Appendix G Problem Ranking and Candidate Site Selection Procedure

Introduction

The purpose of this Appendix is to present the method, criteria and results for determining which areas of the Difficult Run watershed are most in need of restoration or preservation. It describes the procedure used to rank the problems, which have been identified in earlier tasks of GIS analysis, reviewing historical environmental data, stream assessment monitoring, and watershed modeling.

This procedure consists of selecting quantifiable indicators that describe the condition of the watershed, weighing them by importance, then calculating a weighted average score for each area. This score is then used to rank them in priority order for restoration or preservation.

Problems or overall condition can be identified and ranked at three different scales:

- Site These indicators describe conditions that can be pinpointed to a single location, such as a culvert, dumpsite, or streambank erosion point.
- Stream Reach These indicators describe the condition of a length of stream, such as erosion, habitat, buffer, or bioassessment.
- Catchment These indicators describe conditions over a drainage area, such as imperviousness or pollutant loading.

The following three activities will be required to accomplish this task:

1. Choose a set of indicators to characterize watershed condition with a minimum of duplication.
2. Quantify or score each indicator in a normalized fashion so that, for instance, one subwatershed's score can be directly compared with that of another. Whenever possible, scores should be absolute units of measure and not by a relative score or percentile. This would make it easier to see how the watershed conditions and ranking change over time.
3. Weight the indicators against each other so that the ones that are most important in establishing watershed health or vulnerability would have the highest consideration.

Potential Indicators

Sources of Indicators

There are a number of studies, papers, and State and Federal programs that have used watershed indicators to provide information on the condition of watersheds so that they can be compared to each other. Five of these were reviewed for this project to develop a wider range of indicators than those provided in the modeling results and data analysis from tasks 2.8 through 2.10. The literature and internet review identified these sources:

Booth, Derek B. et al. *Reviving Urban Streams: Land Use, Hydrology, Biology, and Human Behavior* Journal of the American Water Resources Association, Oct 2004, p1351.

Maryland Clean Water Action Plan. Final 1998 Report on Unified Watershed Assessment, Watershed Prioritization, and Plans for Restoration Action Strategies. Appendix III. December, 1998. http://www.dnr.state.md.us/download/MD98CWAP.PDF

Norfolk District Corps of Engineers Regulatory Branch. *Stream Attributes Crediting Methodology*. December, 2003. http://www.nao.usace.army.mil/Regulatory/PN/StreamPN/Stream%20attributes%20crediting%20methodology.doc

U.S. EPA, Office of Wetlands, Oceans, and Watersheds. *Index of Watershed Indicators: An Overview*. Washington, DC. August 2002. http://www.epa.gov/iwi/iwi-overview.pdf

Zielinski, Jennifer. *Watershed Vulnerability Analysis*. Center for Watershed Protection, Ellicott City, MD, January 2002. http://www.cwp.org/Vulnerability_Analysis.pdf

Restoration indicators describe specific conditions in the watershed. They are grouped in Table G.1 by four main types: quantity, quality, streams, and GIS. Indicators of quantity describe either the effects of runoff and streamflow or a more specific measure of the amount of flow. Quality indicators refer to contamination; either pollutant loads being conveyed to a water body or direct measures of water quality. Stream indicators describe stream health, primarily from monitoring or assessment data. Indicators of land cover are calculated from GIS data.

Preservation indicators are used to determine if existing areas in good condition are vulnerable to degradation in the future. These indicators are derived either from GIS analysis or modeling and are measures of change.

Based on these sources, there is a significant amount of quantifiable information available for this task. Tables G.1 and G.2 below and the following sections describe the potential indicators.

Table G.1 Potential Restoration Indicators

Type	Indicator	Scale	Normalized Unit	Source
Quantity	Drainage Complaints	Site	Number per mile	County records
	100-year floodplain	Catchment	# of structures in flood plain / watershed area	Modeling
	Stream crossing flooding	Site	Yes / no	Modeling
	Peak discharge	Catchment	cfs / acre	Modeling
	Runoff volume	Catchment	in	Modeling
Quality	Nitrogen loads	Catchment	lb/ac/yr	Modeling
	Phosphorus loads	Catchment	lb/ac/yr	Modeling
	Sediment loads	Catchment	lb/ac/yr	Modeling
	Zinc loads	Catchment	lb/ac/yr	Modeling
Streams	CoE stream rating	Reach	Score / mile	SPS, SPA
	Habitat rating	Reach	Score / mile	SPS, SPA
	Channel Morphology	Reach	Score / mile	SPA
	Stream erosion	Reach	LF / mile	SPA

Type	Indicator	Scale	Normalized Unit	Source
	Stream erosion potential	Reach	LF / mile	Modeling
	Bioassessment	Reach	LF / mile	SPS, follow-up
	Stream buffer	Reach	LF / mile	SPA
	Forested stream buffer	Reach	LF / mile	GIS Analysis
	Streamflow patterns	Reach	% days when daily flow > mean annual flow	Modeling
GIS	Imperviousness	Catchment	Percent of area	GIS Analysis
	Wetland density	Catchment	Percent of area	GIS Analysis
	Forest cover	Catchment	Percent of area	GIS Analysis

Table G.2 Potential Preservation Indicators

Type	Indicator	Scale	Normalized Unit	Source
Preservation	Imperviousness	Catchment	% change, area	GIS Analysis
	Nitrogen loads	Catchment	% change, lb/ac/yr	Modeling
	Phosphorus loads	Catchment	% change, lb/ac/yr	Modeling
	Peak discharge	Catchment	% change cfs / acre	Modeling
	Runoff volume	Catchment	% change, in	Modeling
	Stream erosion potential	Reach	% change , LF / mile	Modeling
	Streamflow patterns	Reach	% change, days daily flow > mean annual flow	Modeling
	Protected land	Catchment	Percent of area	GIS Analysis

Flooding and Water Quantity Indicators

Drainage Complaints -- Complaints from County records are an indication of flooding or other hydraulic problems. They will be tabulated, located, and normalized by the number per mile of stream in each reach.

100-year flooding -- The 100-year floodplain is an indication of flooding significant enough to require flood insurance. The indicator is measured by the number of structures in the floodplain, normalized by watershed area.

Stream crossing flooding -- Frequency of flooding is one of the design criteria for culverts and other stream crossings, described in the level of service (LOS). The indicator compares the modeled flooding frequency with the level of service, and indicates whether or not it is overtopped more frequently than the LOS allows for.

Peak discharge -- Change in peak flow is an indicator of how the hydrology of a subwatershed has changed through urbanization. Higher peak flows for the 1-year storm are indicative of watersheds where there is more erosive stress on streams. The indicator is normalized in cfs/acre by watershed area.

Runoff volume -- Change in runoff volume is an indicator of how the hydrology of a subwatershed has changed through urbanization. Higher volumes for the 1-year storm indicate watersheds in which there is more erosive stress on streams. The measurement of volume in inches normalizes the indicator by watershed area.

Streamflow patterns -- Recent research has shown a good correlation between the flashiness of urban streams and biological conditions. This indicator measures the number of days when daily mean discharge exceeds the annual mean discharge, which is not strongly altered by urban development.

Pollutant Loading and Water Quality Indicators

Modeled Nitrogen loads -- Excess nitrogen loading has been shown to be a significant cause of impairment in Chesapeake Bay water quality. Excessive nitrogen in streams also contributes to algae growth and substrate fouling, which degrades habitat. Loads are measured and normalized by watershed area in lb/yr/acre.

