COMPREHENSIVE FLOOD MANAGEMENT PLAN:

WATERSHED FLOOD EXPOSURE ASSESSMENT

Jacobs

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PURPOSE

An initial ranking of watersheds based on flood exposure was developed to aid in planning for completion of detailed watershed studies that will include hydrologic and hydraulic modeling, followed by risk assessments. The results of this assessment are intended to provide an understanding of potential flood exposure using available information. Detailed vulnerability and risk assessments are anticipated to be performed as part of Phase 2 watershed studies, which will include modeling and analysis of current drainage system capacity under a range of scenarios for future land use and climate conditions. The modeling will allow a site-specific analysis of flood risk and mitigation strategies to reduce that risk for neighborhoods, property, vulnerable communities and critical infrastructure.

This document is a summary of the Watershed Flood Exposure Assessment further documented in the *Historic Flood Conditions & Data Gaps Technical Memorandum* (Jacobs, 2023), included within Volume 3 of this report.

WATERSHEDS

Watershed delineations used to summarize historic flood conditions and engineering data gaps were obtained from the Montgomery County (County or MC) Department of Environmental Protection (MCDEP). The watersheds are United States Geological Survey (USGS) 12-digit watersheds[1], with some MCDEP improvements to watershed boundaries based on review of LiDAR[2] topographic data (see Figure 1).

[1] https://water.usgs.gov/GIS/huc.html

[2] https://www.americangeosciences.org/critical-issues/faq/what-lidar-and-what-it-used

