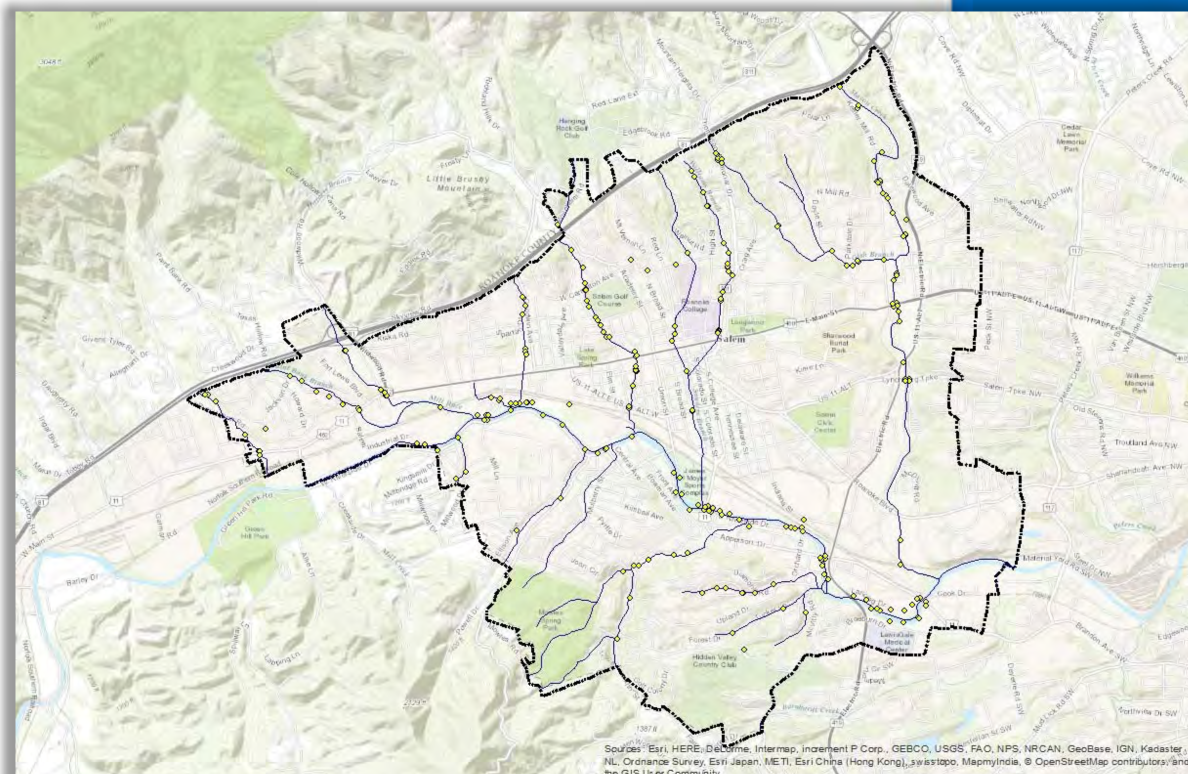
City of Salem
Outfall Prioritization

Optimizing Outfall Screening Efforts with a Desktop Analysis

October 2016

City of Salem



This document is intended to be utilized for prioritizing annual outfall inspections as required by Section II (B)(3)(c)(1)(a) & (b) of the Virginia Pollutant Discharge Elimination System (VPDES) General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems.

EEE Consulting, Inc.

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Appendices

1.0 Introduction and Purpose

The City of Salem (City) stormwater ordinance defines an illicit discharge as "… any discharge to the City's storm sewer system that is not entirely composed of stormwater…" with some exceptions. To address illicit discharges, the City operates an Illicit Discharge Detection and Elimination (IDDE) Program as a component of the City's overall Stormwater Management Program. Operation of the IDDE Program is in compliance with the Virginia Pollutant Discharge Elimination System (VPDES) General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 General Permit).

The IDDE Program includes field screening activities of at least 50 stormwater outfalls annually in an attempt to proactively identify instances of illicit discharges, as required by Section II (B)(3)(c)(1)(b) of the MS4 General Permit. Section II (B)(3)(c)(1)(a) of the MS4 General Permit requires a prioritized schedule of field screening activities based on available criteria such as age of infrastructure, land use, historical illegal discharges, dumping and cross connections. The prioritized schedule is intended to focus screening efforts towards areas with relatively high potential for occurrence of illicit discharges. To prioritize outfall screening, the City conducted a desktop assessment of illicit discharge potential (IDP) utilizing available data and instruction provided by the Environmental Protection Agency (EPA) manual entitled "Illicit Discharge Detection and Elimination – A Guidance Manual for Program Development and Technical Assessments" (EPA Guidance, 2004). This report describes the available data utilized for performing the desktop assessment, the methodology utilized, and results intended to guide prioritization of future annual outfall screening. Utilization of the results demonstrates compliance with Section II (B)(3)(c)(1)(a) of the MS4 General Permit.

Figure A: Example of an active illicit discharge

2.0 Supporting Data

The desktop assessment is performed based on the approach described in the EPA Guidance with modifications based on available data specific to the City. Section 2 includes the following:

- Section 2.1 describes illicit discharge management units, roughly based on subwatershed delineations for the analysis.
- Section 2.2 describes the data compiled and utilized in the assessment with information regarding the source of the data, estimated level of accuracy, and importance for inclusion to prioritization of illicit discharge potential.
- Section 2.3 describes the methodology, including prioritization ranking criteria per dataset, for utilizing the data described in Section 2.2 towards the identification of high priority outfalls.

2.1 Illicit Discharge Management Units

The desktop assessment includes defining illicit discharge outfall screening planning units to segregate illicit discharge potential throughout the City. The planning units were generally delineated to represent subwatersheds within the City limits based on hydrologic feature confluences and also with consideration of railroads, major roadways and significant changes in land us. Delineations of planning units were aided using U.S. Geological Survey (USGS) standard series topographic mapping for the City. The resulting sub-basin planning units used in the analysis presented in this report are provided on the mapping in Appendix A. It is noted that planning units extend only to the City's political boundary; however, illicit discharges could originate from interconnected storm sewer systems. In those cases, the appropriate MS4 should be notified.

2.2 Supporting Datasets

In support towards the goal of identifying areas with the highest likelihood for illicit discharge potential, various available City-wide datasets that provide information potentially relevant to impacts to surface water quality were compiled. Datasets used for the analysis are referred to as "screening factors." Screening factors were selected based on recommended datasets listed in the EPA Guidance and when readily available in GIS. Datasets that were easily developed from hardcopy information were also included. Information for each dataset incorporated into the analysis is described below:

- ***Regulated MS4 outfalls***: A regulated outfall is defined as a point source discharge from the MS4 into waters of the U.S., including surface waters and wetlands. The City maintains current outfall mapping in GIS that was used in the analysis. It is noted that additional outfalls may be identified or added overtime; and when deemed appropriate, this analysis can be updated using the "IDP Computation Spreadsheet" incorporated by reference with this report.
- ***Direct discharge to MS4 outfalls***: The City's MS4 outfall mapping includes direct drainage areas to outfalls, also maintained in GIS and depicted in Appendix A.
- ***Streams data***: Stream data shown in Appendix A mapping was obtained from the National Hydrography Dataset (NHD). It is noted that not all surface water features in the City are included in this dataset and more localized data could be used, when

available. However, the NHD data was considered sufficient for the purposes of the analysis.

- ***Underground Storage tanks***: Data was extracted from the Department of Environmental Quality (DEQ) Virginia Environmental GIS (VEGIS) dataset on Registered Tank Facilities, which is updated daily. Available data was downloaded on September 6, 2016 and a GIS shapefile developed, as shown in Appendix B.
- ***Septic systems***: A GIS septic system dataset was provided by the City of Salem. The dataset included all the parcels serviced by septic systems. The septic system GIS shapefile is shown in Appendix B.
- ***Land Cover***: Land cover data was obtained from the 2011 National Land Use Cover Database (NLCD) that is provided at a spatial resolution of 30 meters. When available, the City could rerun the analysis with more refined land cover data. However, the NLCD data was considered sufficient for the purposes of the analysis and is depicted in Appendix C.
- ***Age of Sanitary Sewer Infrastructure***: Since a dataset does not exist attributing age to the City's sanitary sewer infrastructure, estimations were made based on areas of annexation within the City with the assumption that annexation can provide a relative understanding of the age of the City's infrastructure. The information was digitized from mapping provided by the City's GIS Department and is depicted in Figure B.