Modeled Phosphorus loads -- Excess phosphorus loading contributes to impairment in Chesapeake Bay water quality. Excessive phosphorus in streams also contributes to benthic algae growth and substrate fouling, which degrades habitat. Loads are measured and normalized by watershed area in lb/yr/acre.

Modeled Sediment loads -- Excess sediment has been shown to significantly impair Chesapeake Bay water quality. Sediment smothers aquatic grasses and reduces the amount of light, thus limiting growth. Excessive sediment in streams contributes to substrate fouling, which degrades habitat. Loads are measured and normalized by watershed area in lb/yr/acre.

Modeled Zinc loads -- Zinc is the most prevalent toxic pollutant found in runoff, and was chosen as a surrogate for other nonpoint source toxic pollutants. Loads are measured and normalized by watershed area in lb/yr/acre.

Habitat and Stream Condition Indicators

Corps of Engineers stream attributes rating method -- This is a comprehensive stream rating index combining measures of channel incision, riparian condition, bank erosion, channelization, and instream habitat. Data are derived from the SPA survey. Scores will be normalized by reach length.

Habitat rating (RBP) -- Data from the County's SPA project will be used to identify and quantify stream reaches with poor habitat quality. The overall numerical score for each stream reach will be used as the quantification measure. The habitat index is a score between 0 and 200 rating the physical quality of the stream. It is normalized by reach length.

Stream morphology (CEM) -- Data are from the County's SPS and SPA projects. The Channel Evolution Model (CEM) gives scores showing whether the stream is actively eroding or reaching a point of becoming stable. Scores will be normalized by reach length.

Stream erosion -- Channel erosion is a serious habitat impairment, and a source of pollutants to downstream receiving waters, including excess sediment and phosphorus. While streams naturally erode, meander, and rework floodplains, excess erosion due to watershed development results in sedimentation of spawning areas, smothering of benthic invertebrates, and potential adverse impacts on stream hydraulics.

Stream erosion potential -- Results of hydraulic modeling stable channel routines and stream measurements will be used to estimate the stream reaches with the potential for erosion due to high shear stress. The indicator will be measured and normalized by the linear feet (LF) of potential erosion per mile of stream reach.

Bioassessment -- The Index of Biological Integrity (IBI) from the County's Stream Protection Strategy and follow-up monitoring can be used to identify and quantify degradation in the aquatic community. It will be normalized as a score divided by the length of stream reach.

Riparian stream buffer -- Riparian buffers are necessary for stream stability and are a major component of stream habitat through the production of woody debris. Streams with more extensive streamside buffers tend to have more diverse and healthy biological communities. Length of stream buffer was determined from the SPA, and normalized as a percentage of the stream reach.

Forested stream buffer -- Forested riparian buffers are necessary for stream stability and are a major component of stream habitat through the production of woody debris. Streams with more extensive streamside forested buffers tend to have more diverse and healthy biological communities. Length of forested buffer will be determined from GIS analysis and normalized as a percentage of the stream reach.

GIS Indicators

Imperviousness -- There is evidence to suggest that total levels of impervious surface in a watershed are related to a watershed's overall condition. Imperviousness is the most important contributor to increased stormwater runoff, thermal pollution, and a number of pollutants, particularly those related to automotive uses.

However, imperviousness is a factor in other indicators as well, which gives it a larger influence on subwatershed ranking than its weight as an indicator by itself. Imperviousness is an input parameter for SWMM modeling of both water quality and water quantity, which gives the potential for double counting.

Impervious cover is measured in percent of subwatershed area.

Wetland density -- Wetlands are among the most valuable natural resources in a watershed, providing hydrologic benefits, water quality improvement, and wildlife habitat. This indicator measures the percent of the watershed area that is wetland.

Forest cover -- Large forest blocks have a positive impact on watershed health and aquatic resources, and provide habitat for terrestrial species as well. Forested land has the lowest runoff flow rates and volume, lower sediment runoff, and typically lower pollutant loads than other land uses. The Virginia Dept of Forestry has GIS coverage derived from 2000 satellite imagery that can be used as a base layer. This indicator measures the percent of the watershed area that is forested.

Preservation Indicators

Change in imperviousness -- For analysis of vulnerability, the percent change in imperviousness for each subwatershed will be used. This is an indication of the amount of development that is forecast in the future land use scenario, and how much additional stress will be placed on the watershed.

Change in phosphorus loading -- For analysis of vulnerability, the percent change in phosphorus loading for each subwatershed will be used. This is an indication of the change in water quality that will result from development forecast in the future land use scenario.

Change in nitrogen loading -- For analysis of vulnerability, the percent change in nitrogen loading for each subwatershed will be used. This is an indication of the change in water quality that will result from development forecast in the future land use scenario.

Change in peak discharge -- For analysis of vulnerability, the percent change in peak discharge for each subwatershed will be used. This is an indication of the change in flows that will result from development forecast in the future land use scenario.

Change in runoff volume -- For analysis of vulnerability, the percent change in runoff volume for each subwatershed will be used. This is an indication of the change in hydrology that will result from development forecast in the future land use scenario.

Change in streamflow patterns -- For analysis of vulnerability, the percent change in the number of days when daily mean discharge exceeds the annual mean discharge will be calculated from modeling the future land use scenario.

Change in stream runoff potential -- For analysis of vulnerability, the percent change in the length of streams where there is a potential for erosion due to high shear stress.

Protected land -- Protected lands are those owned by a public agency that are unlikely to be developed in the future. Other condition factors being equal, watersheds with large amounts of protected land less vulnerable because of the likelihood of remaining in a natural state.

Land considered permanently protected includes County, State or Federal parkland or wildlife conservation areas, lands with conservation easements, or any lands with other types of protection that prevents its conversion from open space to developed area, such as Resource Protection Area (RPA). For each catchment, the percent of protected land is the measure used for this indicator.

Steering Committee Review of Procedure

The Difficult Run Watershed Steering Committee appointed a Technical Subcommittee to review the list of potential indicators and decide on the most appropriate ones to be used for prioritizing problems in the watershed. The goal was to identify the smallest number of indicators, which would give a good measure of watershed condition with the least amount of overlap among indicators. There was general discussion on two subjects:

- Sub-committee members first discussed the questions of the amount and accuracy of the data for each indicator. It was agreed that all the indicators in the table had a sufficient amount of data to be used. The one with the least amount of data was bioassessment.
- The subcommittee discussed the use of individual versus composite scores. Some of the indicators, such as habitat rating or the Corps of Engineers (CoE) rating, are composites of several measurements. Use of both leads to double counting. Use of the composite score gives an implied internal weight to the measured data.

The following conclusions were drawn:

- The bioassessment and hydrology (peak discharge and runoff volume) indicators are the most important at describing stream condition.
- Some of the indicators may introduce duplication in measured aspects of stream condition, shown in Table G.3, however, this is not necessarily undesirable.

Table G.3 Indicators That May Introduce Duplication

Measurement	Individual Measurement	CoE Component	Habitat Component
CoE stream rating			
Habitat rating		x	
Channel Morphology (ICEM)	x	x	x
Stream erosion	x	x	x
Stream erosion potential (modeled)	x		

Measurement	Individual Measurement	CoE Component	Habitat Component
Bioassessment	x		
Stream buffer	x	x	x
Forested stream buffer (GIS)	x		
Streamflow patterns (modeled)	x		
Channelization		x	x

The subcommittee agreed on a preliminary weighting of the three main types of indicators (quantity, quality, and streams) as shown in Table G.4, and agreed that individual indicators should initially be weighted equally within each type. The recommended list of indicators is shown in Tables G.5 and G-6.

