Drainage Narrative and Calculations

For

Smithfield Sidewalk Improvements

Isle of Wight County, Virginia

August, 2023

Prepared for:

Isle of Wight County

Kimley»Horn

KHA Project No. 117032020

PROJECT DESCRIPTION

The project is located along US Route 258 and State Route 655 (Great Spring Road) in Smithfield, Virginia. Improvements along US Route 258 are located on the north side of the roadway between the Westside Elementary School to the west of the existing intersection with Route 10, and extending to the east along US 258 to the east side of Grace Street where the improvements tie into the existing sidewalk. The project serves to provide a consistent pedestrian route along the north side of Main Street. Improvements along US 258 consist of new sidewalk improvements across the frontage of Westside Elementary School, performing maintenance and replacement of existing sidewalk between the school and Pole Road, installation of new sidewalk between Pole Road and the east side of the Bypass, mill and overlay of existing roadway and shoulder pavement from the Bypass to Grace Street, and new curb and gutter and sidewalk improvements from Grace Street to the eastern end of the project limits. Additional improvements are located along the west side of Great Spring Road from US 258 to Quail Street, consisting of new curb and gutter and sidewalk improvements.

PROJECT LOCATION AND ADJACENT AREAS

The project limits extend along US 258 between the eastern entrance to Westside Elementary School entrance to approximately 260 linear feet to the east of Grace Street, for approximately 3900 linear feet. The project limits also extend down Great Springs Road from US 258 to Quail Street for approximately 700 linear feet. The project site is located west of downtown Smithfield and is centered on the existing signalized intersection of US 258 and State Route 10.

EXISTING SITE CONDITIONS

The existing condition along the north side of US Route 258 varies along the project limits. The western portion of the project has existing curb and gutter and in most instances sidewalk infrastructure as well, although the sidewalk is narrower than current design standards allow. The existing condition along US 258 between Pole Road and Grace Street consists of no curb and gutter and no sidewalk infrastructure. Great Springs Road is currently a two lane, undivided roadway with roadside ditches on both sides of the roadway.

OFF-SITE AREAS

The land disturber will be responsible for final stabilization and maintenance of all off-site areas. There are no designated offsite areas where land disturbing will take place.

SOILS

The following soil types were identified within the project site by the United States Department of Agriculture's Natural Resources Conservation Service Web Soil Survey: Uchee Loamy Sand (100% AOI).

Uchee Loamy Sand, 0 to 2 percent slopes

Uchee Loamy Sand makes up 100 percent of the project site. Slopes are 0 to 2 percent. The parent material consists of loamy marine deposits. Depth to a root restrictive layer is greater than 80 inches. The natural drainage class is well drained and the runoff class is low. Uchee Loamy Sand has a moderately high capacity (0.20 to 0.57 in/hr) of the most limiting layer to transit water with little to no frequency of flooding or ponding. The depth to the water table is about 42 to 60 inches

with moderate (about 6.4 inches) water storage in profile. Nonirrigated land capability classification is 2s. This soil does not meet hydric criteria.

CRITICAL EROSION AREAS

There are no identified critical erosion areas near this project that have the potential for serious erosion problems.

EROSION AND SEDIMENT CONTROL MEASURES

All proposed erosion and sediment control measures are in accordance with the Virginia *Erosion and Sediment Control Handbook, 3rd Edition 1992* and the most current revisions to the VDOT *Road and Bridge Standards, 2016 edition.*

Descriptions of the erosion and sediment measures that will be used for this project are given below:

Inlet Protection and Culvert Inlet Protection

Inlet protection will be provided on all existing and proposed storm drain inlets and culvert end sections within the site, including all storm structures downstream of the project site.

Silt Fence (Type A):

Silt fence is placed as shown on the plans to trap sediment-laden runoff from exiting the project site.

PERMANENT STABILIZATION

Erosion and sediment control measures will be used during the construction phases of the project. Once construction has been completed, permanent stabilization will take place utilizing the appropriate permanent seeding mix over denuded areas.

STORMWATER MANAGEMENT CONSIDERATIONS

Water Quality

Performance based water quality calculations were performed utilizing the Virginia Runoff Reduction Method (VRRM) compliance spreadsheet for redevelopment provided by the Virginia Department of Environmental Quality (DEQ). These calculations require a total of 0.27 lb/yr reduction in the total phosphorous load. The total project area is 0.47 acres. Since this is less than 5 acres, this project qualifies for the purchasing of nutrient credits to satisfy water quality requirements. The removal requirement of 0.27 lb/yr will be achieved through the purchase of nutrient credits. Quality calculations can be found in Appendix C.

Water Quantity

The proposed project area has three existing outfalls that will be utilized in the post development condition:

- Outfall 1: The portions of the project in front of Westside Elementary School and near the intersection of Main street and US-258 are captured by a closed system and conveyed along Main St to a 30" RCP at the intersection of Middle Street and Main Street.

- Outfall 2: At the southern end of improvements along Great Spring Road, runoff leaves the site through a 24" pipe which flows south to a 36" pipe which acts as the point of analysis for the outfall. This outfall captures runoff from the project area along Main Street between Pole Road and Route 10, as well as all runoff from the project area along Great Spring Road.

- Outfall 3: Between Grace Street and Cary Street on the eastern side of the project, runoff outfalls from the site through a 24" pipe flowing south. This outfall captures runoff from the project area between Route 10 and Cary Street.

Outfall 1

Proposed improvements within the drainage basin of Outfall 1 does not include new curb and gutter, only the construction of new sidewalk behind the existing curb and gutter. These proposed improvements do not result in the development of concentrated flow, only sheet flow across the proposed sidewalk. According to section 9VAC25-870-66 subdivision D regarding water quantity, no further water quantity controls are required if the increased volume of sheet flow is diverted to a stormwater conveyance system that conveys the runoff without causing down-gradient erosion, sedimentation, or flooding. The immediate outfall of the project are curb inlets for a manmade system (reinforced concrete pipes), it can be assumed that no erosion occurs in the pipes.

Outfall 2

Flooding has been reported upstream of Outfall 2 at the location of proposed structure 6-2. Today this area captures flow from a 24" pipe (which accepts flow from the existing v ditch flowing through the adjacent heavily wooded parcel to the north), dual 12" pipes form the east side of Great Spring Road, and the roadside ditch along the west side of Great Spring Road. Today the junction between these 3 flows is a series of headwalls which create a box and causes localized flooding due flow rate but mostly due to in-efficient flow path from the ditch to the series of culvert pipes.

We plan to enclose the junction between the 3 sources of flow with structure 6-2. This will aid the flow in continuing downstream and limit the overtopping which impacts Great Spring Road. Our Planned improvements will not address the existing flooding that occurs due to the undersized 24" pipe that receives the flow from the ditch to the north.