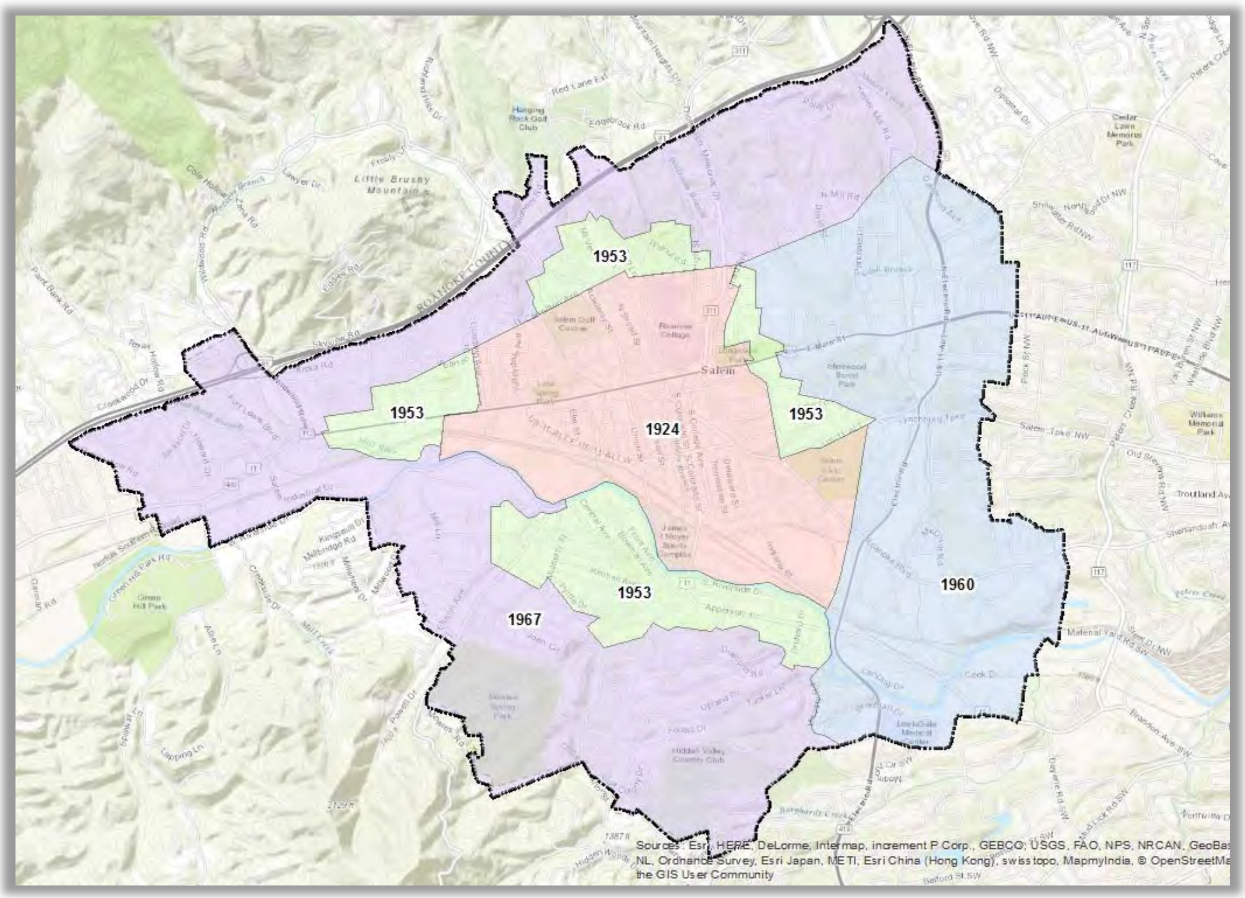


Figure B. Dataset utilized for relative estimation of age of infrastructure.

3.0 Screening Factors

The data described in Section 2.2 was utilized to develop screening factors for characterization of each planning units described in Section 2.1. This section describes the screening factors and purpose for inclusion in the characterization of planning units. The section also includes discussion regarding:

- The range of values computed amongst planning units for each screening factors are separated into four intervals and assigned scoring points values (1 through 4), with the lowest (1) representing the lowest IDP and the highest (4) representing the highest IDP. Four intervals were chosen due to the fact that the smallest variation in the screening factors includes four results for all planning units (relative estimated age of infrastructure). This allows for consistent interval point scores for all screening factors.
- Specific screening factors are weighted based on the perceived reliability of the information to define the factor and its impact to surface water quality.

3.1 Pollutant Generating Land Cover

Land cover is an obvious metric for predicting illicit discharge potential since land cover with a higher density of development corresponds with higher levels of imperviousness, stormwater system infrastructure, and activities that can introduce pollutants to the storm sewer. GIS analysis determined the percentage of each type of NLCD land cover within each planning unit. Developed land cover was combined to represent potential pollutant generating land cover area defined as “developed” NLCD land cover classifications, as illustrated in Appendix D and summarized in Appendix E.

The “generating land cover” screening factor per planning unit is represented as a percentage of the total planning unit area and ranges from 34 to 100 percent. Intervals are split nearly evenly as presented in Table 1. GIS analysis results and IDP scoring for each planning unit is provided in Appendix F, column ‘g.’

Table 1. “Potentially generating land cover” screening factor intervals and IDP point scores.

% of developed acreage in planning unit	IDP Score*
34 to 50	1
51 to 66	2
67 to 82	3
83 to 100	4

* The potentially generating land cover screening factor IDP Score is given 1.5 times the weight of other screening factors due to the strong correlation between land cover and water quality.

3.2 Direct Drainage Area to MS4 Outfalls

As reflected in Appendix A, drainage areas directly discharging to regulated MS4 outfalls are proportional to the total area of each planning unit, ranging from nearly 0% where no outfalls exist, to almost 64% as occurs in Planning Unit ‘O.’ Since increased area of direct drainage to MS4 outfalls potentially represents increased opportunity for an illicit discharge to be introduced into the storm sewer system, the summation of direct drainage area to outfalls within each planning unit is identified as a screening factor.

The “direct drainage area to MS4 outfalls” screening factor per planning unit ranges from 0 to 373 acres. Intervals are split nearly evenly as presented in Table 2. GIS analysis results and IDP scoring for each planning unit is provided in Appendix F, column ‘b.’

Table 2. “Direct drainage to MS4 outfall” screening factor intervals and IDP point scores.

Direct Drainage Area (acres) to MS4 Outfalls within planning unit	IDP Score
0 to 93	1
94 to 186	2
187 to 279	3
280 to 373	4

3.3 Outfall Density per Stream Mile

As recommended by the EPA Guidance, outfall density per stream mile is included as a screening factor. This screening factor was computed by dividing the outfalls within each planning unit by the stream length within the basin, based on the NHD data described in Section 2.2. This metric is applicable to evaluation of IDP within planning units since it represents the relative number of locations for illicit discharge to directly impact surface waters within a planning unit.

The “outfall density per stream mile” screening factor per planning unit ranges from 0 to 12 outfalls per stream mile. Two Planning Units (‘N’ and ‘Q’) have no outfalls resulting in a zero density. Intervals are split nearly evenly as presented in Table 3. GIS analysis results and IDP scoring for each planning unit is provided in Appendix F, column ‘c.’

Table 3. “Outfall density per stream mile” screening factor intervals and IDP point scores.

Outfalls per Stream Mile within planning unit	IDP Score
0 to 3	1
4 to 6	2
7 to 9	3
10 to 12	4

3.4 Underground Storage Tanks

Illicit discharges can potentially result from leaking underground storage tanks (USTs). Utilizing the DEQ resources described in Section 2.2, the opportunity exists to incorporate locations of USTs into the characterization of the planning units within the City. Although regulated USTs should have spill containment provisions at the fill pipe, overfill devices to alert the owner when overfills may occur, corrosion protection on both tank and product lines, and release detection on both tank and product lines, leaks and subsequent introduction of contaminants can still occur. Areas with USTs often are synonymous with other sources of illicit discharges such as fuel spills. Contaminants introduced to ground water can ultimately be transported to surface waters.

To provide a relative comparison among planning units, the density of USTs per potentially generating land cover area, as depicted in Appendix D, is computed as the UST screening factor (based on USTs per 10-acres of generating land cover area). The UST screening factor per planning unit ranges from 0 to 0.92 tanks per 10-acres. Intervals are split nearly evenly as presented in Table 4. GIS analysis results and IDP scoring for each planning unit is provided in Appendix F, column 'd.'

Table 4. "Underground storage tank" screening factor intervals and IDP point scores.

USTs per 10-acres planning unit	IDP Score
0 to 0.23	1
0.24 to 0.46	2
0.47 to 0.69	3
0.70 to 0.92	4

3.5 Septic Systems

As recommended by the EPA Guidance, septic systems should be considered as a screening factor. Septic systems, especially older systems, are prone to failure. Utilizing the City's septic system GIS data, the opportunity exists to incorporate locations of septic systems into the characterization of the planning units within the City. Similar to USTs, failure of septic systems can result in continuous impact to surface water. Further, since the City has also been assigned a waste load allocation (WLA) for the "Upper Roanoke River Watershed for E. coli" it is prudent to consider septic systems as a screening factor.