Table G.4 Proposed Weighting Factors

Type	Weight
Quantity	40
Quality	30
Streams	30
TOTAL	100

Table G.5 Selected Indicators, Existing Conditions

Type	Indicator	Scale	Normalized Unit	Source
Quantity	Drainage complaints	Site	Yes / no	County records
	Stream crossing flooding	Site	Yes / no	Modeling
	100-year floodplain	Catchment	# of structures in flood plain / watershed area	Modeling
	Peak discharge	Catchment	cfs / acre	Modeling
	Runoff volume	Catchment	in	Modeling
Quality	Nitrogen loads	Catchment	lb/ac/yr	Modeling
	Phosphorus loads	Catchment	lb/ac/yr	Modeling
	Sediment loads	Catchment	lb/ac/yr	Modeling
	Wetland density	Catchment	Percent of area	GIS Analysis
	Forest cover	Catchment	Percent of area	GIS Analysis
Streams	Habitat rating	Reach	Score / mile	SPS, SPA
	Channel morphology	Reach	Score / mile	SPS
	Stream erosion	Reach	LF / mile	SPA
	Bioassessment	Reach	LF / mile	SPS, follow-up
	Stream buffer	Reach	LF/mile	SPA
	Streamflow patterns	Reach	% days when daily flow > mean annual flow	Modeling

Table G.6: Selected Indicators, Future Conditions

Vulnerability	Imperviousness	Catchment	change, area	GIS Analysis
	Nitrogen loads	Catchment	% change, lb/ac/yr	Modeling
	Phosphorus loads	Catchment	% change, lb/ac/yr	Modeling
	Peak discharge	Catchment	% change cfs / acre	Modeling
	Runoff volume	Catchment	% change, in	Modeling
	Stream erosion potential	Reach	% change , LF / mile	Modeling
	Streamflow patterns	Reach	% change, days when daily flow > mean annual flow	Modeling

Results

Indicators Used

The problem ranking task was carried out simultaneously with completion of the modeling and analysis. In the process, the selection of the indicators used was modified. In practice it proved difficult to use all the selected indicators as proposed, for the following reasons:

1. Hydraulic modeling was not far enough along to assess streamflow patterns according to the Booth article referenced earlier. The analysis task proved to be prohibitive, as well, since it required processing data for 365 days of flows in 167 modeled stream reaches.

2. Stream assessment data across the watershed did not appear uniform enough for quantitative analysis. Most of these indicators couldn't be used as planned.

The final set of indicators used for the project is shown in the tables below. Restoration indicators for catchments relied on modeling results primarily, with measurements also made from GIS coverages, as shown in Table G.7.

Table G.7 Catchment Restoration Indicators

Indicator	Criteria	Units
Quantity	Peak discharge	cfs/acre
	Runoff volume	inches
Quality	Nitrogen	lb/ac/yr
	Phosphorus	lb/ac/yr
	Sediment	lb/ac/yr
Landcover	Wetland	percent of catchment
	Forest	percent of catchment

Use of the stream indicators was somewhat subjective. Sites were typically selected if they showed two or more of the impairments in Table G.8.

Table G.8 Stream Reach Selection

Indicator	Criteria
Habitat Rating	Overall habitat rating of poor and very poor
Channel Morphology	CEM Type II (incision) and III (widening)
Stream Erosion	Severe to extreme erosion inventory impact score (score of 7-10) and moderate to high restoration potential
Bank Stability	Low bank stability (habitat assessment parameter) score of 3 or lower

Indicator	Criteria
Riparian Buffer	Severe to extreme erosion inventory impact score (score of 7-10) and moderate to high restoration potential

Additional sites for stream improvements were selected based on specific locations of severe and extreme inventory points, or clusters of points for data from the following layers.

Table G.9 Stream Site Selection

Indicator	Criteria
Pipe Impact	Moderate to severe impact score
Crossing Impact	Moderate to severe impact score
Ditch Impact	Moderate to severe impact score
Obstruction	Moderate to severe impact score
Dump Site Impact	Moderate to severe impact score
Utility Impact	Moderate to severe impact score

The preservation indicators for catchments used in the analysis were a simplified set of the ones recommended, relying on water quality modeling results alone. The catchments that showed low pollutant loading for existing conditions and a large percent change between existing and future conditions were considered the most vulnerable to degradation and thus good candidates for preservation.

The threshold values for TSS, TN, and TP were used to determine good conditions. These were based on comparisons with values for the whole watershed, and with estimates of loadings from “irreducible concentrations” from stormwater runoff (Schueler, 2000) Values used to set the thresholds are shown in Table G.10, in lb/ac/yr.

Table G.10: Threshold Values for Preservation Candidate Sites

	TSS	TN	TP
Low	17.8	0.9	0.18
Average	63.1	2.8	0.41
High	197.9	7.9	0.92
Irreducible	20 to 40	1.9	0.20
Threshold	30.0	2.0	0.20

The percent change between existing and future loads was calculated. If one or more of the parameters doubled (increase of 200% or more), then the catchment was flagged as a preservation candidate.

Table G.11 Preservation Indicators

Indicator	Criteria	Units
Quantity	Peak discharge	%change, cfs/acre
	Runoff volume	% change, inches
Quality	Nitrogen	% change, lb/ac/yr
	Phosphorus	% change, lb/ac/yr
	Sediment	% change, lb/ac/yr
Landcover	Imperviousness	% change,

Candidate Sites

A total of 253 candidate sites were selected for further field review and analysis based on the prioritization of problems in the catchments and at stream sites. The types of candidate sites are as follows. Stream Restoration sites (S), Catchment sites (C), Regional pond alternatives sites (D), Flooding sites for roads and structures (F) and Preservation sites (P).

Stream Restoration

Stream restoration candidate sites are shown below in Maps G.1 and G.2. A total of 87 Stream Restoration Sites were selected.

Catchment Restoration Ranking

Existing Conditions

The 201 catchments in the Difficult Run watershed were ranked based on existing conditions using the quantity and quality indicators listed above in Table G.6. The modeling and GIS results for each of the parameters were normalized according to the specific needs of the indicator and compiled into a single database. The value for each parameter was ranked within the range of values in the dataset. Scores from 1-10 were then applied to the ranked values.

- For the modeled indicators (100 year floodplain, runoff volume, peak discharge, nitrogen loads, phosphorus loads and sediment loads) higher values reflect lower quality conditions and received a lower score, which will indicate a higher priority ranking for restoration.
- For the GIS derived landscape indicators (wetland density, forest cover) higher values reflect higher quality conditions and received a high score, which will indicate a lower priority ranking for restoration.

The score for each catchment was then multiplied by the indicator weight to develop the weighted score. The weighted scores for all of indicators were then summed and placed on a 0-100 scale. Each catchment's scaled score was then ranked within the 201 catchments. The lowest score indicates the lowest relative quality and the highest priority in the watershed. Table G.12 below shows an example with the indicator weights, and top 10 priority catchments.

A total of 46 catchment sites were selected. Refer to Map G.3 for their location and the results of the existing conditions catchment ranking.

Regional Pond Alternatives

There were 52 known sites where Regional Ponds were planned but are currently unbuilt. During the modeling task, the drainage area to each of these sites was delineated as one or more separate catchments, so it is possible to rank the unbuilt regional pond sites using the same prioritization scheme as the other areas of Difficult Run. The sites are shown on Map G.4.