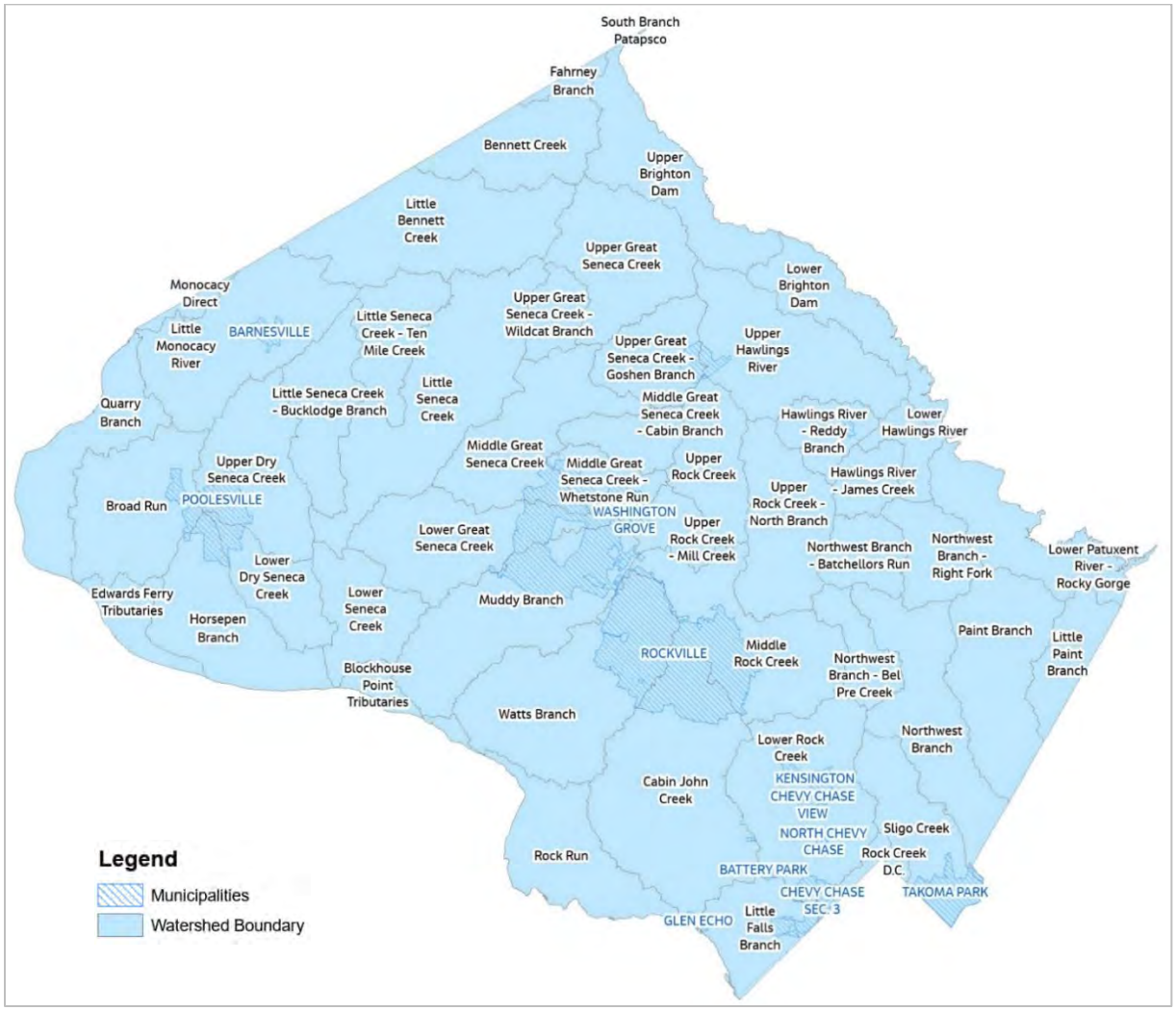

Figure 1 Watersheds Used for Flood Exposure Assessment (Source: MCDEP - adapted from USGS 12-Digit Watershed)

FLOOD EXPOSURE DATA

Data were collected from County agencies and Montgomery-National Capital Park and Planning Commission (M-NCPPC) in Spring and Summer of 2022. Several data sets were collected to assist in characterizing past flood conditions in the County, shown in Figure 2. Data are generally organized according to whether they inform an understanding of flood hazards (mapping of flood hazard areas), flood receptors (areas or locations that may be vulnerable to flood impacts) or observed impacts (flood event or flood impact information from County records).

These data come from several sources within the County, from public sources, and from existing Jacobs work. While none of these data sets offer a clear and comprehensive picture of flood hazards, exposures, or past flood impacts, together – and along with a knowledge of their limitations – they have been used to generate a watershed-level summary that can be found in Volume 3 of this report (*Historic Flood Conditions & Data Gaps Technical Memorandum* (Jacobs, 2023)). The flood hazards and flood receptors data were used to develop the watershed flood exposure ranking.

Flood Hazards	**Receptors**	**Observed** Impacts
• FEMA and County Floodplains • Jacobs simplified flood model (ADI Flood Modeller) 100-year 2065 preliminary flood zone for WSSC Water	• Critical Facilities • Areas of Social Vulnerability • Non-residential Buildings • Residential Buildings • Impervious Area • Environmentally Sensitive Areas	• DOT DAR program project/solution calls • DEP erosion calls • Flooding related 311 calls • 911 flood response calls • Frequently flooded roads (DOT and MCFRS) • Survey results

Figure 2 Summary of Data Collected for Watershed Flood Exposure Assessment

ADI = Alternating Direction Implicit [solver]
MCDOT DAR = Department of Transportation Drainage Assistance Request
FEMA = Federal Emergency Management Agency
MCFRS = Montgomery County Fire and Rescue
WSSC Water = Washington Suburban Sanitary Commission

FLOOD EXPOSURE RANKING OF WATERSHEDS

The methodology described below was used to develop an initial prioritized list of watersheds based on flood exposure for further analysis in Phase 2 of the Comprehensive Flood Management Plan. Flood exposure, rather than observed and reported flooding, forms the basis for an initial ranking because a prioritization based on observed flooding information may skew the results towards those watersheds where residents are more knowledgeable about and familiar with methods for reporting to, and requesting services from, the County.