To provide a relative comparison among planning units, the density of septic systems per potentially generating land cover area, as described in Section 3.1, is computed as the septic system screening factor (based on septic systems per 10-acres of area). The septic system screening factor per planning unit ranges from 0 to 0.76 septic systems per 10-acres. Intervals are split nearly evenly as presented in Table 5. GIS analysis results and IDP scoring for each planning unit is provided in Appendix F, column 'e.'

Table 5. "Septic screening" screening factor intervals and IDP point scores.

Septic systems per 10-acres per planning unit	IDP Score
0 to 0.19	1
0.20 to 0.38	2
0.39 to 0.57	3
0.58 to 0.76	4

3.6 Estimated age of Sanitary Sewer Infrastructure

As recommended by the EPA Guidance, estimation of the age of sanitary sewer infrastructure should be considered as a screening factor since failing of the system can often be attributed to age of the infrastructure. The EPA Guidance recommends IDP increases with the age of the sanitary sewer as design life passes and pipe breaks occurs and capacity is exceeded, resulting on overflows and infiltration and inflow (I & I). Older and aging infrastructure experience more leaks, cross-connections and broken pipes that can contribute sewage to the storm drain system. Further, since the City has been assigned a WLA for the "Upper Roanoke River Watershed for E. coli" it is prudent to consider sanitary sewer infrastructure as a screening factor.

As described in Section 2.2, since information was not readily available regarding the age of the sanitary sewer infrastructure, estimations were made based on areas of annexation within the City with the assumption that annexation can provide a relative understanding of the age of the City's infrastructure. The average relative age of infrastructure screening factor within planning units (based on dates of annexation of areas within the City) is based on four separate annexation dates and ranges from 49 to 92 years old. Intervals are split nearly evenly as presented in Table 6. GIS analysis results and IDP scoring for each planning unit is provided in Appendix F, column 'f.'

Table 6. "Estimated age of sanitary sewer infrastructure" screening factor intervals and IDP point scores.

Relative average age of infrastructure	IDP Score*
49 to 60	0.5
61 to 71	1
72 to 82	1.5
83 to 92	2

* The estimated age of sanitary sewer infrastructure screening factor IDP Score is given half the weight of other screening factors since the data used to estimate the age of infrastructure is very approximate and presumptive.

3.7 Outfall Density within Generating Land Cover

As previously discussed, land cover is an obvious metric for predicting illicit discharge potential. With the understanding the runoff is more likely to reach surface waters through manmade conveyance (i.e. impervious surface, curb and gutter), a screening factor representing the density of outfalls per generating land cover area that would include these types of conveyances is computed and considered as a screening factor.

The density of outfalls within a generating area was determined as outfalls per 100-acres of generating land cover per planning unit. The range amongst planning units is 0 to 6.46 outfalls per 100-acres of potentially generating land cover. Intervals are split nearly evenly as presented in Table 7. GIS analysis results and IDP scoring for each planning unit is provided in Appendix F, column 'h.'

Table 7. "Outfall density within generating land cover" screening factor intervals and IDP point scores.

Outfalls in generating land cover (outfalls/100 acres)	IDP Score
0 to 1.62	1
1.63 to 3.24	2
3.25 to 4.86	3
4.87 to 6.46	4

4.0 Scoring and Ranking of Planning Units

With each screening factor assigned point values, a raw IDP score was generated for each planning unit by summing the point values for all screening factors, as shown in Appendix F, column 'i.' To normalize the results to a 0 – 100 scoring scale, the raw IDP scores were divided by the highest raw score and multiplied by 100, resulting in the normalized score for each planning unit as given in Appendix F, column 'j.' Finally, the normalized scores were ranked based on 100 having the highest IDP, and descending values having a descending ranking (Appendix F, column 'k'). Mapping depicting the IDP rankings for the planning unit management units is provided in Appendix G.

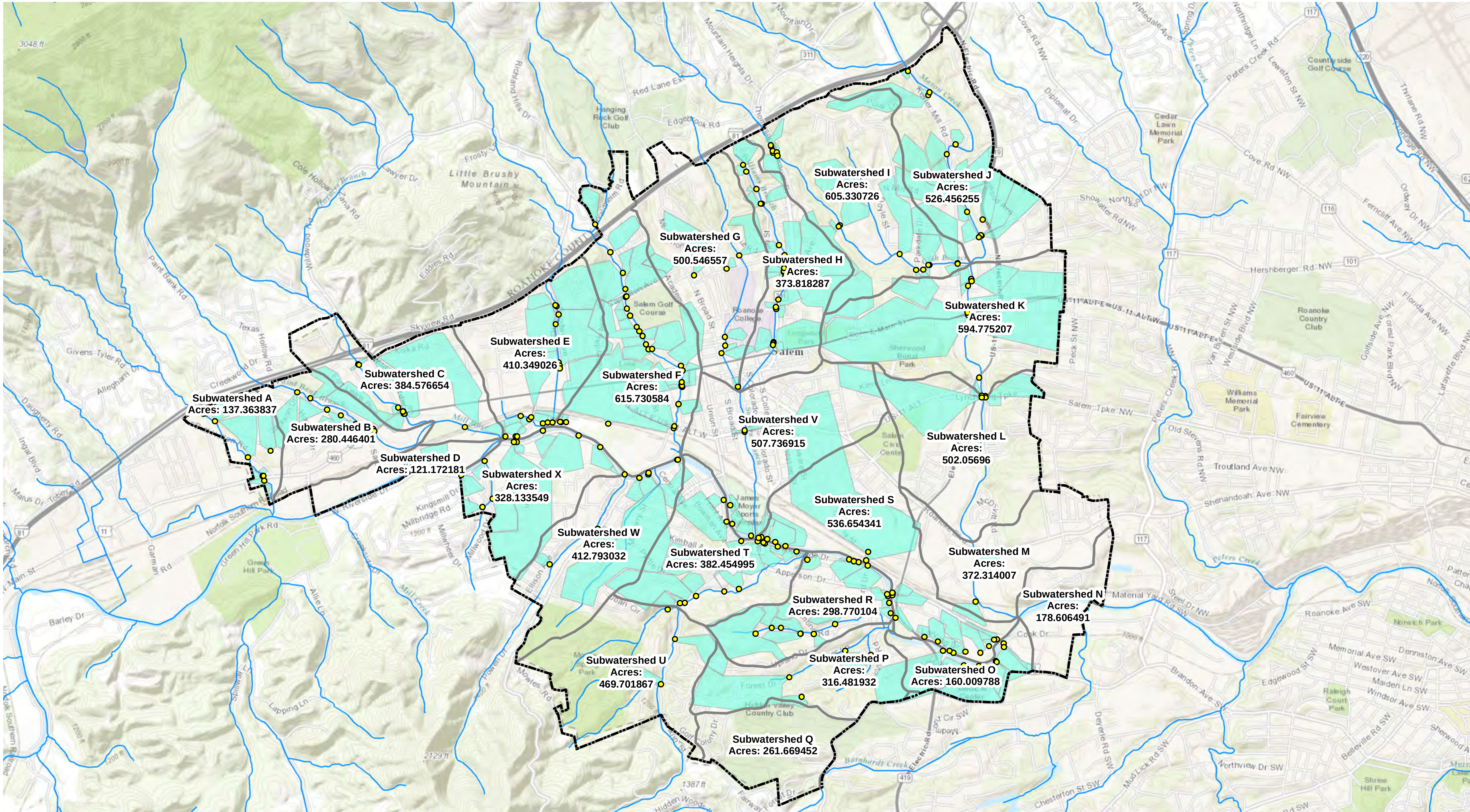
5.0 Application of Results for Outfall Screening Prioritization

The application of this information for developing a prioritized schedule for outfall screening addresses Section II (B)(3)(c)(1)(a) of the MS4 General Permit, focusing screening efforts towards areas with relatively higher potential for occurrence of illicit discharges. The Table in Appendix H and mapping in Appendix G can be utilized for selecting outfalls for annual screening. An example application may include screening outfalls within planning units with a higher IDP at an increased frequency. For example, outfalls with higher IDP are screened twice during a permit cycle, while those with a relatively low IDP are screened once. An example prioritization schedule is provided in Table 8. The lowest number of outfalls screened during a year occurs for those with higher IDP, assuming resources may be necessary to address identified potential illicit discharges. The example ensures all outfalls are screened during the permit cycle.

Table 8. Outfall screening prioritization schedule based on results from the IDP assessment.