Flooding Sites for Road Crossings

Hydraulic modeling identified the culverts that were overtopped by any of the modeled storm years (1,2,5,10,25,50,100). The overtopping was then compared to the level of service for that road and the associated required flow that the road must pass. If the culvert did not pass the required flow it was selected as a candidate site. There were 89 culverts that overtopped for one or more storm flow, 34 were selected as candidate sites. The sites are shown on Map G.5.

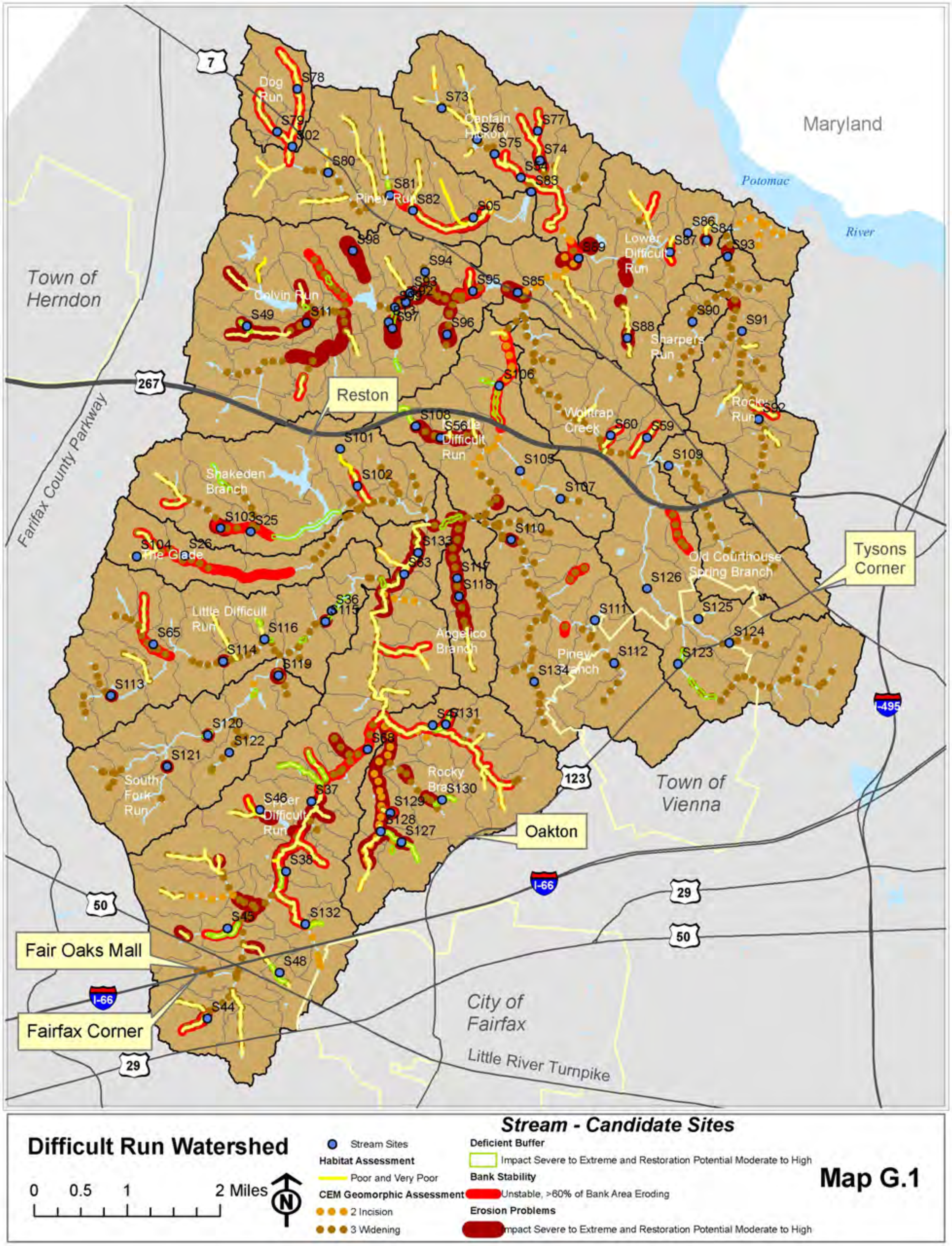
Catchment Preservation Ranking

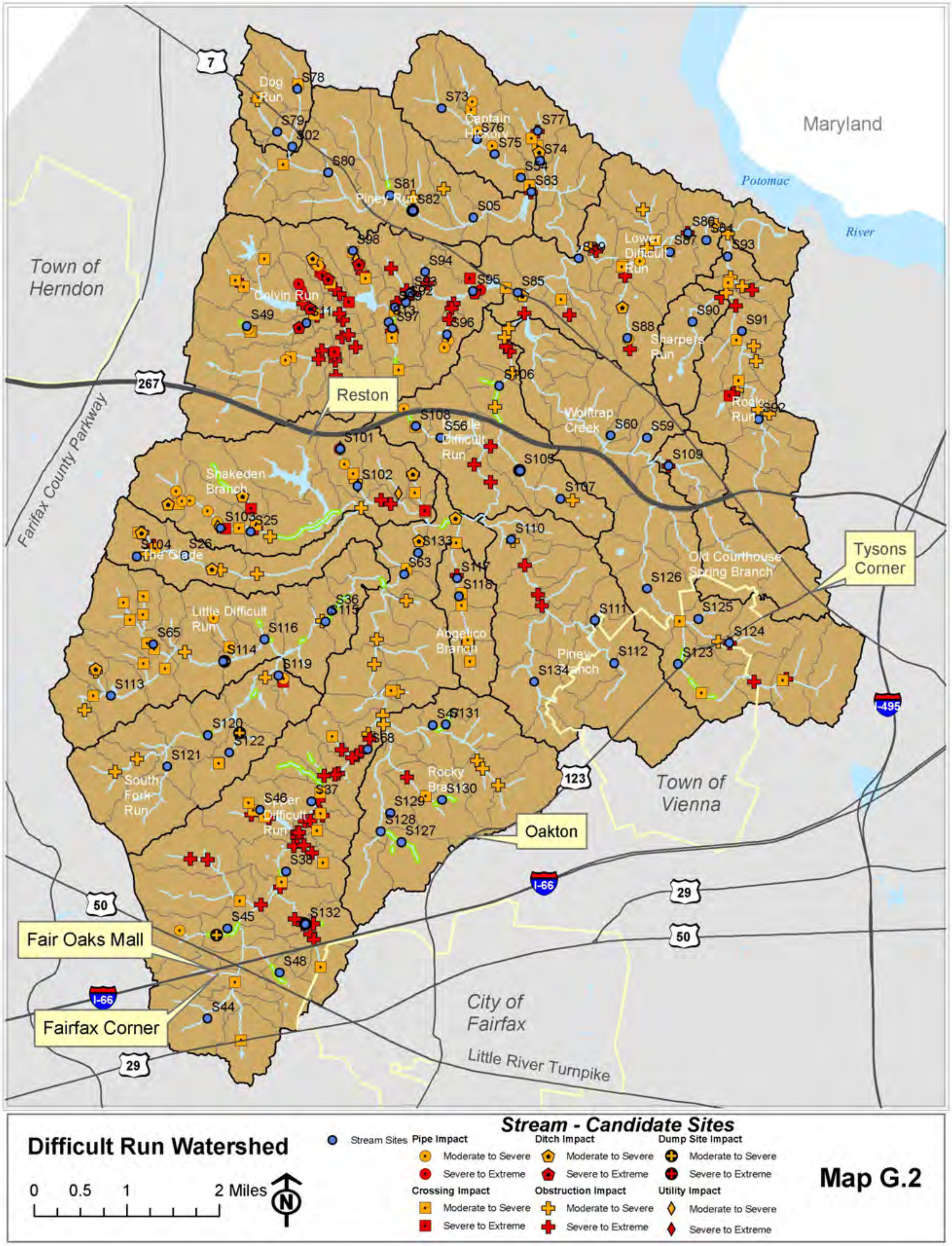
The future conditions model results and impervious cover percentages were compiled to generate a ranking of vulnerability. The catchments the showed the greatest percent change in the model results and imperviousness between existing and future conditions are considered the most vulnerable to degradation.