For Outfall 2, channel protection and flood protection have been analyzed to the point of 1%, which is where the runoff enters a 36" pipe at the intersection of Great Spring Road and Quail Street. The projects' contributing disturbed area for this outfall is 0.24 acres, and the total contributing drainage area at the point of analysis is 48 acres (per StreamStats). The total contributing drainage area from SteamStats was verified with project survey as well as available GIS information. Drainage maps delineating the site's contributing drainage area and the total contributing area can be found in Appendix A.

Channel Protection

Channel protection was analyzed to the point of 1% using StormCAD software. At this point, the total contributing drainage area is 48 acres. C factors were assigned per VDOT Drainage Manual, Appendix 6E-1.

According to StormCAD results, the velocity through the 36" pipe at the point of analysis during the 10-year storm event is 8.10 ft/s which is nonerosive in a closed system. The model was also run for the 2-year storm and the velocity is 8.03 ft/s. Since the velocity during the 2-year storm is nonerosive, channel protection criteria is met. StormCAD results for the 10 year storm can be found in Appendix B.

Flood Protection

The same StormCAD model used for channel protection was used to analyze the system for satisfying flood protection. Results show that during the 10-year storm event, the HGL is contained within the manmade system, and the pipes are not over capacity. Flood protection criteria has been met. StormCAD results for the 10 year storm can be found in Appendix B.

Outfall 3

For Outfall 3, channel protection and flood protection have been analyzed to the point of 1%, which is where the runoff enters a 24" pipe across from the laundromat on Main Street. The projects' contributing disturbed area for this outfall is 0.12 acres, and the total contributing drainage area at the point of analysis is 27 acres (per StreamStats). The total contributing drainage area from SteamStats was verified with project survey as well as available GIS information. Drainage maps delineating the site's contributing drainage area and the total contributing area can be found in Appendix A.

Channel Protection

Channel protection was analyzed to the point of 1% using StormCAD software. At this point, the total contributing drainage area is 27 acres. C factors were assigned per VDOT Drainage Manual, Appendix 6E-1.

According to StormCAD results, the velocity through the 24" pipe at the point of analysis during the 10-year storm event is 10.35 ft/s which is nonerosive in a closed system. The model was also run for the 2-year storm and the velocity is 10.14 ft/s Since the velocity during the 2-year storm is nonerosive, channel protection criteria is met. StormCAD results for the 10 year storm can be found in Appendix B.

Flood Protection

The same StormCAD model used for channel protection was used to analyze the system for satisfying flood protection. Results show that during the 10-year storm event, the HGL is contained within the manmade system, and the pipes are not over capacity. Flood protection criteria has been met. StormCAD results for the 10 year storm can be found in Appendix B.

CALCULATIONS

All calculations used for this design are attached in the appendices.

DESIGN PARAMETERS AND ASSUMPTIONS

- *State Hydraulic Unit Code (HUC)*
  - *VAHU6 = JL40*

- *HUC12 = 020802060903*

- *Design Storm:*
  - Rational method for spread calculations
  - 2-yr flow velocities for erosion control in ditches and channels
  - 10-yr storm for capacity in ditches and storm sewer
- *B, D, E Factors for Isle of Wight County:*

	2-yr	10-yr	25-yr
B	71.07	54.11	47.20
D	12.25	9.25	7.50
E	0.86	0.72	0.65

- *24-hr Precipitation Values for Isle of Wight County:*
  - 2-yr ⇨ 3.59-in
  - 10-yr ⇨ 5.53-in
  - 25-yr ⇨ 6.84-in
  - 50-yr ⇨ 7.97-in
  - 100-yr ⇨ 9.22-in
- *Manning's "N" Values:*
  - 0.013 for concrete pipes/culverts
  - 0.015 for pavement hydraulics
- *Gutter Longitudinal Slope (per section 9.4.3.3 of the VDOT Drainage Manual, 2002 edition):*
  - 0.3% (minimum)
  - 0.5% (desired)
- *Pavement Cross Slope:*
  - 2.0% (typical)
- *Gutter Width:*
  - Standard width = 2-ft
- *Gutter Cross Slope:*
  - 8.33% (1-in/ft)
- *Amount of Local Depression:*
  - 2-in in areas with curb and gutter
- *Allowable Spread:*
  - On grade inlets:
    - Intensity = 4.0-in/hr
    - Maximum Design Spread Width = Gutter + ½ lane
  - Inlets in sag locations:
    - Intensity = 4.0-in/hr
    - Maximum Design Spread Width = Gutter + ½ lane
    - Check storm intensity = 6.5-in/hr
- *Inlet Lengths:*
  - Varies upon spread calculations
  - Based upon a 50% capture efficiency at each sump inlet (minimum)
- *Acceptable Hydraulic Grade Line Elevation:*
  - 0-in below flow line at inlet (desirable)

  - 0-in below inlet rim (minimum)
- *C Value:*
  - Appendix 6E-1 (VDOT Drainage Manual, 2002 edition; see appendix I)
- *Pipe Slopes:*
  - 0.20% (minimum)
  - 0.50% (desirable)
  - 16.0% (maximum)
- *Design Velocity for Pipes:*
  - 3-fps (desirable)
  - 10-fps (maximum)