<table>
<tr><th>Planning Unit</th><th>No. Outfalls</th><th>IDP Score</th><th>Frequency (Permit Cycle year)</th><th>Total Outfalls*</th><th>Minimum Screening Achieved?</th></tr>
<tr><td>H</td><td>21</td><td>100</td><td rowspan="3">Year 1 & 3</td><td rowspan="3">68</td><td rowspan="3">Yes</td></tr>
<tr><td>F</td><td>31</td><td>96</td></tr>
<tr><td>E</td><td>16</td><td>90</td></tr>
<tr><td>K</td><td>11</td><td>85</td><td rowspan="5">Year 2 & 4</td><td rowspan="5">76</td><td rowspan="5">Yes</td></tr>
<tr><td>S</td><td>20</td><td>83</td></tr>
<tr><td>J</td><td>17</td><td>79</td></tr>
<tr><td>V</td><td>5</td><td>75</td></tr>
<tr><td>A, C, O</td><td>23</td><td>73</td></tr>
<tr><td>R</td><td>16</td><td>73</td><td rowspan="10">Year 5</td><td rowspan="10">90</td><td rowspan="10">Yes</td></tr>
<tr><td>I, X</td><td>24</td><td>69</td></tr>
<tr><td>T</td><td>13</td><td>67</td></tr>
<tr><td>B, D, G</td><td>14</td><td>65</td></tr>
<tr><td>W</td><td>8</td><td>56</td></tr>
<tr><td>P</td><td>4</td><td>54</td></tr>
<tr><td>L</td><td>3</td><td>52</td></tr>
<tr><td>M, N</td><td>2</td><td>48</td></tr>
<tr><td>Q</td><td>0</td><td>40</td></tr>
<tr><td>U</td><td>3</td><td>33</td></tr>
</table>

Appendix A: Mapping for Planning Units and other Supporting Data



3e EEE Consulting, Inc.
Environmental, Engineering and Educational Solutions

Projection: NAD 1983 StatePlane Virginia South FIPS 4502 Feet

Proj. 16-083

N

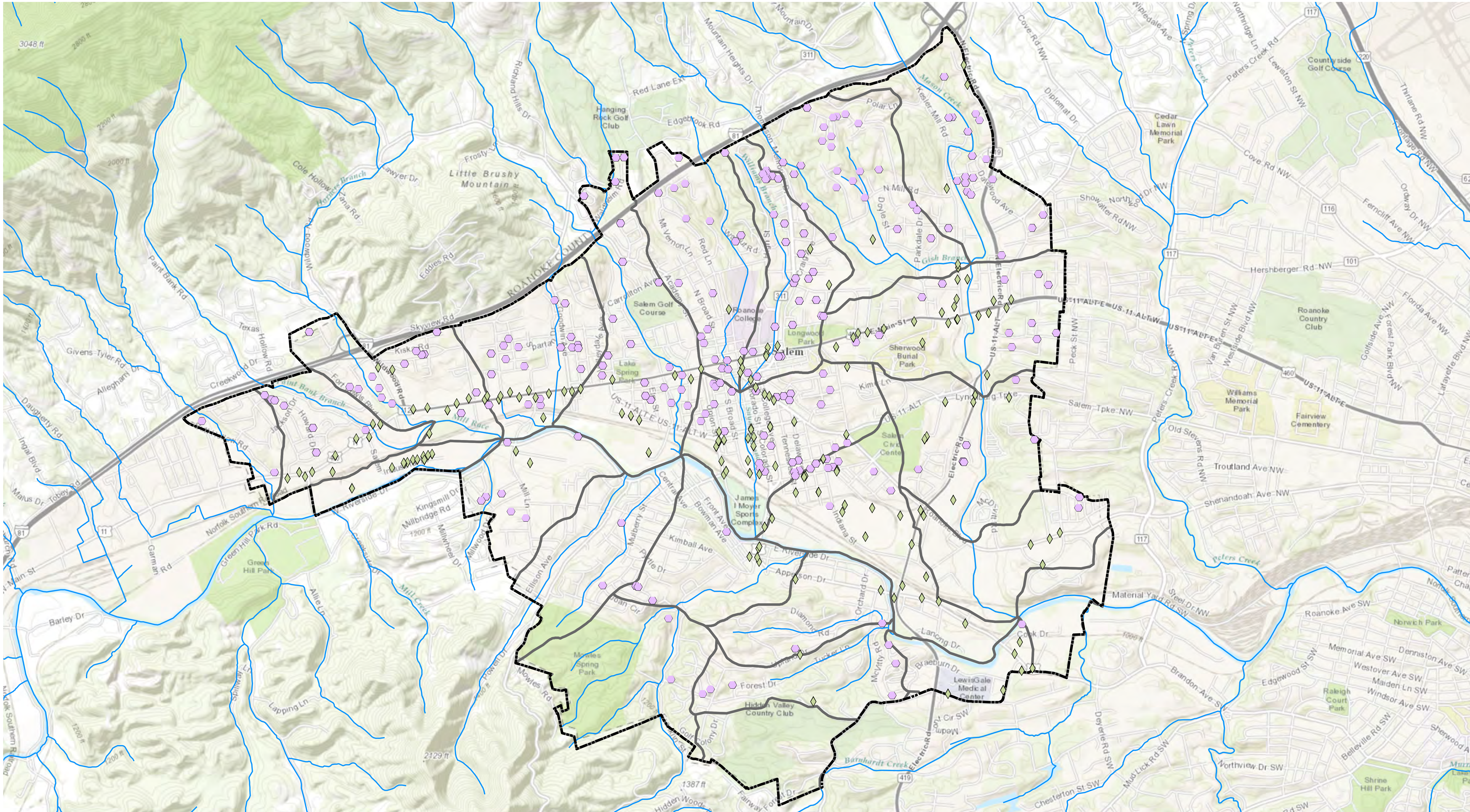
MS4 Outfalls
National Hydrographic Dataset (NHD)
Outfall Drainage Area
Sub-Basin Planning Unit
City of Salem Corporate Limits

APPENDIX A
SUB-BASIN PLANNING UNITS FOR IDP EVALUATION
SALEM OUTFALL PRIORITIZATION

0 0.5 1 Miles

City of Salem, VA
Sources: National Hydrography Dataset (NHD), ESRI Topographic Base Mapping
Prepared by JJL, 09-21-2016

Appendix B: Mapping for Developed Screening Factor Datasets



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Projection: NAD 1983 StatePlane Virginia South FIPS 4502 Feet

Proj. 16-083

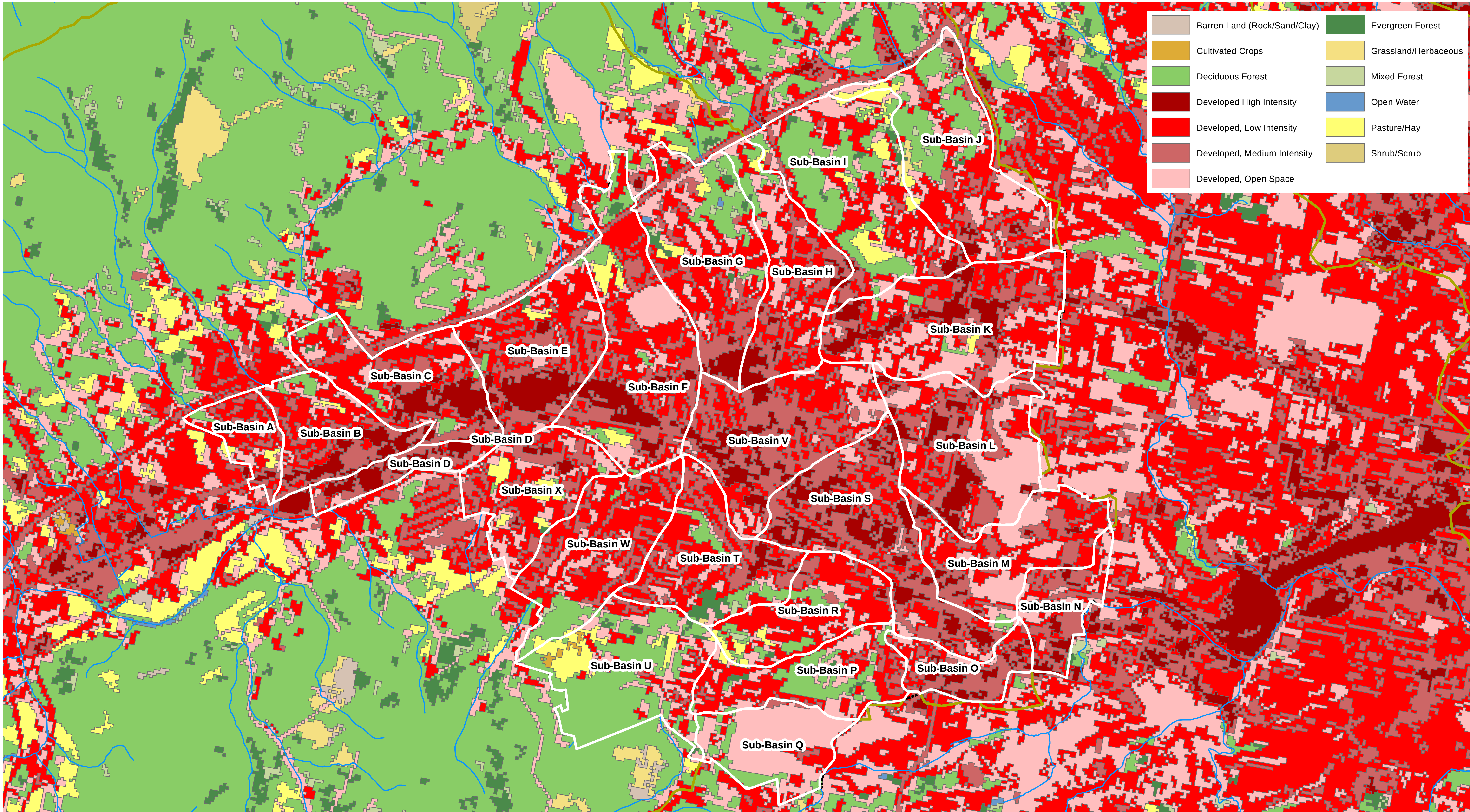
- DEQ Registered Tank Facilities [downloaded 09-06-2016]
- Septic Systems
- National Hydrographic Dataset (NHD)
- Sub-Basin Planning Units
- City of Salem Corporate Limits