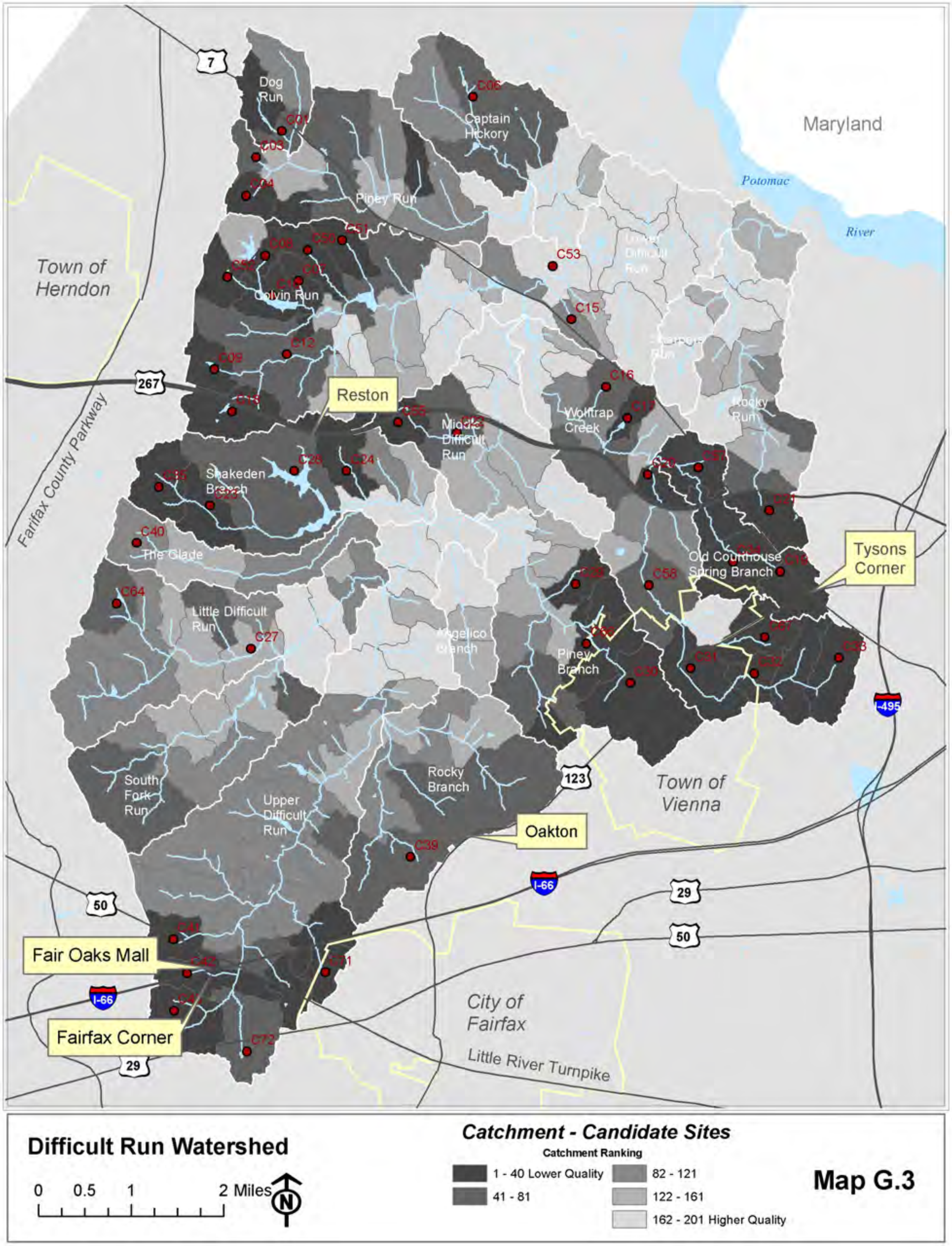
- For all indicators (runoff volume, peak discharge, nitrogen loads, phosphorus loads, sediment loads, and impervious cover) higher percent changes reflect more vulnerability and received a lower score, which will indicate a higher priority ranking for preservation.

Similar to the existing conditions catchment ranking, the score for each catchment was multiplied by the indicator weight to develop the weighted score. The weighted scores for all of indicators were then summed and placed on a 0-100 scale. Each catchment's scaled score was then ranked within the 201 catchments. The lowest score indicates the highest vulnerability and the highest priority in the watershed for preservation. Table G.13 below shows an example with the indicator weights, and top 10 priority catchments.

A total of 34 catchment sites were selected. Refer to Map G.6 for their location and the results of the preservation catchment ranking. Map G.7 shows all of the candidate sites across the watershed.


Maryland
Potomac
River
Town of Herndon
Fairfax County Parkway
Reston
Tysons Corner
Town of Vienna
Oakton
Fair Oaks Mall
Fairfax Corner
City of Fairfax
Little River Turnpike
Dog Run
Captain Hickory
Piney Run
Colvin Run
Lower Difficult Run
Sharpers Run
Rocky Run
Wolftrap Creek
Little Difficult Run
Shaker Branch
The Glade
Little Difficult Run
Old Courthouse Spring Branch
Angelico Branch
Piney Branch
South Fork Run
Rocky Branch
Upper Difficult Run
7
267
123
29
50
I-66
I-495
Difficult Run Watershed
0 0.5 1 2 Miles
N
Stream - Candidate Sites
Stream Sites
Habitat Assessment
Poor and Very Poor
CEM Geomorphic Assessment
2 Incision
3 Widening
Deficient Buffer
Impact Severe to Extreme and Restoration Potential Moderate to High
Bank Stability
Unstable, >60% of Bank Area Eroding
Erosion Problems
Impact Severe to Extreme and Restoration Potential Moderate to High
Map G.1


Maryland
Potomac
River
Town of Herndon
Fairfax County Parkway
Reston
Tysons Corner
Town of Vienna
Oakton
City of Fairfax
Fair Oaks Mall
Fairfax Corner
Little River Turnpike
Dog Run
Captain Hickory
Piney Run
Lower Difficult Run
Sharpers Run
Rocky Run
Wolftrap Creek
Middle Difficult Run
Colvin Run
Shaken Branch
The Glade
Little Difficult Run
Old Courthouse Spring Branch
Angelico Branch
Piney Branch
South Fork Run
Rocky Branch
Upper Difficult Run
7
267
123
50
29
I-66
I-495
Difficult Run Watershed
0 0.5 1 2 Miles
N
Stream - Candidate Sites
Stream Sites
Pipe Impact
Moderate to Severe
Severe to Extreme
Crossing Impact
Moderate to Severe
Severe to Extreme
Ditch Impact
Moderate to Severe
Severe to Extreme
Obstruction Impact
Moderate to Severe
Severe to Extreme
Dump Site Impact
Moderate to Severe
Severe to Extreme
Utility Impact
Moderate to Severe
Severe to Extreme
Map G.2


