess Anne (7)	$9,328,100
Dam Neck Road at Drakesmile Road	Upper West Neck Creek	Rose Hall (3)	$3,300,000
Dam Neck Road at Taylor Farm Road	Upper West Neck Creek	Rose Hall (3)	$10,452,500
Drakesmile Road at HRSD Shipps Corner PRS	Upper West Neck Creek	Rose Hall (3)	$990,000
Drakesmile Road at Shipps Corner Road	Upper West Neck Creek	Rose Hall (3)	$3,560,000
Eagles Nest	Upper West Neck Creek	Princess Anne (7)	$3,403,750
General Booth Boulevard at Corporate Landing	Upper West Neck Creek	Princess Anne (7)	$10,051,250
Highgate Greens and Seaboard Forest Phase 1 - Live Oak Trail at Seaboard Road	Upper West Neck Creek	Princess Anne (7)	$18,597,800

Project Name	Drainage Basin	Council District (Voting District)	Cost (in 2021 dollars)
Highgate Greens and Seaboard Forest Phase 2 - Highgate Greens and Sawyer's Meadow	Upper West Neck Creek	Princess Anne (7)	$15,723,600
Leroy Road at Farmers Court	Upper West Neck Creek	Princess Anne (7)	$4,287,500
Nimmo Parkway at Seaboard Road	Upper West Neck Creek	Princess Anne (7)	$2,240,000
Penshurst Way	Upper West Neck Creek	Rose Hall (3)	$1,822,500
Princess Anne Road at Landstown Centre Way	Upper West Neck Creek	Princess Anne (7)	$2,850,000
Princess Anne Road at Mathews Green Road	Upper West Neck Creek	Princess Anne (7)	$26,914,000
Princess Anne Woods	Upper West Neck Creek	Princess Anne (7)	$16,620,000
Seaboard Road at County Place	Upper West Neck Creek	Princess Anne (7)	$1,447,500
South Rosemont Road at Buckner Boulevard	Upper West Neck Creek	Centerville (1) / Rose Hall (3)	$1,873,100
South Rosemont Road at Concert Drive	Upper West Neck Creek	Centerville (1)	$155,000
Strawbridge Park	Upper West Neck Creek	Princess Anne (7)	$598,500
Taylor Farm Road at Aviator Drive	Upper West Neck Creek	Rose Hall (3)	$10,250,000
Three Oaks	Upper West Neck Creek	Princess Anne (7)	$14,607,800
Tower Bridge Loop North	Upper West Neck Creek	Rose Hall (3)	$5,076,100
West Neck Road at North Landing Road	Upper West Neck Creek	Princess Anne (7)	$5,089,000
West Neck Road at Signature Drive	Upper West Neck Creek	Princess Anne (7)	$825,000
Windy Willow Court	Upper West Neck Creek	Rose Hall (3)	$1,170,000
Woodhouse Corner Phase 2A - West Southgate	Upper West Neck Creek	Princess Anne (7)	$29,654,000
Woodhouse Corner Phase 3 - East Southgate	Upper West Neck Creek	Princess Anne (7)	$13,595,000

Project Name	Drainage Basin	Council District (Voting District)	Cost (in 2021 dollars)
Woodhouse Corner Phase 4A - Nimmo Parkway Eastbound at Rockingchair Lane	Upper West Neck Creek	Princess Anne (7)	$3,520,000
Woodhouse Corner Phase 4B - McComas Way at General Booth Boulevard	Upper West Neck Creek	Princess Anne (7)	$1,108,800
Woodhouse Corner Phase 5A - McComas Way at Nimmo Parkway	Upper West Neck Creek	Princess Anne (7)	$1,760,000
Woodhouse Corner Phase 5B - General Booth Boulevard at Strawbridge Marketplace	Upper West Neck Creek	Princess Anne (7)	$8,637,000

Tier 3 is reserved for those projects highly influenced by existing tailwater conditions and the future impacts of SLR, especially for storms more frequent than the 100-year event, where the most practical solutions are limited to neighborhood and/or City-wide flood protection measures. Nine projects were determined to be in Tier 3, as summarized in Table 80 below.

Table 80. Upper West Neck Creek Tier 3 Projects

Project Name	Drainage Basin	Council District (Voting District)
Buyrn Circle at Buyrn Court	Upper West Neck Creek	Princess Anne (7)
Holland Oaks and Holland Pines North	Upper West Neck Creek	Princess Anne (7)
Lake Placid	Upper West Neck Creek	Rose Hall (3)
Mulberry Loop	Upper West Neck Creek	Rose Hall (3)
Princess Anne Place	Upper West Neck Creek	Princess Anne (7)
Princess Anne Road at Seaboard Road	Upper West Neck Creek	Princess Anne (7)
Springhaven Drive at Windy Pines Bend	Upper West Neck Creek	Rose Hall (3) / Princess Anne (7)
Tower Bridge Loop at Seven Kings Road	Upper West Neck Creek	Rose Hall (3)
Windy Pines Bend at Piney Woods Lane	Upper West Neck Creek	Rose Hall (3) / Princess Anne (7)

Recommendations

As the models continue to be updated with new information, SFAs and projects within the Upper West Neck Creek drainage basin are recommended for further refinement. Specifically, the most recent model updates added more detail to the perimeter of the drainage basin to reflect more interconnectivity with surrounding basins. SFAs near the boundaries should be reevaluated as it is expected that the extent of existing flooding has decreased with the model updates. The scope and cost of the proposed projects for those SFAs may also be reduced.