APPENDIX B
SEPTIC SYSTEMS & REGISTERED TANK FACILITIES
SALEM OUTFALL PRIORITIZATION

0 0.5 1 Miles

City of Salem, VA
Sources: DEQ VEGIS Registered Tank Facilities Database [downloaded 09-06-2016]
National Hydrography Dataset (NHD), ESRI Topographic Base Mapping
Prepared by JJL, 09-21-2016

Appendix C: Mapping for NLCD



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Projection: NAD 1983 StatePlane Virginia South FIPS 4502 Feet

Proj. 16-083

N

National Hydrographic Dataset (NHD)

Sub-Basin Planning Units

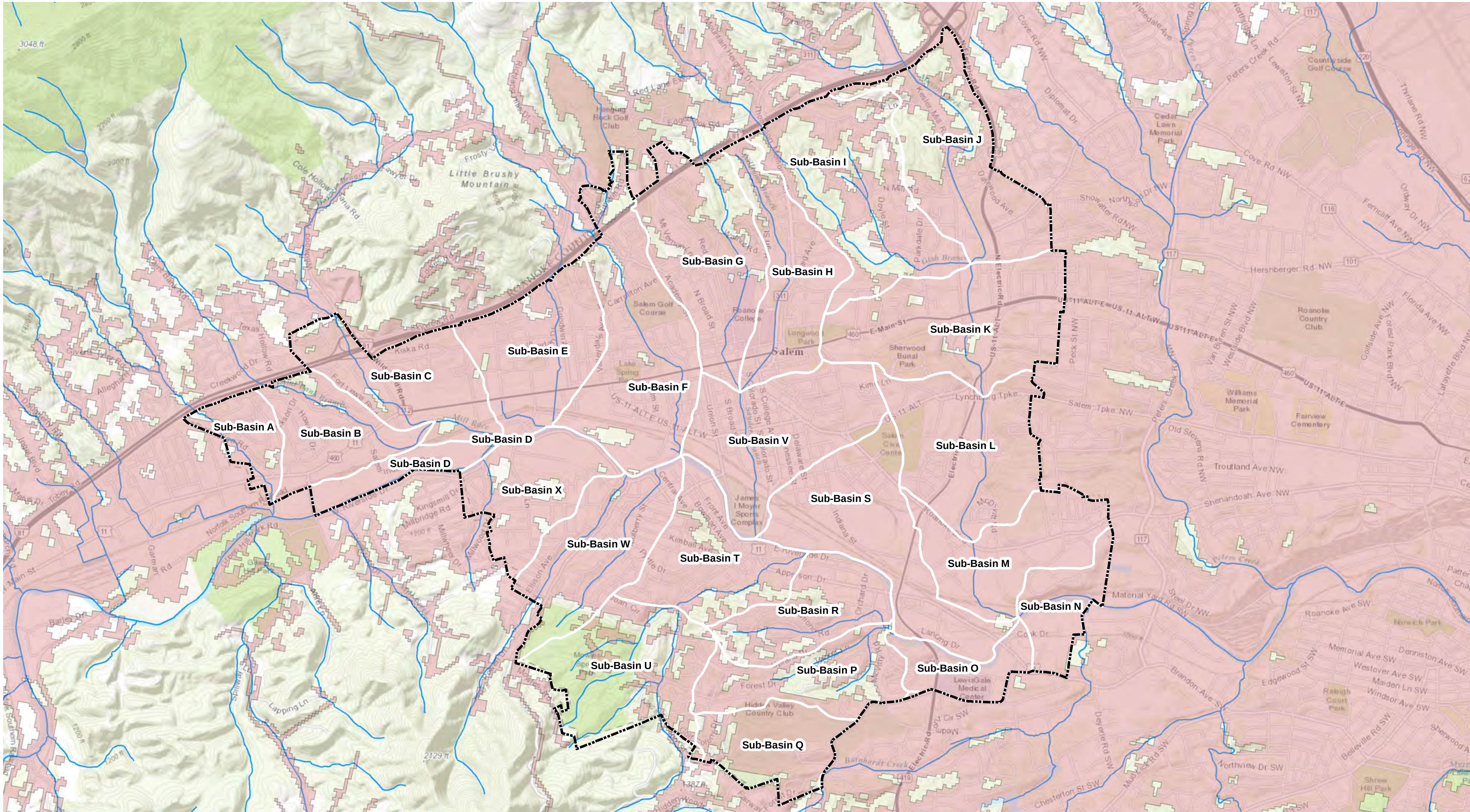
City of Salem Corporate Limits

APPENDIX C
NATIONAL LAND USE COVER DATA
SALEM OUTFALL PRIORITIZATION

0 0.5 1 Miles

City of Salem, VA
Sources: National Land Cover Dataset (NLCD), National Hydrography Dataset (NHD), ESRI Topographic Base Mapping
Prepared by JJL, 09-21-2016

Appendix D: Mapping for NLCD Generating Land Cover



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Projection: NAD 1983 StatePlane Virginia South FIPS 4502 Feet

Proj. 16-083

National Hydrographic Dataset (NHD)

NLCD Developed Land

Sub-Basin Planning Units

City of Salem Corporate Limits

APPENDIX D
NLCD GENERATING LAND COVER
SALEM OUTFALL PRIORITIZATION

0 0.5 1 Miles

City of Salem, VA
Sources: National Land Cover Dataset (NLCD), National Hydrography Dataset (NHD), ESRI Topographic Base Mapping
Prepared by JJL, 09-21-2016

Appendix E: Tabular Information for NLCD Pollutant generating Land Cover

NLCG Generating Land Cover

Planning Unit	Drainage Area (Acres)	Developed, High Intensity (%)	Developed, Low Intensity (%)	Developed, Medium Intensity (%)	Developed, Open Space (%)	Total Developed Generating Land Cover (%)	Non-developed (%)*
A	137	2	52	24	12	91	9
B	281	19	28	39	9	95	5
C	385	18	24	40	12	94	6
D	121	40	39	13	7	99	1
E	410	18	30	39	10	97	3
F	616	10	24	38	16	88	12
G	501	5	18	38	21	81	19
H	374	9	23	42	19	92	8
I	605	2	7	32	19	60	40
J	527	3	13	32	26	73	27
K	595	14	20	38	26	98	2
L	502	14	25	29	32	100	0
M	372	5	27	38	29	99	1
N	179	12	37	28	22	99	1
O	160	20	47	23	10	100	0
P	317	0	8	42	24	74	26
Q	262	0	3	14	70	87	13
R	299	1	9	56	18	83	17
S	537	26	44	23	6	99	1
T	383	4	25	45	12	86	14
U	470	0	2	14	18	34	66
V	508	15	41	33	11	100	0
W	413	0	20	54	14	88	12
X	328	3	21	44	22	90	10

* Non-developed NLCD land cover for the purposes of this analysis includes the following categories: barren lands, cultivated crops, deciduous forest, evergreen forest, grassland, mixed forest, open water, and shrub/scrub.