Appendix A - Drainage Area Maps

SHEET NUMBER

SMITHFIELD SIDEWALK IMPROVEMENTS
PREPARED FOR
ISLE OF WIGHT COUNTY
SMITHFIELD VIRGINIA

INLET DRAINAGE AREA MAP

KHA PROJECT 117032020
DATE 7/31/2023
SCALE AS SHOWN
DESIGNED BY MAM
DRAWN BY MAM
CHECKED BY APF

Kimley-Horn and Associates, Inc.
Virginia Beach, Virginia
Roadway Engineer

Kimley»Horn

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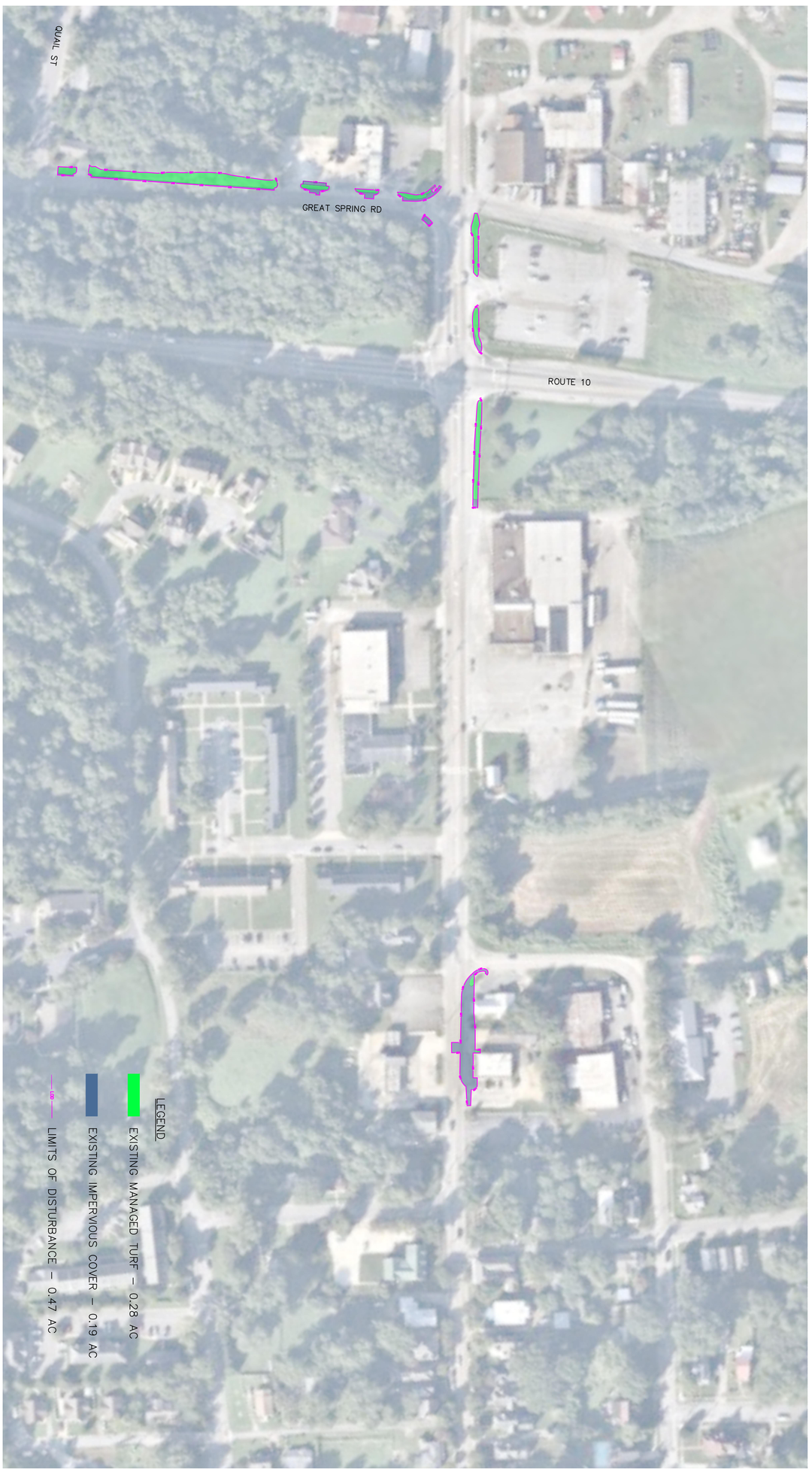
WWW.KIMLEY-HORN.COM

No.	REVISIONS	DATE

MATCHLINE – SEE ABOVE



MATCHLINE – SEE BELOW

GRAPHIC SCALE IN FEET
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NORTH

SHEET NUMBER

SMITHFIELD SIDEWALK IMPROVEMENTS
PREPARED FOR
ISLE OF WIGHT COUNTY
SMITHFIELD VIRGINIA

EXISTING LAND COVER MAP

KHA PROJECT 117032020
DATE 7/31/2023
SCALE AS SHOWN
DESIGNED BY MAM
DRAWN BY MAM
CHECKED BY APF

Kimley-Horn and Associates, Inc.
Virginia Beach, Virginia
Roadway Engineer

Kimley»Horn

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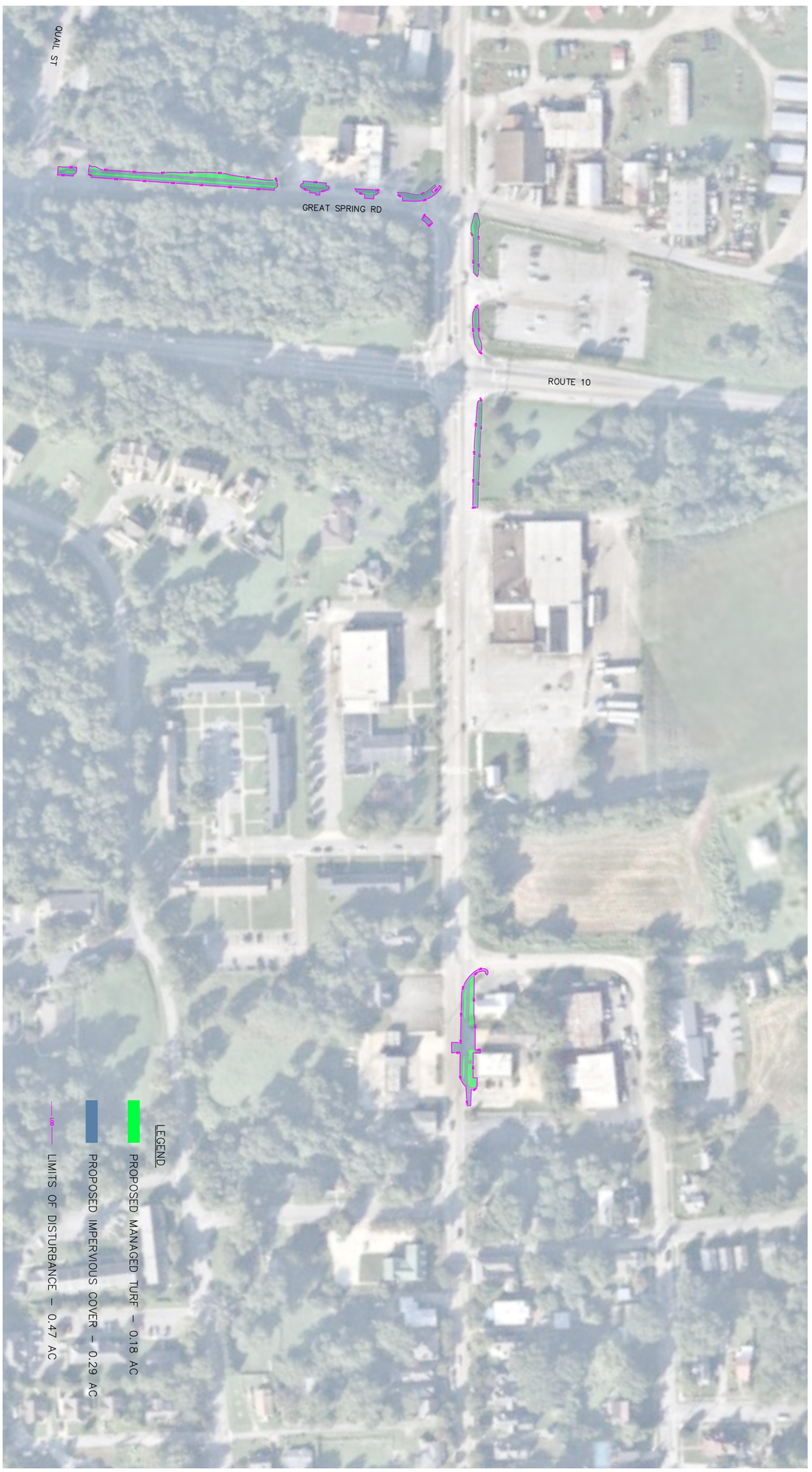
No.	REVISIONS	DATE