The flood-exposure based approach includes the following steps (illustrated in Figure 3):

- Identify attributes that describe flood exposure of the watersheds.
- Measure these attributes using two sources of flood hazard areas information:
  - FEMA 100- and 500-year floodplains, which define areas of **riverine flooding**, which are areas where flood waters overtop stream and river banks, and
  - Flood Modeller 100-year 2065 flood zones, which define areas of both riverine flooding as well as local **pluvial flooding (Jacobs, 2020)**. Pluvial flooding is also sometimes referred to as **interior** flooding or **urban** flooding or **flash** flooding, where direct rainfall runoff exceeds capacity of saturated soils and drainage systems resulting in overland flow upstream of defined stream and river channels. Pluvial flooding can happen in any location, not necessarily near a water body. This modeling was done using future rainfall conditions projected under one scenario of climate conditions in 2065.
- Normalize scores for individual attributes using a 5-point scale and apply overall exposure scoring and weighting using a multi-attribute rating technique (MART, also referred to Multi-Objective Decision Analysis [MODA]) to each flood hazard scenario.
- Conduct a sensitivity analysis for each flood hazard scenario to understand impacts of various weighting scenarios.
- Combine the sensitivity analysis results for both flood hazard sources (FEMA and Flood Modeller) to produce a list of prioritized watersheds, differentiated by tier.

Figure 3 Flood Exposure Assessment Flowchart

The watershed flood exposure analysis was used to develop an initial watershed ranking in order to prioritize the next phase of work based on measures of flood exposure of non-residential buildings, residential buildings, socially vulnerable areas, total impervious areas, number of critical facilities and infrastructure, environmentally sensitive areas. A summary of the various attributes is included Table 1.

The extent of FEMA-studied riverine floodplain information is good throughout the County. The Flood Modeller analysis was previously conducted for WSSC Water and provides combined riverine and pluvial flood zone mapping in most of Montgomery County where WSSC Water provides water/wastewater service; but did not include modeling in some areas without water/sewer service. To make use of both sources of information, the following two flood exposure scenarios were calculated:

1. Flood exposure based on draft FEMA (September 2022) 100-year and 500-year floodplain extent
2. Flood exposure based on draft Jacobs and WSSC Flood Modeller 100-year 2065 flood extents

Measures for each of these attributes were calculated for both the FEMA (100-year and 500-year floodplain extent via draft FEMA NFHL) and available Flood Modeller 100-year 2065 flood zone area. Measured values for each attribute for both flood hazard scenarios are included in Volume 3 Appendices: Historic Flood Conditions & Data Gaps TM (Jacobs, 2023).

Table 1 Description of Attribute Measurements for Flood Exposure Assessment

Attribute	Measure of Attribute within Mapped Flood Hazard Areas[a]
Non-Residential Buildings	Number of non-residential buildings (categorized as non-residential from property land use designations)
Residential Buildings	Number of residential buildings (categorized as residential from property land use designations)
Socially Vulnerable Areas	Socially vulnerable areas (CDC SVI greater than 0.5)
Total Impervious Area	Total impervious area (i.e. total flooded impervious area for each modeling output)
Critical Facilities and Infrastructure	Number of critical facilities and infrastructure
Environmentally Sensitive Areas	USFWS National Wetlands Inventory area

[a] The noted measurements were made for both the FEMA 100- and 500-year floodplain extent (riverine exposure) and the available Flood Modeller 100-year 2065 flood zone extent (combined riverine/pluvial exposure).

RECOMMENDED TIERED RANKING OF WATERSHEDS

Tier designations for each flood hazard data set were combined to generate a single recommended prioritization list for completing detailed watershed studies. The maximum of either flood exposure score sum (FEMA or Flood Modeller) was used to identify a tier designation. The combined list is presented in Table 2. The methods and results presented here were discussed with a Core Team of Montgomery County staff representing a range of County agencies. Figure 4 provides mapping of watersheds by tier. Table 2 represents a recommendation for prioritization of watershed studies for the purpose of identifying flood hazards and mitigations.