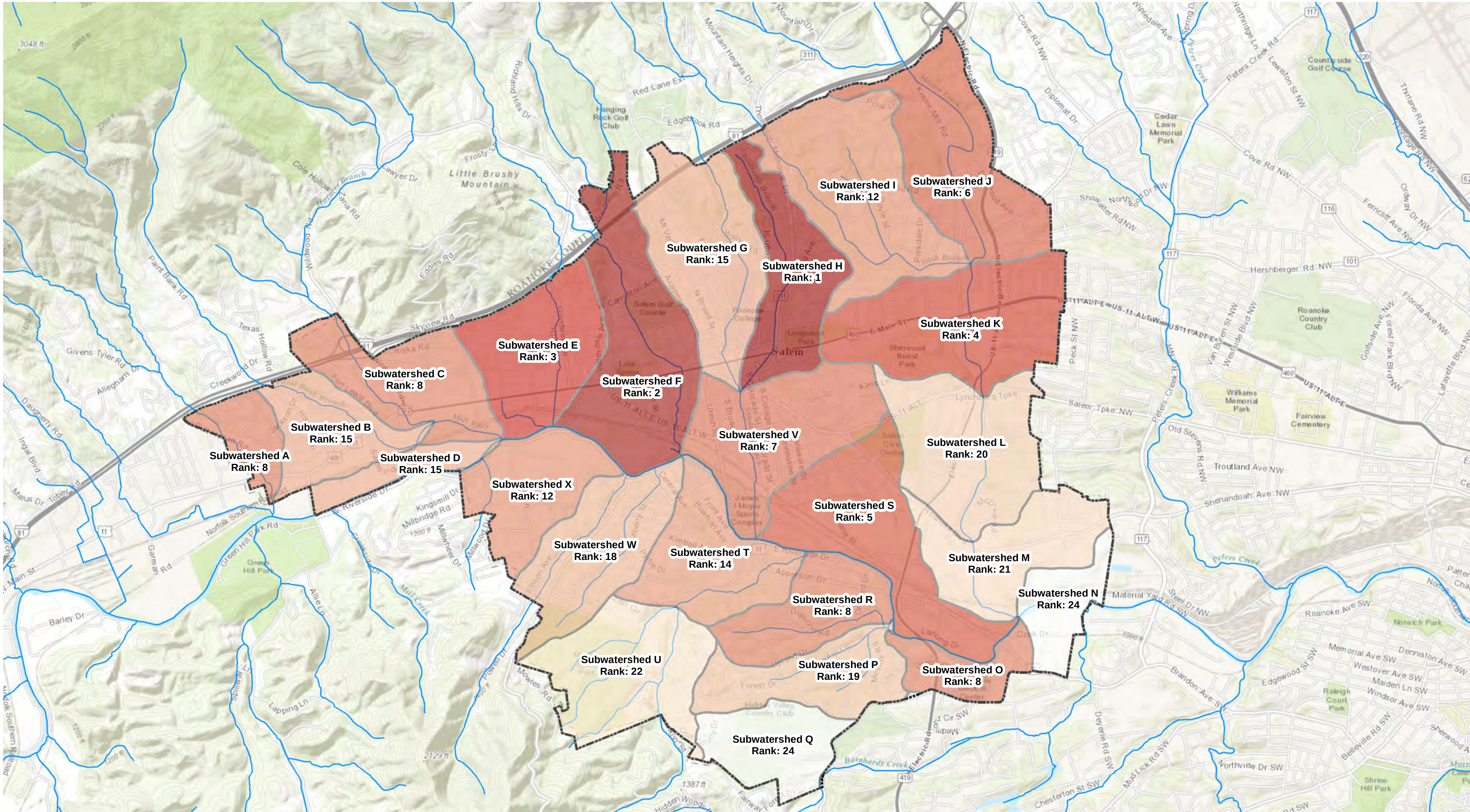
Appendix F: IDP Results for Screening Factors and Planning Units

Screening Factors Summary IDP

(a) Planning unit	(b) Direct DA to MS4 Outfalls (acres)	(c) Outfall Density (#/stream mile)	(d) Registered USTs in GLC (#/10 ac.)	(e) Septic in GLC (#/10 ac.)	(f) Est. Age of Infrastructure (years)	(g) Generating Land Cover (GLC) (%)	(h) Outfall Density in GLC (#/100 ac)	(i) Raw IDP Score	(j) Normalized IDP Score	(k) Rank
A	58 (1)	10 (4)	0 (1)	0.16 (1)	49 (0.5)	91 (6)	6.4 (4)	17.5	73	8
B	68 (1)	5 (2)	0.38 (2)	0.26 (2)	49 (0.5)	95 (6)	2.6 (2)	15.5	65	15
C	153 (2)	5 (2)	0.28 (2)	0.42 (3)	49 (0.5)	94 (6)	2.2 (2)	17.5	73	8
D	12 (1)	2 (1)	0.92 (4)	0.00 (1)	49 (0.5)	99 (6)	1.7 (2)	15.5	65	15
E	198 (3)	11 (4)	0.25 (2)	0.45 (3)	49 (0.5)	97 (6)	4.0 (3)	21.5	90	3
F	318 (4)	11 (4)	0.17 (1)	0.39 (2)	92 (2)	88 (6)	5.7 (4)	23	96	2
G	86 (1)	5 (2)	0.05 (1)	0.45 (3)	92 (2)	81 (4.5)	2.0 (2)	15.5	65	15
H	182 (2)	12 (4)	0.25 (2)	0.78 (4)	92 (2)	95 (6)	5.9 (4)	24	100	1
I	201 (3)	5 (2)	0.08 (1)	0.69 (4)	49 (0.5)	60 (3)	4.1 (3)	16.5	69	12
J	207 (3)	10 (4)	0.08 (1)	0.50 (3)	49 (0.5)	73 (4.5)	4.4 (3)	19	79	6
K	373 (4)	12 (4)	0.36 (2)	0.21 (2)	49 (0.5)	98 (6)	1.9 (2)	20.5	85	4
L	108 (2)	3 (1)	0.14 (1)	0.12 (1)	49 (0.5)	100 (6)	0.6 (1)	12.5	52	20
M	19 (1)	3 (1)	0.16 (1)	0.05 (1)	49 (0.5)	99 (6)	0.5 (1)	11.5	48	21
N	0 (1)	0 (1)	0.06 (1)	0.00 (1)	49 (0.5)	99 (6)	0.0 (1)	11.5	48	23*
O	102 (2)	7 (3)	0.31 (2)	0.13 (1)	49 (0.5)	100 (6)	4.4 (3)	17.5	73	8
P	125 (2)	3 (1)	0.04 (1)	0.21 (2)	49 (0.5)	74 (4.5)	1.7 (2)	13	54	19
Q	4 (1)	0 (1)	0.00 (1)	0.00 (1)	49 (0.5)	87 (4)	0.0 (1)	9.5	40	23*
R	133 (2)	8 (3)	0.12 (1)	0.08 (1)	49 (0.5)	83 (6)	6.5 (4)	17.5	73	8
S	261 (3)	9 (3)	0.39 (2)	0.17 (1)	92 (2)	99 (6)	3.7 (3)	20	83	5
T	185 (2)	6 (2)	0.15 (1)	0.12 (1)	63 (1)	86 (6)	4.0 (3)	16	67	14
U	24 (1)	1 (1)	0.00 (1)	0.12 (1)	49 (0.5)	34 (1.5)	1.9 (2)	8	33	22
V	127 (2)	3 (1)	0.53 (3)	0.55 (3)	92 (2)	100 (6)	1.0 (1)	18	75	7
W	177 (2)	3 (1)	0.00 (1)	0.06 (1)	49 (0.5)	88 (6)	2.2 (2)	13.5	56	18
X	198 (3)	5 (2)	0.07 (1)	0.24 (2)	49 (0.5)	90 (6)	3.1 (2)	16.5	69	12

* No outfalls within planning unit. In the case of Planning Unit Q, direct discharge crosses into an adjacent Planning Unit.