Plotted By:Marquis, Caroline Sheet Set:SMITHFIELD SIDEWALK Layout:Proposed August 02, 2023 03:45:14pm K:\VAB_RDWY\117032020 - Smithfield Sidewalk\Engineering\Drainage\Maps\Land Cover Map.dwg

MATCHLINE – SEE ABOVE



MATCHLINE – SEE BELOW

0 50 100 200
GRAPHIC SCALE IN FEET

NORTH

SHEET NUMBER

SMITHFIELD SIDEWALK IMPROVEMENTS
PREPARED FOR
ISLE OF WIGHT COUNTY
SMITHFIELD VIRGINIA

PROPOSED LAND COVER MAP

KHA PROJECT 117032020
DATE 7/31/2023
SCALE AS SHOWN
DESIGNED BY MAM
DRAWN BY MAM
CHECKED BY APF

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Virginia Beach, Virginia
Roadway Engineer

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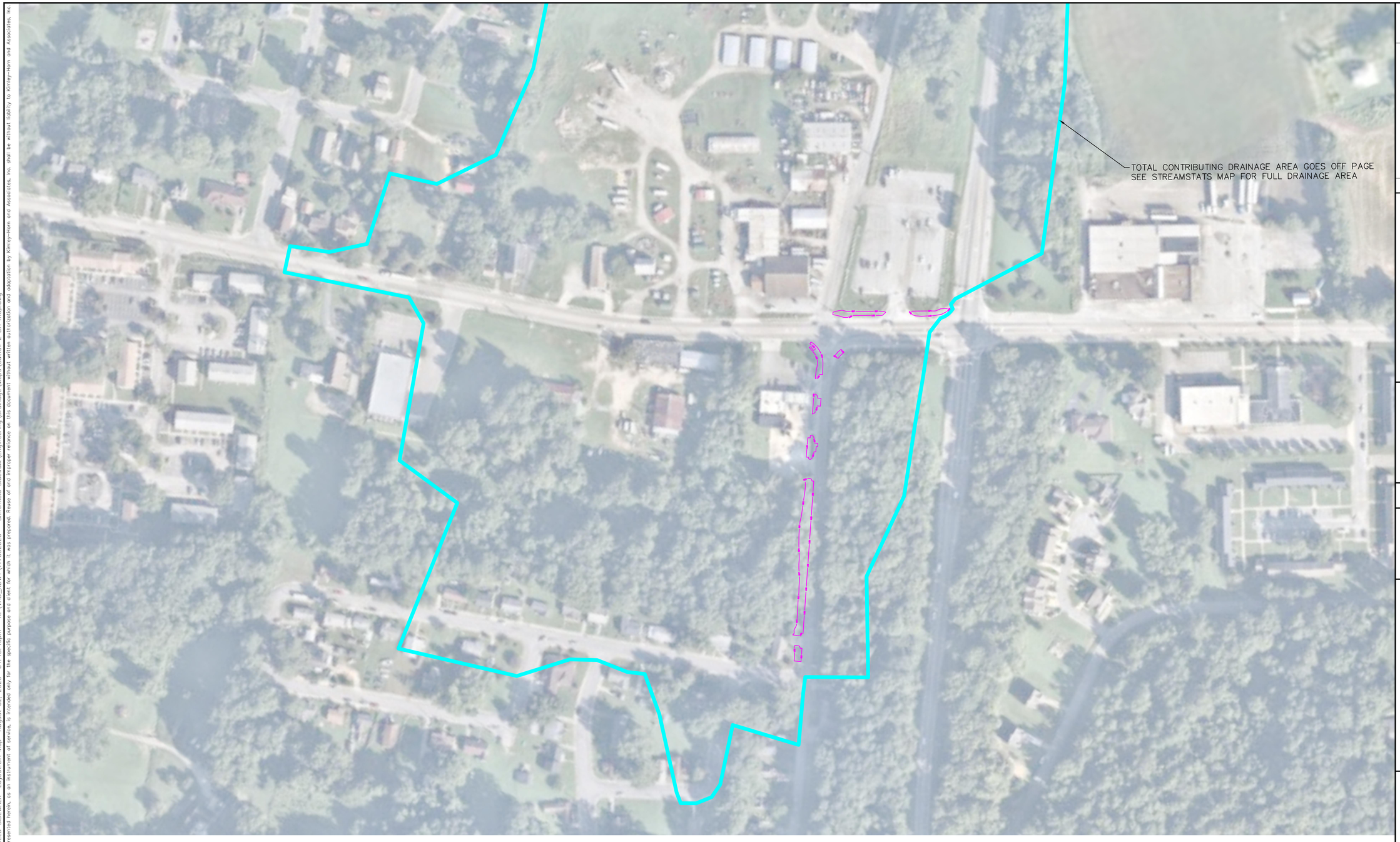
No.	REVISIONS	DATE