Maryland
Potomac
River
Town of Herndon
Fairfax County Parkway
Dog Run
Captain Hickory
Piney Run
Colvin Run
Lower Difficult Run
Wolftrap Creek
Rocky Run
Reston
Middle Difficult Run
Shakeden Branch
The Glade
Little Difficult Run
Angelico Branch
Old Courthouse Spring Branch
Tysons Corner
Piney Branch
South Fork Run
Upper Difficult Run
Rocky Branch
Town of Vienna
Oakton
Fair Oaks Mall
Fairfax Corner
City of Fairfax
Little River Turnpike
7
267
123
I-66
I-495
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50
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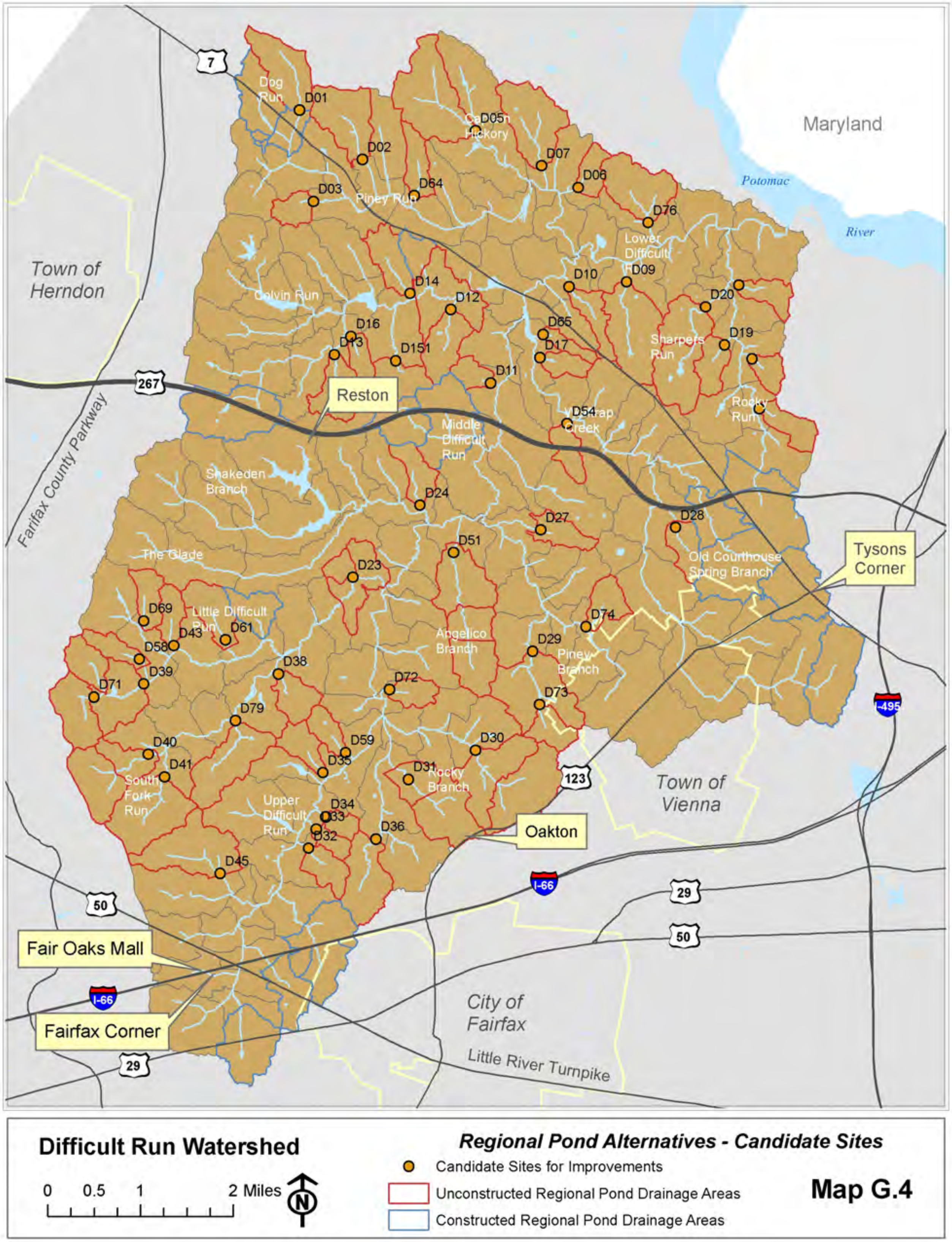
C01
C03
C04
C51
C08
C30
C52
C07
C53
C15
C12
C09
C16
C18
C55
C02
C17
C37
C28
C24
C20
C21
C25
C26
C40
C64
C58
C19
C27
C67
C33
C31
C32
C36
C39
C41
C42
C71
C72
Difficult Run Watershed
0
0.5
1
2 Miles
N
Catchment - Candidate Sites
Catchment Ranking
1 - 40 Lower Quality
41 - 81
82 - 121
122 - 161
162 - 201 Higher Quality
Map G.3


Maryland
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Fairfax Corner
City of Fairfax
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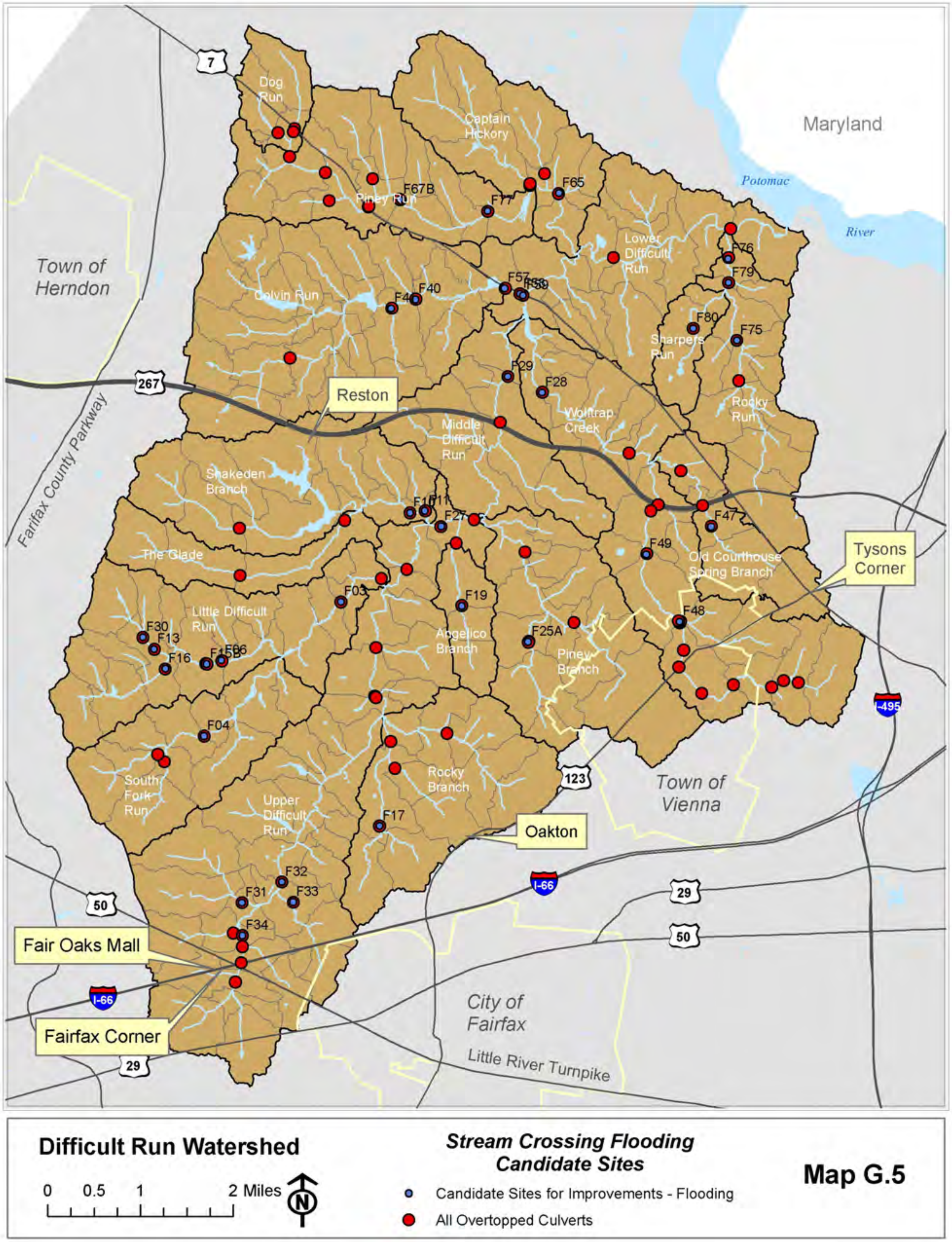
Piney Run
Colvin Run
Lower Difficult
Sharpers Run
Rocky Run
Middle Difficult Run
Shaker Branch
The Glade
Old Courthouse Spring Branch
Little Difficult Run
Angelico Branch
Piney Branch
South Fork Run
Upper Difficult Run
Rocky Branch
Difficult Run Watershed
0 0.5 1 2 Miles
N
Regional Pond Alternatives - Candidate Sites
Candidate Sites for Improvements
Unconstructed Regional Pond Drainage Areas
Constructed Regional Pond Drainage Areas
Map G.4