Appendix G: Mapping for IDP per Planning Unit



N

3e EEE Consulting, Inc.
Environmental, Engineering and Educational Solutions

Projection: NAD 1983 StatePlane Virginia South FIPS 4502 Feet

Proj. 16-083

National Hydrographic Dataset (NHD)

City of Salem Corporate Limits

Final Aggregate Planning Unit Priority Ranking

Low — High

APPENDIX G
IDP RANKING PER SUB-BASIN PLANNING UNIT
SALEM OUTFALL PRIORITIZATION

0 0.5 1 Miles

City of Salem, VA
Sources: National Hydrography Dataset (NHD), ESRI Topographic Base Mapping
Prepared by JJL, 09-21-2016

Appendix H: Tabular Information Identifying Outfall ID per Planning Unit

Outfall ID	Outfall HUC6 Watershed	Associated Sub-Basin Name	Sub-Basin Normalized IDP	Final Sub-Basin Rank	Latitude	Longtitude
072-02	RU09	**H**	100	1	-80.05219053	37.29859678
072-01	RU09	**H**	100	1	-80.05097065	37.30030557
039-06	RU09	**H**	100	1	-80.05425221	37.30737207
039-01	RU09	**H**	100	1	-80.05490577	37.30871494
060-12	RU09	**H**	100	1	-80.05160662	37.30113365
060-11	RU09	**H**	100	1	-80.05157564	37.30113199
060-09	RU09	**H**	100	1	-80.05157434	37.3012357
060-10	RU09	**H**	100	1	-80.05161567	37.30123928
060-08	RU09	**H**	100	1	-80.05158294	37.30148693
107-02	RU09	**H**	100	1	-80.05266037	37.29469621
060-05	RU09	**H**	100	1	-80.05158649	37.30266186
060-03	RU09	**H**	100	1	-80.05221463	37.30360953
085-01	RU09	**H**	100	1	-80.05242735	37.29774076
025-05	RU09	**H**	100	1	-80.05611067	37.31027717
025-03	RU09	**H**	100	1	-80.05647795	37.31091029
039-05	RU09	**H**	100	1	-80.05438269	37.3073628
107-04	RU09	**H**	100	1	-80.05267823	37.29462117
107-05	RU09	**H**	100	1	-80.05268077	37.29456239
107-06	RU09	**H**	100	1	-80.05271827	37.29443409
072-03	RU09	**H**	100	1	-80.05145274	37.30067789
085-02	RU09	**H**	100	1	-80.05248269	37.29792132
068-04	RU09	**F**	96	2	-80.06977268	37.29932935
144-01	RU09	**F**	96	2	-80.06348332	37.28886124
043-01	RU09	**F**	96	2	-80.07337157	37.30520585
064-01	RU09	**F**	96	2	-80.07159528	37.30267959
068-05	RU09	**F**	96	2	-80.06972744	37.29859021
068-06	RU09	**F**	96	2	-80.06968864	37.29865663
068-07	RU09	**F**	96	2	-80.06963543	37.29863665
068-01	RU09	**F**	96	2	-80.07008702	37.30082611
089-02	RU09	**F**	96	2	-80.06920595	37.29690808
088-01	RU09	**F**	96	2	-80.06841093	37.29586258
089-01	RU09	**F**	96	2	-80.06955595	37.29753237
104-03	RU09	**F**	96	2	-80.06699885	37.2938568
104-04	RU09	**F**	96	2	-80.06658499	37.29387598
104-02	RU09	**F**	96	2	-80.0673055	37.29430419
088-02	RU09	**F**	96	2	-80.06810114	37.29547465
104-01	RU09	**F**	96	2	-80.06769501	37.29505567
162-02	RU09	**F**	96	2	-80.06393757	37.28660558
162-01	RU09	**F**	96	2	-80.06388744	37.28680833
163-04	RU09	**F**	96	2	-80.07149713	37.28692925
122-05	RU09	**F**	96	2	-80.0631514	37.29061504
122-06	RU09	**F**	96	2	-80.063152	37.29054508
122-09	RU09	**F**	96	2	-80.06303327	37.29042018
122-08	RU09	**F**	96	2	-80.06310668	37.29044191

Outfall ID	Outfall HUC6 Watershed	Associated Sub-Basin Name	Sub-Basin Normalized IDP	Final Sub-Basin Rank	Latitude	Longtitude
122-07	RU09	**F**	96	2	-80.06308918	37.29053258
122-01	RU09	**F**	96	2	-80.06326802	37.29237855
122-02	RU09	**F**	96	2	-80.06312026	37.29192908
122-03	RU09	**F**	96	2	-80.06305339	37.29195473
122-04	RU09	**F**	96	2	-80.06311494	37.29085802
164-07	RU09	**F**	96	2	-80.07693642	37.28701957
141-02	RU09	**F**	96	2	-80.07704114	37.28702384
164-08	RU09	**F**	96	2	-80.07632688	37.28701422
090-03	RU09	**E**	90	3	-80.07764088	37.29764837
090-04	RU09	**E**	90	3	-80.07779022	37.29774133
125-01	RU09	**E**	90	3	-80.07730425	37.29249526
090-05	RU09	**E**	90	3	-80.07741552	37.29691096
090-06	RU09	**E**	90	3	-80.07772494	37.29599159
165-01	RU09	**E**	90	3	-80.0832714	37.28562141
140-13	RU09	**E**	90	3	-80.08158275	37.28751852
140-12	RU09	**E**	90	3	-80.08055753	37.28720694
165-04	RU09	**E**	90	3	-80.08209183	37.28563305
165-05	RU09	**E**	90	3	-80.08191398	37.28564244
164-03	RU09	**E**	90	3	-80.07899703	37.28687433
164-05	RU09	**E**	90	3	-80.07792558	37.28695646
125-05	RU09	**E**	90	3	-80.07719478	37.29220682
164-04	RU09	**E**	90	3	-80.07843457	37.28696332
125-06	RU09	**E**	90	3	-80.07717997	37.29195083
140-10	RU09	**E**	90	3	-80.0803519	37.28740724
076-01	RU10	**K**	85	4	-80.03009044	37.30078011
076-02	RU10	**K**	85	4	-80.03043111	37.30013742
150-02	RU10	**K**	85	4	-80.02825452	37.29006219
116-04	RU10	**K**	85	4	-80.02896187	37.29174261
081-06	RU10	**K**	85	4	-80.02953309	37.29591575
081-05	RU10	**K**	85	4	-80.02972765	37.29689997
081-01	RU10	**K**	85	4	-80.03004872	37.29778508
081-04	RU10	**K**	85	4	-80.03037376	37.29745623
081-02	RU10	**K**	85	4	-80.02987094	37.29747287
081-07	RU10	**K**	85	4	-80.03044007	37.29769793
076-05	RU10	**K**	85	4	-80.03003059	37.30058101
277-01	RU09	**S**	83	5	-80.03322631	37.2674418
278-02	RU09	**S**	83	5	-80.03141679	37.26643872
277-02	RU09	**S**	83	5	-80.03480619	37.26783901
248-01	RU09	**S**	83	5	-80.03853134	37.27185534
248-02	RU09	**S**	83	5	-80.03855727	37.2716388
259-01	RU09	**S**	83	5	-80.0381589	37.26956562
279-04	RU09	**S**	83	5	-80.02644505	37.26773492
278-01	RU09	**S**	83	5	-80.03185511	37.26660865
278-03	RU09	**S**	83	5	-80.03006622	37.26656234

Outfall ID	Outfall HUC6 Watershed	Associated Sub-Basin Name	Sub-Basin Normalized IDP	Final Sub-Basin Rank	Latitude	Longtitude
278-05	RU09	**S**	83	5	-80.02735658	37.26708042
278-04	RU09	**S**	83	5	-80.02830506	37.26647676
217-09	RU09	**S**	83	5	-80.05365318	37.27675465
218-01	RU09	**S**	83	5	-80.05303731	37.2765938
231-05	RU09	**S**	83	5	-80.04139546	37.27555372
231-03	RU09	**S**	83	5	-80.04163447	37.27480159
248-04	RU09	**S**	83	5	-80.03854337	37.27186807
233-05	RU09	**S**	83	5	-80.05210851	37.27634493
233-06	RU09	**S**	83	5	-80.05091025	37.27597849
217-07	RU09	**S**	83	5	-80.0540252	37.27670664
279-10	RU09	**S**	83	5	-80.02680085	37.26768551
051-05	RU10	**J**	79	6	-80.02900626	37.30474716
051-01	RU10	**J**	79	6	-80.02888211	37.30625611
034-01	RU10	**J**	79	6	-80.0315769	37.30873666
034-03	RU10	**J**	79	6	-80.03197371	37.30897187
030-02	RU10	**J**	79	6	-80.03311571	37.31219974
006-01	RU10	**J**	79	6	-80.03771651	37.31975773
016-01	RU10	**J**	79	6	-80.03212316	37.31311153
034-02	RU10	**J**	79	6	-80.0313884	37.3084294
030-06	RU10	**J**	79	6	-80.03237802	37.31008392
030-07	RU10	**J**	79	6	-80.03239107	37.31021835
030-08	RU10	**J**	79	6	-80.032699	37.31014087
030-09	RU10	**J**	79	6	-80.0326379	37.31001119
051-04	RU10	**J**	79	6	-80.0290705	37.30479757
012-04	RU10	**J**	79	6	-80.03532767	37.31758686
051-06	RU10	**J**	79	6	-80.02928094	37.30461977
034-09	RU10	**J**	79	6	-80.03066571	37.30694482
006-03	RU10	**J**	79	6	-80.03519924	37.31786234
200-02	RU09	**V**	75	7	-80.05731804	37.27965611
217-01	RU09	**V**	75	7	-80.05705558	37.27793246
217-02	RU09	**V**	75	7	-80.05487901	37.27690014
160-02	RU09	**V**	75	7	-80.05581828	37.28639776
160-01	RU09	**V**	75	7	-80.05581385	37.28655433
173-02	RU09	**A**	73	8	-80.11108096	37.28161134
173-03	RU09	**A**	73	8	-80.11097058	37.28162278
173-04	RU09	**A**	73	8	-80.110883	37.28117331
133-03	RU09	**A**	73	8	-80.11667287	37.28655461
133-02	RU09	**A**	73	8	-80.11763266	37.28730505
133-01	RU09	**A**	73	8	-80.11799772	37.28723344
171-02	RU09	**A**	73	8	-80.1102014	37.28392314
173-01	RU09	**A**	73	8	-80.11279777	37.28331069
137-05	RU09	**C**	73	8	-80.09498479	37.28752172
137-06	RU09	**C**	73	8	-80.09491169	37.2875392
137-04	RU09	**C**	73	8	-80.09505527	37.28776522