List of Appendices

A	Benefit-Cost Analysis (BCA) Methodology
B-1	Buckner Farms
B-1-1	Phase 1: Dam Neck Road at Holland Road
B-1-2	Phase 2A: Holland Road at Shipps Corner Road
B-1-3	Phase 2B Light Horse Loop and Storm Bird Loop
B-1-4	Phase 3A: Criollo Drive
B-1-5	Phase 3B: Buckner Boulevard at Crofts Pride Drive
B-1-6	Phase 4A: Brigands Way at Dam Neck Road
B-1-7	Phase 4B: Grassland Farms
B-1-8	Phase 4C: Buckner Farms North
B-2	Buyrn Circle at Buyrn Court
B-3	Buryn Farm
B-4	Castleton
B-5	Christopher Farms
B-5-1	Phase 1: Princess Anne Crossing
B-5-2	Phase 2: North Christopher Farms
B-6	Court House Forest
B-7	Courthouse Drive at James Madison Boulevard
B-8	Dam Neck Road and Harpers Road
B-8-1	Phase 1: London Bridge Road at Harpers Road
B-8-2	Phase 2: Dam Neck Road at Harpers Road
B-9	Dam Neck Road at Drakesmile Road
B-10	Dam Neck Road at Princess Anne Road
B-11	Dam Neck Road at Taylor Farm Road
B-12	Drakesmile Road at HRSD Shipps Corner Pressure Reducing Station (PRS)
B-13	Drakesmile Road at Shipps Corner Road
B-14	Eagles Nest
B-15	Foxfire
B-16	General Booth Boulevard at Corporate Landing
B-17	Heron Ridge Estates
B-18	Highgate Greens and Seaboard Forest
B-18-1	Phase 1: Live Oak Trail at Seaboard Forest
B-18-2	Phase 2: Highgate Greens at Bodnar Lane
B-19	Holland Oaks and Holland Pines North
B-20	Holland Woods
B-21	Indian River Road
B-22	Lake Placid
B-23	Landstown Meadows and Landstown Lakes
B-24	Laurel Oak Lane at Holland Road
B-25	Leroy Road at Farmers Court
B-26	Litchfield Manor, Highcourt, and Princess Anne Quarter
B-27	London Bridge Road at Hunt Club Farm
B-28	Maple Shade Drive at Wild Cherry Court
B-29	Mayberry Drive at London Bridge Road
B-30	Mulberry Loop
B-31	Nestlebrook Trail
B-32	Nimmo Parkway at Seaboard Road

B-33	Penshurst Way
B-34	Pine Ridge and Middle Oaks Plantation
B-34-1	Phase 1: Pine View Avenue at London Bridge Road
B-34-2	Phase 2: Breezy Pines Lane at Bartholomews Crossing
B-35	Prince George Estates
B-36	Princess Anne Place
B-37	Princess Anne Road at Landstown Centre Way
B-38	Princess Anne Road at Mathews Green Road
B-39	Princess Anne Road at North Landing Road
B-40	Princess Anne Road at Seaboard Road
B-41	Princess Anne Woods
B-42	Rollingwood
B-43	Saville Garden Way at Holland Road
B-44	Seaboard Road and Chloe Lane
B-45	Seaboard Road at County Place
B-46	Seaboard Road at Heron Ridge Lane
B-47	Signature Circle
B-48	South Rosemont Road at Buckner Boulevard
B-49	South Rosemont Road at Concert Drive
B-50	Springhaven Drive at Windy Pines Bend
B-51	Strawbridge Park
B-52	Strawbridge Park North
B-53	Taylor Farm at Aviator Drive
B-54	Three Oaks
B-55	Tower Bridge Loop North
B-56	Tower Bridge Loop at Seven Kings Road
B-57	Tree Garden Way at Kindling Hollow Road
B-58	Victoria Park
B-59	West Neck Road at North Landing Road
B-60	West Neck Road at Signature Drive
B-61	Windy Pines Bend at Piney Woods Lane
B-62	Windy Willow Court
B-63	Woodhouse Corner
B-63-1	Phase 1: Hunters Run Trail at Rockingchair Lane
B-63-2	Phase 2A: West Southgate
B-63-3	Phase 2B: Hunt Club Forest
B-63-4	Phase 3: East Southgate
B-63-5	Phase 4A: Nimmo Parkway Eastbound at Rockingchair Lane
B-63-6	Phase 4B: McComas Way at General Booth Boulevard
B-63-7	Phase 5A: McComas Way at Nimmo Parkway
B-63-8	Phase 5B: General Booth Boulevard at Strawbridge Marketplace