Table G.12 Catchment Ranking – Existing Conditions – Top 10 Priority Catchments

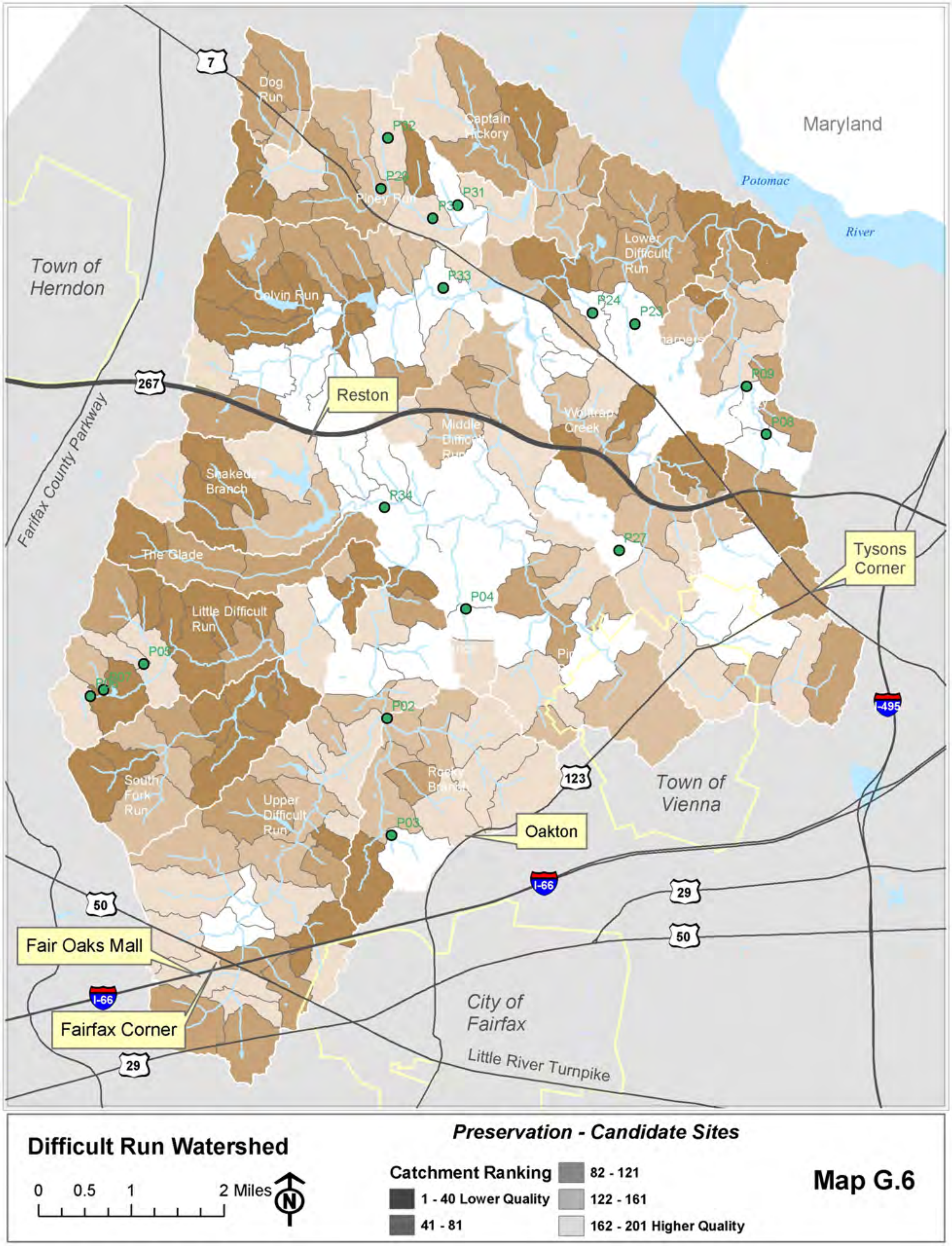
	Category	Quantity			Water Quality			Landcover		Total	0-100	Rank
	Indicator	Peak Discharge	Runoff Volume	Floodplain	Nitrogen	Phosphorus	Sediment	Wetland	Forest			
	Number of Indicators	3			3			2		8		
	Indicator Weight									100.0		
	Percent Indicator of Category	37.5	37.5	25.0	33.3	33.3	33.5	50.0	50.0			
	Percent Category of Total	40.0			40.0			20.0		100.0		
Wolftrap Creek	DFWC0003	15	15	10	53	67	13	10	20	**203**	**20**	**1**
Difficult Run	DFDF9501	15	15	100	27	53	13	10	10	**243**	**24**	**2**
Old Courthouse Spring	DFOR0099	15	15	100	27	53	13	10	10	**243**	**24**	**2**
Wolftrap Creek	DFWC0004	15	15	10	53	53	27	60	20	**253**	**25**	**4**
Piney Branch	DFPB0002	15	30	20	67	53	27	30	20	**262**	**26**	**5**
Rocky Run	DFRR0001	15	15	100	27	53	13	40	10	**273**	**27**	**6**
Piney Branch	DFPB0001	30	15	100	40	53	13	10	20	**282**	**28**	**7**
Colvin Run	DFCR9401	15	15	100	27	67	13	50	10	**297**	**30**	**8**
Piney Branch	DFPB9801	15	15	100	40	53	13	50	10	**297**	**30**	**8**
Difficult Run	DFDF9701	15	15	100	40	67	13	40	10	**300**	**30**	**10**