Outfall ID	Outfall HUC6 Watershed	Associated Sub-Basin Name	Sub-Basin Normalized IDP	Final Sub-Basin Rank	Latitude	Longtitude
137-03	RU09	**C**	73	8	-80.09510437	37.28774226
130-01	RU09	**C**	73	8	-80.10031584	37.29200223
130-02	RU09	**C**	73	8	-80.10020855	37.29196866
137-02	RU09	**C**	73	8	-80.0956329	37.28810868
166-01	RU09	**C**	73	8	-80.08794653	37.28641111
279-02	RU09	**O**	73	8	-80.02568837	37.26736213
279-03	RU09	**O**	73	8	-80.02564578	37.26703028
283-02	RU09	**O**	73	8	-80.0302014	37.26531348
277-03	RU09	**O**	73	8	-80.03263644	37.26660408
283-01	RU09	**O**	73	8	-80.02847619	37.26527475
279-07	RU09	**O**	73	8	-80.02655153	37.2657443
282-01	RU09	**O**	73	8	-80.02643141	37.26566873
233-01	RU09	**R**	73	8	-80.04837806	37.27476671
275-01	RU09	**R**	73	8	-80.04748514	37.26796634
274-02	RU09	**R**	73	8	-80.04899422	37.26798343
274-01	RU09	**R**	73	8	-80.04903715	37.2679763
261-03	RU09	**R**	73	8	-80.05125465	37.26848712
261-02	RU09	**R**	73	8	-80.0523136	37.26846705
259-02	RU09	**R**	73	8	-80.03870637	37.26998549
259-03	RU09	**R**	73	8	-80.03889195	37.27092865
260-01	RU09	**R**	73	8	-80.04506687	37.26889101
273-01	RU09	**R**	73	8	-80.05417895	37.26789228
248-06	RU09	**R**	73	8	-80.03903109	37.27154007
248-05	RU09	**R**	73	8	-80.03914625	37.27172143
232-02	RU09	**R**	73	8	-80.04357798	37.27487021
232-03	RU09	**R**	73	8	-80.04301866	37.27470035
231-07	RU09	**R**	73	8	-80.04142807	37.27433279
231-02	RU09	**R**	73	8	-80.04245254	37.27461834
048-01	RU10	**I**	69	12	-80.04525594	37.30551024
020-05	RU10	**I**	69	12	-80.05307335	37.31207856
048-04	RU10	**I**	69	12	-80.04539119	37.30539791
056-03	RU10	**I**	69	12	-80.03165359	37.30218575
056-02	RU10	**I**	69	12	-80.03165948	37.30213692
057-07	RU10	**I**	69	12	-80.03488515	37.30198244
057-03	RU10	**I**	69	12	-80.03644375	37.301522
020-02	RU10	**I**	69	12	-80.0531075	37.31223399
020-04	RU10	**I**	69	12	-80.05266154	37.31212105
026-02	RU10	**I**	69	12	-80.05258251	37.3117904
057-05	RU10	**I**	69	12	-80.03562284	37.30156056
057-02	RU10	**I**	69	12	-80.03834154	37.30295018
057-06	RU10	**I**	69	12	-80.0350223	37.30198941
020-06	RU10	**I**	69	12	-80.05329301	37.31266014
020-07	RU10	**I**	69	12	-80.0533481	37.31275548
165-03	RU09	**X**	69	12	-80.08195814	37.28512972

Outfall ID	Outfall HUC6 Watershed	Associated Sub-Basin Name	Sub-Basin Normalized IDP	Final Sub-Basin Rank	Latitude	Longtitude
164-01	RU09	**X**	69	12	-80.07488408	37.28581539
164-02	RU09	**X**	69	12	-80.07898538	37.2862124
163-01	RU09	**X**	69	12	-80.07238445	37.28477714
178-04	RU09	**X**	69	12	-80.08827817	37.28200544
206-03	RU09	**X**	69	12	-80.08577835	37.2791152
206-01	RU09	**X**	69	12	-80.08464653	37.27988855
165-06	RU09	**X**	69	12	-80.08229146	37.28513284
178-02	RU09	**X**	69	12	-80.0856194	37.28332068
217-04	RU09	**T**	67	14	-80.0577168	37.27811747
245-01	RU09	**T**	67	14	-80.05782837	37.27171991
263-01	RU09	**T**	67	14	-80.06291495	37.27058745
263-02	RU09	**T**	67	14	-80.06233331	37.27061537
233-04	RU09	**T**	67	14	-80.0532807	37.27618397
217-03	RU09	**T**	67	14	-80.05409932	37.27635755
244-01	RU09	**T**	67	14	-80.06108373	37.2712491
200-03	RU09	**T**	67	14	-80.05809379	37.28011899
217-06	RU09	**T**	67	14	-80.05600062	37.27637034
234-01	RU09	**T**	67	14	-80.0534307	37.27626584
233-03	RU09	**T**	67	14	-80.05180595	37.27591439
233-02	RU09	**T**	67	14	-80.04963195	37.2754805
245-02	RU09	**T**	67	14	-80.05619713	37.27197507
135-02	RU09	**B**	65	15	-80.10574422	37.28881553
168-01	RU09	**B**	65	15	-80.0984965	37.28610196
168-02	RU09	**B**	65	15	-80.09836841	37.28591038
135-01	RU09	**B**	65	15	-80.10728628	37.2893338
136-02	RU09	**B**	65	15	-80.10220409	37.28729119
136-01	RU09	**B**	65	15	-80.10382014	37.28779443
169-01	RU09	**B**	65	15	-80.10049676	37.28651203
177-01	RU09	**D**	65	15	-80.08983452	37.28262628
177-02	RU09	**D**	65	15	-80.09093015	37.28270212
106-01	RU09	**G**	65	15	-80.05861512	37.29358647
070-01	RU09	**G**	65	15	-80.06189281	37.30070971
061-02	RU09	**G**	65	15	-80.0567768	37.30256613
062-05	RU09	**G**	65	15	-80.06401697	37.30175801
106-02	RU09	**G**	65	15	-80.05820495	37.29428845
106-03	RU09	**G**	65	15	-80.05823983	37.29508776
061-07	RU09	**G**	65	15	-80.0582109	37.30135562
121-05	RU09	**G**	65	15	-80.0566609	37.29053055
182-03	RU09	**W**	56	18	-80.06680767	37.28237159
182-04	RU09	**W**	56	18	-80.06676527	37.28251095
183-02	RU09	**W**	56	18	-80.06350614	37.28374542
214-01	RU09	**W**	56	18	-80.07248852	37.27728582
238-03	RU09	**W**	56	18	-80.07796893	37.27394461
181-02	RU09	**W**	56	18	-80.06948907	37.28232137

Outfall ID	Outfall HUC6 Watershed	Associated Sub-Basin Name	Sub-Basin Normalized IDP	Final Sub-Basin Rank	Latitude	Longtitude
183-03	RU09	**W**	56	18	-80.0634481	37.28374157
182-08	RU09	**W**	56	18	-80.06780875	37.28199833
275-03	RU09	**P**	54	19	-80.04387167	37.26645319
299-01	RU09	**P**	54	19	-80.04876392	37.26217196
287-03	RU09	**P**	54	19	-80.05022298	37.26393014
276-04	RU09	**P**	54	19	-80.04089408	37.26612918
150-03	RU10	**L**	52	20	-80.02823736	37.28989729
150-04	RU10	**L**	52	20	-80.0286583	37.29007253
150-05	RU10	**L**	52	20	-80.02867067	37.28991062
250-01	RU10	**M**	48	21	-80.0290139	37.27363974
257-01	RU10	**M**	48	21	-80.02898504	37.27116412
264-02	RU09	**U**	33	22	-80.06431144	37.26997244
271-01	RU09	**U**	33	22	-80.06342393	37.2672802
290-04	RU09	**U**	33	22	-80.06494074	37.2631218