LEGEND

PROJECT DISTURBED AREA DRAINING TO OUTFALL 2 – 0.24 ACRES

OVERALL CONTRIBUTING DRAINAGE AREA FOR OUTFAL 2 – 52 ACRES

NORTH

GRAPHIC SCALE IN FEET
0 50 100 200

No.	REVISIONS	DATE

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Roadway Engineer

KHA PROJECT	117032020
DATE	7/31/2023
SCALE	AS SHOWN
DESIGNED BY	APF
DRAWN BY	DFL
CHECKED BY	WFM

OUTFALL 2 DRAINAGE AREA MAP

SMITHFIELD SIDEWALK IMPROVEMENTS
PREPARED FOR
ISLE OF WIGHT COUNTY
SMITHFIELD VIRGINIA

SHEET NUMBER

LEGEND

PROJECT DISTURBED AREA DRAINING TO OUTFALL 3 – 0.11 ACRES

OVERALL CONTRIBUTING DRAINAGE AREA FOR OUTFAL 3 – 27 ACRES

NORTH

GRAPHIC SCALE IN FEET
0 50 100 200

No.	REVISIONS	DATE

Kimley»Horn

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Roadway Engineer

KHA PROJECT 117032020			
DATE	7/31/2023		
SCALE	AS SHOWN	DESIGNED BY	APF
		DRAWN BY	DFL
		CHECKED BY	WFM

OUTFALL 3 DRAINAGE AREA MAP

SMITHFIELD SIDEWALK IMPROVEMENTS
PREPARED FOR
ISLE OF WIGHT COUNTY
SMITHFIELD VIRGINIA

SHEET NUMBER

StreamStats Report

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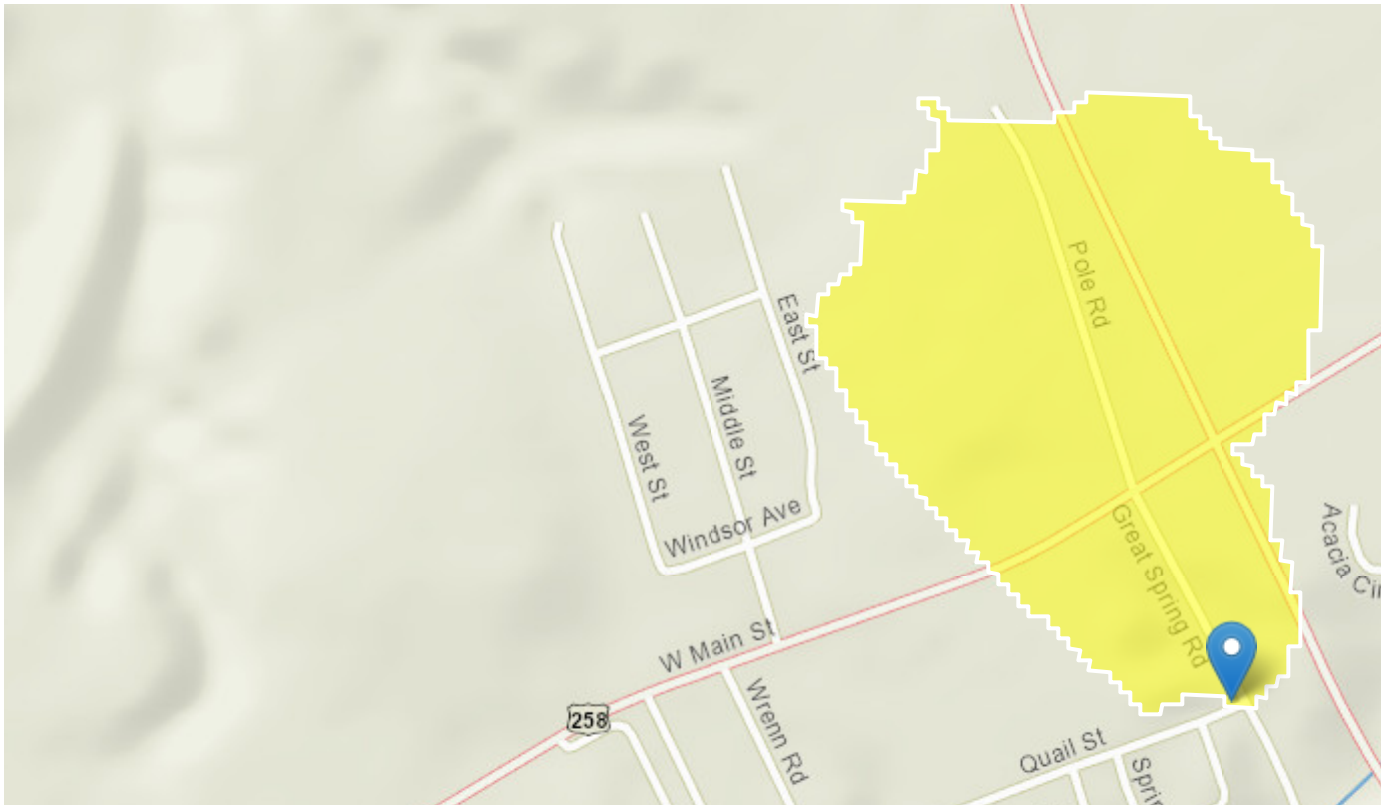

Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.0754	square miles

Peak-Flow Statistics

Peak-Flow Statistics Parameters [Coastal Plain 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0754	square miles	0.06	7866

Peak-Flow Statistics Flow Report [Coastal Plain 2011 5144]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	ASEp
20-percent AEP flood	15.7	ft^3/s	44
10-percent AEP flood	25.4	ft^3/s	47
4-percent AEP flood	42.8	ft^3/s	51
2-percent AEP flood	61.7	ft^3/s	55
1-percent AEP flood	84.2	ft^3/s	58
0.5-percent AEP flood	113	ft^3/s	64

Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

Application Version: 4.10.1
StreamStats Services Version: 1.2.22
NSS Services Version: 2.2.1