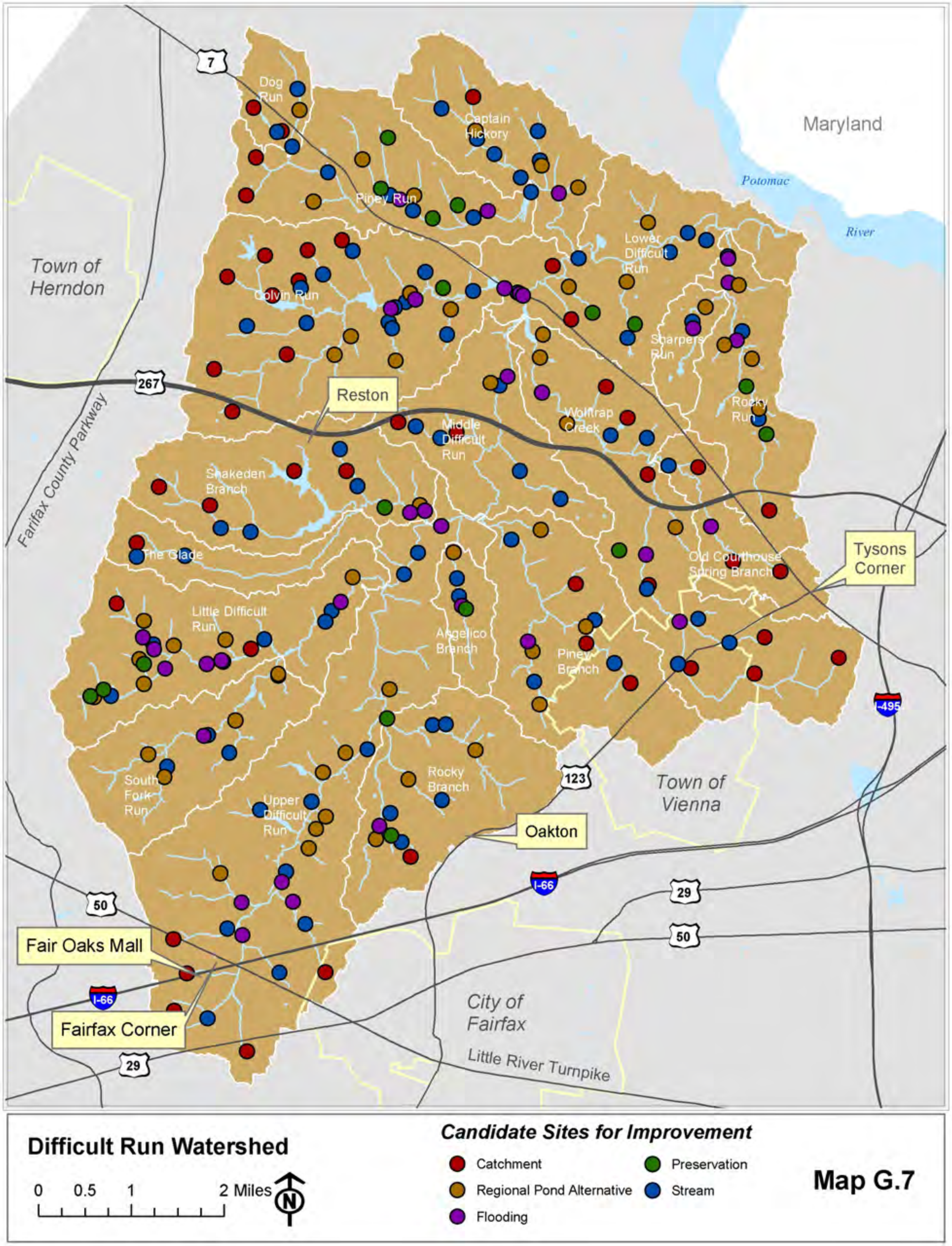
Table G.13 Catchment Ranking - Future Conditions – Top 10 Priority Catchments

	Category	Quantity		Water Quality			Landcover	Total	0-100	Rank
	Indicator	Peak Discharge	Runoff Volume	Nitrogen	Phosphorus	Sediment	Impervious			
	Number of Indicators	2		3			1	6		
	Indicator Weight							100.0		
	Percent Indicator of Category	50.0	50.0	33.3	33.3	33.5	100.0			
	Percent Category of Total	40.0		40.0			20.0	100.0		
Snakeden Branch	DFSB0006	20	20	13	13	13	20	**100**	**10**	**1**
Snakeden Branch	DFSB9402	20	20	13	13	13	20	**100**	**10**	**1**
Difficult Run	DFDF7102	20	20	13	13	27	20	**113**	**11**	**3**
Wolftrap Creek	DFWC0015	40	20	13	13	13	20	**120**	**12**	**4**
Difficult Run	DFDF0033	40	20	13	13	27	20	**133**	**13**	**5**
Colvin Run	DFCR0004	20	20	27	27	27	20	**140**	**14**	**6**
Colvin Run	DFCR0008	20	20	13	13	13	60	**140**	**14**	**6**
Colvin Run	DFCR9301	20	20	13	13	13	60	**140**	**14**	**6**
Rocky Run	DFRR0003	20	20	13	13	13	60	**140**	**14**	**6**
Wolftrap Creek	DFWC9001	20	40	13	13	13	40	**140**	**14**	**6**


Maryland
Potomac
River
Town of Herndon
Fairfax County Parkway
Reston
Tysons Corner
Town of Vienna
Oakton
Fair Oaks Mall
Fairfax Corner
City of Fairfax
Little River Turnpike
Dog Run
Captain Hickory
Piney Run
Colvin Run
Lower Difficult Run
Sharpers Run
Rocky Run
Wolftrap Creek
Middle Difficult Run
Shakeden Branch
The Glade
Little Difficult Run
Old Courthouse Spring Branch
Angelico Branch
Piney Branch
South Fork Run
Upper Difficult Run
Rocky Branch
F67B
F77
F65
F76
F79
F80
F75
F57
F40
F28
F29
F47
F49
F48
F27
F19
F03
F25A
F30
F13
F16
F04
F17
F32
F31
F33
F34
7
267
123
50
29
I-66
I-495

Difficult Run Watershed
0 0.5 1 2 Miles
N
Stream Crossing Flooding Candidate Sites
Candidate Sites for Improvements - Flooding
All Overtopped Culverts
Map G.5


Maryland
Potomac
River
Town of Herndon
Farifax County Parkway
Reston
Tysons Corner
Oakton
Town of Vienna
Fair Oaks Mall
Fairfax Corner
City of Fairfax
Little River Turnpike
Dog Run
Captain Hickory
Piney Run
Lower Difficult Run
Colvin Run
Wolftrap Creek
Middle Difficult Run
Shaker Branch
The Glade
Little Difficult Run
South Fork Run
Upper Difficult Run
Rocky Branch
P31
P33
P24
P09
P34
P27
P04
P02
P03
7
267
123
50
29
I-66
I-495
Difficult Run Watershed
0 0.5 1 2 Miles
Preservation - Candidate Sites
Catchment Ranking
1 - 40 Lower Quality
41 - 81
82 - 121
122 - 161
162 - 201 Higher Quality
Map G.6


Maryland
Potomac
River
Town of Herndon
Fairfax County Parkway
Reston
Tysons Corner
Oakton
Fair Oaks Mall
Fairfax Corner
Town of Vienna
City of Fairfax
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Rocky Run
Wolftrap Creek
Middle Difficult Run
Snakeden Branch
The Glade
Old Courthouse Spring Branch
Little Difficult Run
Angelico Branch
Piney Branch
South Fork Run
Upper Difficult Run
Rocky Branch
7
267
123
I-66
I-495
29
50
Difficult Run Watershed
0 0.5 1 2 Miles
N
Candidate Sites for Improvement
Catchment
Regional Pond Alternative
Flooding
Preservation
Stream
Map G.7