StreamStats Report

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Workspace ID: VA20220928173442708000
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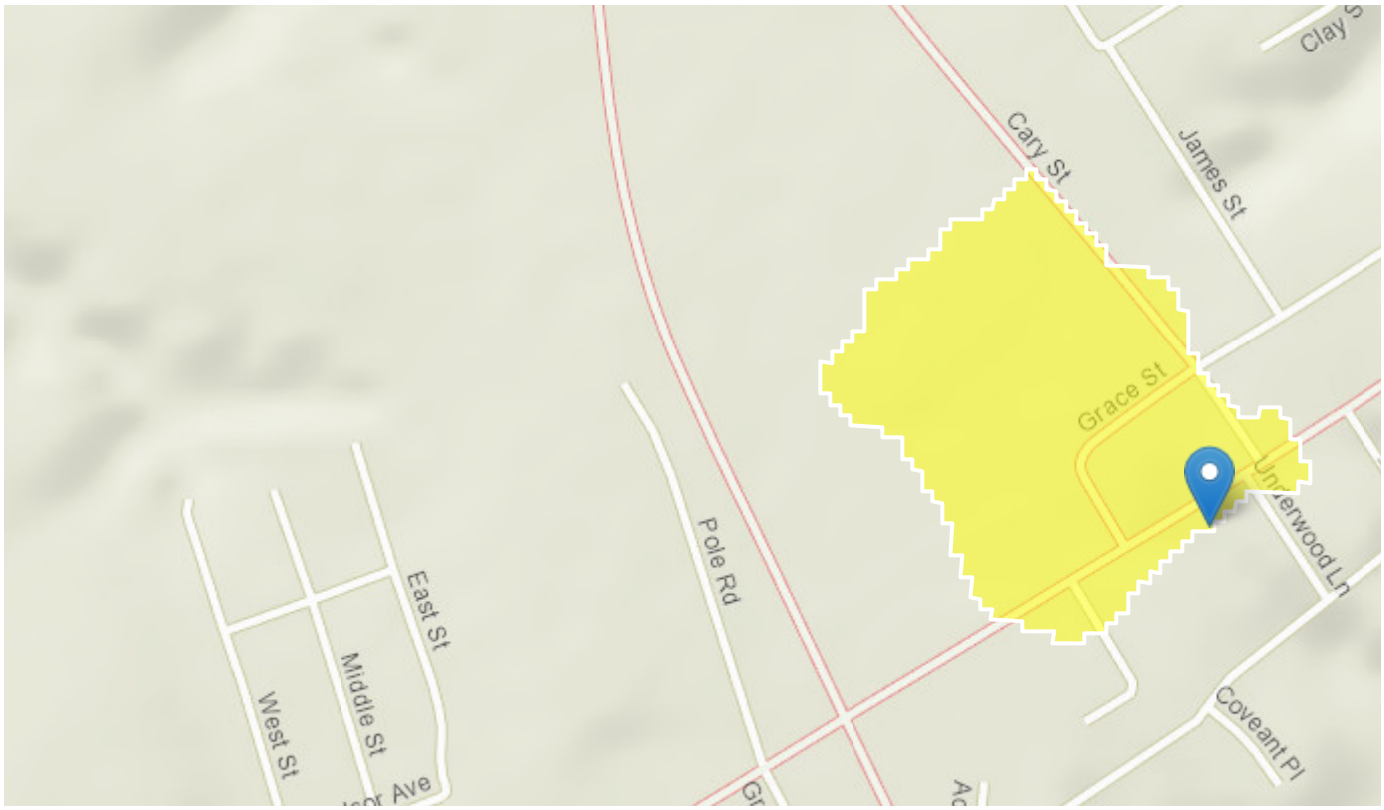
Time: 2022-09-28 13:35:05 -0400



Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.0426	square miles

Peak-Flow Statistics

Peak-Flow Statistics Parameters [Coastal Plain 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.0426	square miles	0.06	7866

Peak-Flow Statistics Disclaimers [Coastal Plain 2011 5144]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Peak-Flow Statistics Flow Report [Coastal Plain 2011 5144]

Statistic	Value	Unit
20-percent AEP flood	10.8	ft^3/s
10-percent AEP flood	17.7	ft^3/s
4-percent AEP flood	30.2	ft^3/s
2-percent AEP flood	43.9	ft^3/s
1-percent AEP flood	60.4	ft^3/s
0.5-percent AEP flood	81.8	ft^3/s

Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

Application Version: 4.10.1

StreamStats Services Version: 1.2.22

NSS Services Version: 2.2.1

Appendix B - StormCAD Calculations

OUTFALL 2 - 10 YEAR STORM

Conduit FlexTable: VDOT LD-229

Start Node	Stop Node	Upstream Inlet Area (acres)	Upstream Inlet C	System CA (acres)	System Flow Time (min)	System Intensity (in/h)	System Rational Flow (cfs)	Invert (Start) (ft)	Invert (Stop) (ft)	Length (Unified) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Capacity (Design) (cfs)	Velocity (ft/s)	Time (Pipe Flow) (hours)
6-1	6-2	1.000	0.400	2.400	36.296	3.461	8.37	7.87	7.71	7.1	0.022	24.0	33.85	2.67	0.000
6-1	6-2														
6-2	EX-2	(N/A)	(N/A)	13.200	60.041	2.559	34.04	7.61	5.61	75.2	0.027	24.0	36.90	10.84	0.002
6-2	EX-2														
EX-1	6-2	27.000	0.400	10.800	60.000	2.560	27.87	8.00	7.75	21.7	0.012	24.0	24.29	8.87	0.001
EX-1	6-2														
EX-2	EX-4	3.000	0.800	15.600	60.156	2.555	40.18	5.03	3.83	37.0	0.032	24.0	40.73	12.79	0.001
EX-2	EX-4														
EX-4	Outfall 2	(N/A)	(N/A)	21.600	60.205	2.554	55.61	3.83	3.75	13.3	0.006	36.0	51.71	8.10	0.000
EX-4	Outfall 2														
EX-3	EX-4	12.000	0.500	6.000	30.000	3.852	23.30	3.83	3.83	17.7	0.000	24.0	0.23	7.42	∞
EX-3	EX-4														
EX-5	6-1	5.000	0.400	2.000	36.000	3.477	7.01	9.61	7.87	70.5	0.025	18.0	16.51	3.97	0.002
EX-5	6-1														

OUTFALL 2 - 10 YEAR STORM

Conduit FlexTable: VDOT LD-347 Pipe

Start Node	Stop Node	Hydraulic Grade Line (Out) (ft)	Diameter (in)	Flow (cfs)	Length (Scaled) (ft)	Friction Slope (ft/ft)	Velocity (ft/s)	Headloss (ft)	Hydraulic Grade Line (In) (ft)	Elevation Ground (Start) (ft)
6-1	6-2	12.17	24.0	8.37	7.1	0.001	2.67	0.01	12.18	13.00
6-2	EX-2	9.62	24.0	34.04	75.2	0.023	10.84	1.70	11.32	12.66
EX-1	6-2	12.17	24.0	27.87	21.7	0.015	8.87	0.33	12.50	12.50
EX-2	EX-4	7.55	24.0	40.18	37.0	0.032	12.79	1.17	8.72	9.95
EX-4	Outfall 2	6.63	36.0	55.61	13.3	0.006	8.10	0.08	6.71	9.48
EX-3	EX-4	7.55	24.0	23.30	17.7	0.011	7.42	0.19	7.74	9.50
EX-5	6-1	12.33	18.0	7.01	70.5	0.004	3.97	0.31	12.65	11.00

OUTFALL 2 - 10 YEAR STORM

Conduit FlexTable: VDOT Report

-Node- Upstream Downstream	Diameter (in)	Length (Unified) (ft)	Material	Slope (Calculated) (ft/ft)	Invert (Start) (ft)	Invert (Stop) (ft)	Upstream Inlet C	Upstream Inlet Area (acres)	System CA (acres)	System Flow Time (min)	System Intensity (in/h)	System Rational Flow (cfs)	Flow (cfs)	Capacity (Design) (cfs)	Velocity (ft/s)	Cover (Start) (ft)	Cover (Stop) (ft)	Upstream Structure Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (In) (ft)	-Ground- Upstream Downstream (ft)
6-1	24.0	7.1	Concrete	0.022	7.87	7.71	0.400	1.000	2.400	36.296	3.461	8.37	8.37	33.85	2.67	3.13	2.95	12.33	12.18	13.00
6-2																				12.66
6-2	24.0	75.2	Concrete	0.027	7.61	5.61	(N/A)	(N/A)	13.200	60.041	2.559	34.04	34.04	36.90	10.84	3.05	2.34	12.17	11.32	12.66
EX-2																				9.95
EX-1	24.0	21.7	Concrete	0.012	8.00	7.75	0.400	27.000	10.800	60.000	2.560	27.87	27.87	24.29	8.87	2.50	2.91	12.70	12.50	12.50
6-2																				12.66
EX-2	24.0	37.0	Concrete	0.032	5.03	3.83	0.800	3.000	15.600	60.156	2.555	40.18	40.18	40.73	12.79	2.92	3.65	9.62	8.72	9.95
EX-4																				9.48
EX-4	36.0	13.3	Concrete	0.006	3.83	3.75	(N/A)	(N/A)	21.600	60.205	2.554	55.61	55.61	51.71	8.10	2.65	2.73	7.55	6.71	9.48
Outfall 2																				9.48
EX-3	24.0	17.7	Concrete	0.000	3.83	3.83	0.500	12.000	6.000	30.000	3.852	23.30	23.30	0.23	7.42	3.67	3.65	7.88	7.74	9.50
EX-4																				9.48
EX-5	18.0	70.5	Concrete	0.025	9.61	7.87	0.400	5.000	2.000	36.000	3.477	7.01	7.01	16.51	3.97	-0.11	3.63	11.04	12.65	11.00
6-1																				13.00

OUTFALL 3 - 10 YEAR STORM

Conduit FlexTable: VDOT LD-229

Start Node	Stop Node	Upstream Inlet Area (acres)	Upstream Inlet C	System CA (acres)	System Flow Time (min)	System Intensity (in/h)	System Rational Flow (cfs)	Invert (Start) (ft)	Invert (Stop) (ft)	Length (Unified) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Capacity (Design) (cfs)	Velocity (ft/s)	Time (Pipe Flow) (hours)
5-4	5-5	0.030	0.900	0.465	6.680	5.667	2.66	16.96	16.88	37.0	0.002	18.0	4.89	2.82	0.004
5-4	5-5														
5-5	5-6	0.070	0.800	0.521	7.500	5.464	2.87	16.88	16.70	41.3	0.004	18.0	6.93	3.74	0.003
5-5	5-6														
EX-1	5-6	21.100	0.350	7.385	48.000	2.094	15.59	16.93	16.91	87.0	0.000	24.0	3.43	4.96	0.005
EX-1	5-6														
5-1	5-2	0.240	0.700	0.168	6.000	5.848	0.99	17.53	17.46	10.1	0.007	18.0	8.73	3.28	0.001
5-1	5-2														
5-6	EX-2	0.200	0.650	8.036	48.292	2.085	16.89	16.70	15.59	46.9	0.024	0.0	59.40	10.10	0.001
5-6	EX-2														
EX-2	Outfall 3	5.000	0.600	11.036	48.370	2.083	23.17	15.58	12.00	223.6	0.016	24.0	28.62	10.14	0.006
EX-2	Outfall 3														
5-2	5-3	0.220	0.750	0.333	6.052	5.834	1.96	17.46	17.04	111.4	0.004	18.0	6.45	3.20	0.010
5-2	5-3														
5-3	5-4	0.140	0.750	0.438	6.632	5.679	2.51	17.04	16.96	12.2	0.007	18.0	8.50	4.19	0.001
5-3	5-4														

OUTFALL 3 - 10 YEAR STORM

Conduit FlexTable: VDOT LD-347 Pipe

Start Node	Stop Node	Hydraulic Grade Line (Out) (ft)	Diameter (in)	Flow (cfs)	Length (Scaled) (ft)	Friction Slope (ft/ft)	Velocity (ft/s)	Headloss (ft)	Hydraulic Grade Line (In) (ft)	Elevation Ground (Start) (ft)
5-4	5-5	18.13	18.0	2.66	37.0	0.001	2.82	0.02	18.15	20.50
5-5	5-6	18.09	18.0	2.87	41.3	0.001	3.74	0.02	18.11	20.86
EX-1	5-6	18.33	24.0	15.59	87.0	0.005	4.96	0.67	19.01	21.33
5-1	5-2	18.25	18.0	0.99	10.1	0.000	3.28	0.00	18.25	20.70
5-6	EX-2	17.50		16.89	46.9	0.015	10.10	0.32	17.82	20.71
EX-2	Outfall 3	14.00	24.0	23.17	223.6	0.015	10.14	3.29	17.29	21.06
5-2	5-3	18.20	18.0	1.96	111.4	0.001	3.20	0.04	18.23	21.29
5-3	5-4	18.17	18.0	2.51	12.2	0.001	4.19	0.00	18.17	21.17

OUTFALL 3 - 10 YEAR STORM

Conduit FlexTable: VDOT Report

-Node- Upstream Downstream	Diameter (in)	Length (Unified) (ft)	Material	Slope (Calculated) (ft/ft)	Invert (Start) (ft)	Invert (Stop) (ft)	Upstream Inlet C	Upstream Inlet Area (acres)	System CA (acres)	System Flow Time (min)	System Intensity (in/h)	System Rational Flow (cfs)	Flow (cfs)	Capacity (Design) (cfs)	Velocity (ft/s)	Cover (Start) (ft)	Cover (Stop) (ft)	Upstream Structure Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (In) (ft)	-Ground- Upstream Downstream (ft)
5-4	18.0	37.0	Concrete	0.002	16.96	16.88	0.900	0.030	0.465	6.680	5.667	2.66	2.66	4.89	2.82	2.04	2.48	18.17	18.15	20.50
5-5																				20.86
5-5	18.0	41.3	Concrete	0.004	16.88	16.70	0.800	0.070	0.521	7.500	5.464	2.87	2.87	6.93	3.74	2.48	2.51	18.13	18.11	20.86
5-6																				20.71
EX-1	24.0	87.0	Concrete	0.000	16.93	16.91	0.350	21.100	7.385	48.000	2.094	15.59	15.59	3.43	4.96	2.40	1.80	19.07	19.01	21.33
5-6																				20.71
5-1	18.0	10.1	Concrete	0.007	17.53	17.46	0.700	0.240	0.168	6.000	5.848	0.99	0.99	8.73	3.28	1.67	2.33	18.26	18.25	20.70
5-2																				21.29
5-6	0.0	46.9	Concrete	0.024	16.70	15.59	0.650	0.200	8.036	48.292	2.085	16.89	16.89	59.40	10.10	2.01	3.47	18.09	17.82	20.71
EX-2																				21.06
EX-2	24.0	223.6	Concrete	0.016	15.58	12.00	0.600	5.000	11.036	48.370	2.083	23.17	23.17	28.62	10.14	3.48	7.60	17.50	17.29	21.06
Outfall 3																				21.60
5-2	18.0	111.4	Concrete	0.004	17.46	17.04	0.750	0.220	0.333	6.052	5.834	1.96	1.96	6.45	3.20	2.33	2.63	18.25	18.23	21.29
5-3																				21.17
5-3	18.0	12.2	Concrete	0.007	17.04	16.96	0.750	0.140	0.438	6.632	5.679	2.51	2.51	8.50	4.19	2.63	2.04	18.20	18.17	21.17
5-4																				20.50

Appendix C - VRRM Calculations

DEQ Virginia Runoff Reduction Method Re-Development Compliance Spreadsheet - Version 3.0

BMP Design Specifications List: 2011 Stds & Specs

Site Summary - Linear Development Project***

Project Title: NA
Date: NA

Total Rainfall (in):	43
Total Disturbed Acreage:	0.47

Site Land Cover Summary

Pre-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	0.28	0.28	60
Impervious Cover (acres)	0.00	0.00	0.00	0.19	0.19	40
					0.47	100

Post-ReDevelopment Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	% of Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0
Managed Turf (acres)	0.00	0.00	0.00	0.18	0.18	38
Impervious Cover (acres)	0.00	0.00	0.00	0.29	0.29	62
					0.47	100

Site Tv and Land Cover Nutrient Loads

	Final Post-Development (Post-ReDevelopment & New Impervious)	Post-ReDevelopment	Post-Development (New Impervious)	Adjusted Pre-ReDevelopment
Site Rv	0.68	0.61	0.95	0.61
Treatment Volume (ft^3)	1,163	819	345	819
TP Load (lb/yr)	0.73	0.51	0.22	0.51

Pre-ReDevelopment TP Load per acre (lb/acre/yr)	Final Post-Development TP Load per acre (lb/acre/yr)	Post-ReDevelopment TP Load per acre (lb/acre/yr)
1.39	1.56	1.39

Total TP Load Reduction Required (lb/yr)	0.27	N/A***	N/A***

****This is a linear development project*

	Final Post-Development Load (Post-ReDevelopment & New Impervious)	Pre-ReDevelopment
TN Load (lb/yr)	5.23	4.09

Site Compliance Summary - ***Linear Development Project

Maximum % Reduction Required Below Pre-ReDevelopment Load	20%

Total Runoff Volume Reduction (ft^3)	0
Total TP Load Reduction Achieved (lb/yr)	0.00
Total TN Load Reduction Achieved (lb/yr)	0.00
Remaining Post Development TP Load (lb/yr)	0.73
Remaining TP Load Reduction (lb/yr) Required	0.27

Drainage Area Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
Forest/Open (acres)	0.00	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres)	0.00	0.00	0.00	0.00	0.00	0.00
Impervious Cover (acres)	0.00	0.00	0.00	0.00	0.00	0.00
Total Area (acres)	0.00	0.00	0.00	0.00	0.00	0.00

Drainage Area Compliance Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
TP Load Reduced (lb/yr)	0.00	0.00	0.00	0.00	0.00	0.00
TN Load Reduced (lb/yr)	0.00	0.00	0.00	0.00	0.00	0.00

Runoff Volume and CN Calculations

	1-year storm	2-year storm	10-year storm
Target Rainfall Event (in)	0.00	0.00	0.00

Drainage Areas	RV & CN	Drainage Area A	Drainage Area B	Drainage Area C	Drainage Area D	Drainage Area E
CN		0	0	0	0	0
RR (ft^3)		0	0	0	0	0
1-year return period	RV wo RR (ws-in)	0.00	0.00	0.00	0.00	0.00
	RV w RR (ws-in)	0.00	0.00	0.00	0.00	0.00
	CN adjusted	0	0	0	0	0
2-year return period	RV wo RR (ws-in)	0.00	0.00	0.00	0.00	0.00
	RV w RR (ws-in)	0.00	0.00	0.00	0.00	0.00
	CN adjusted	0	0	0	0	0
10-year return period	RV wo RR (ws-in)	0.00	0.00	0.00	0.00	0.00
	RV w RR (ws-in)	0.00	0.00	0.00	0.00	0.00
	CN adjusted	0	0	0	0	0

Appendix D – Spread Calculations

Appendix 9B-1 LD-204 Stormwater Inlet Computations

LD-204
Rev. 6-85

PPMS# 0.00 PROJ 0 DATE August 2, 2023 SHEET OF

INLET																										Sag Inlets Only				
NUMBER	TYPE	LENGTH (FT)	STATION	DRAINAGE AREA (AC)	C	CA	sum CA	I (IN/HR)	Q INCR (CFS)	Q_b, CARRYOVER (CFS)	Q_T, GUTTER FLOW (CFS)	S, GUTTER SLOPE (FT/FT)	S_X, CROSS SLOPE (FT/FT)	T, SPREAD (FT)	W (FT)	W/T	S_W, (FT/FT)	S_W/S_X	E_0	a = 12W(S_W - S_X)+Local Depression	$S`_W$ = a/(12w)	$S_e = S_X + S`_W(E_0)$, (FT/FT)	COMPUTED LENGTH, L_T, (FT)	L, SPECIFIED LENGTH (FT)	L/L_T	E	Q_i, INTERCEPTED (CFS)	Qb, CARRYOVER (CFS)	d (FT)	h (FT)	d/h	T, SPREAD @ SAG (FT)	REMARKS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	
INLETS - ON GRADE																																	
5-2	-	8	-	0.23	0.72	0.166	0.166	4.0	0.662	0.000	0.662	0.0100	0.0200	3.82	2	0.52	0.0833	4.17	0.96	3.52	0.147	0.161	5	8	1.60	1.00	0.66	0.000					Bypass to: 5-3
6-1	-	14	-	0.75	0.85	0.638	0.638	4.0	2.550	0.000	2.550	0.0226	0.0200	7.13	2	0.28	0.0833	4.17	0.74	3.52	0.147	0.129	13	14	1.08	1.00	2.55	0.000					
INLETS - IN SAG																																	
5-3	-	4	-	0.11	0.90	0.099	0.099	4.0	0.396	0.000	0.396	0.0010	0.0200	6.01	2	0.33	0.0833	4.17	0.82	3.52	0.147	0.140	2.75	4	1.45	1.00	0.40	0.000	0.094	0.458	0.205	4.701	8'Throat for 50% blockage
5-3	-	4	-	0.03	0.90	0.027	0.027	4.0	0.108	0.000	0.108	0.0010	0.0200	6.01	2	0.33	0.0833	4.17	1.00	3.52	0.147	0.167	1.34	4	2.99	1.00	0.11	0.000					