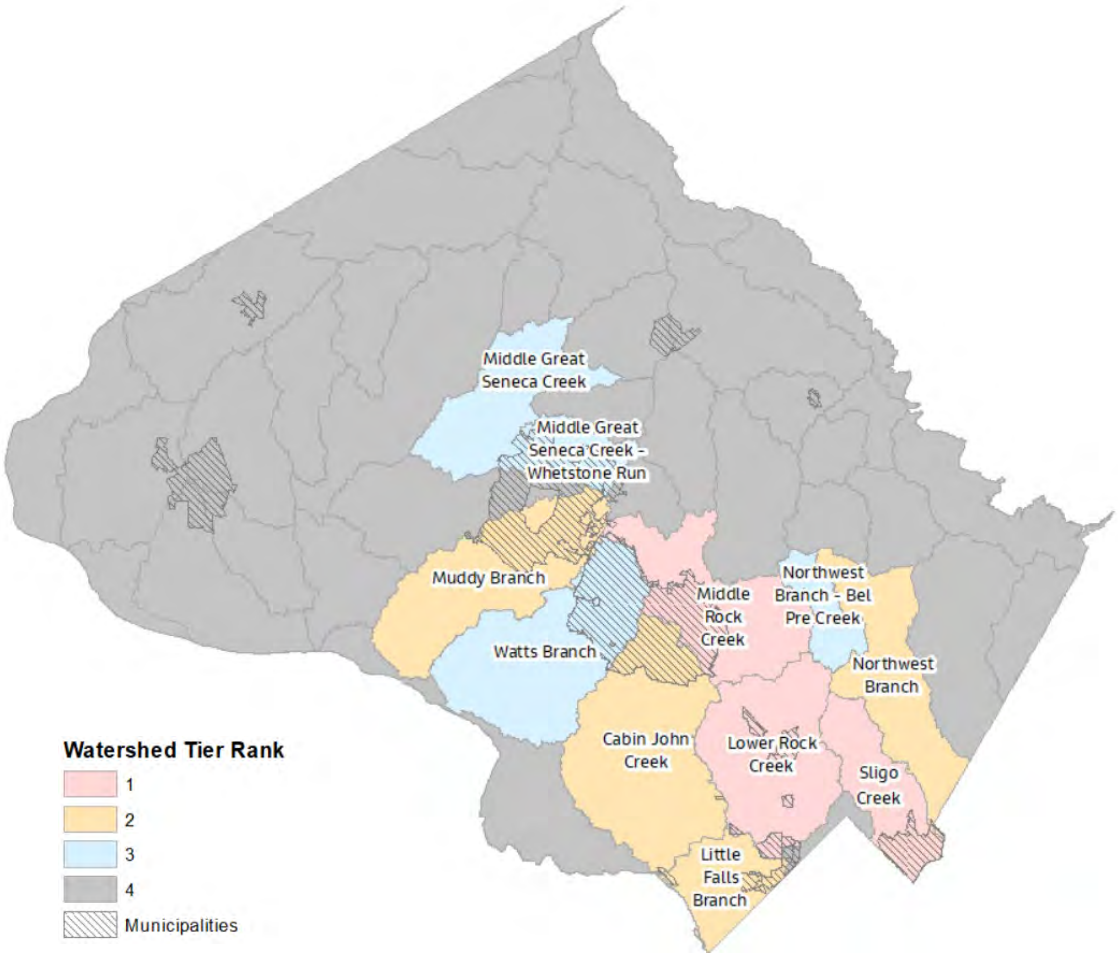

Figure 4 Recommended Tiered Ranking of Watersheds Based on Maximum Flood Exposure Score

Table 2 Recommended Tiered Ranking of Watersheds Based on Maximum Flood Exposure Score

Tier	Watershed	Maximum of Flood Exposure Score[a]	Tier	Watershed	Maximum of Flood Exposure Score[a]
1	Middle Rock Creek	26.31	4	Edwards Ferry Tributaries	1.41
	Lower Rock Creek	24.59		Blockhouse Point Tributaries	1.13
	Sligo Creek	19.96		Hawlings River - James Creek	1.01
2	Cabin John Creek	17.41		Upper Rock Creek	0.93
	Little Falls Branch	12.75		Broad Run	0.88
	Northwest Branch	12.38		Hawlings River - Reddy Branch	0.87
	Muddy Branch	11.95		Northwest Branch - Batchellors Run	0.76
3	Middle Great Seneca Creek	11.69		Upper Dry Seneca Creek	0.75
	Middle Great Seneca Creek - Whetstone Run	10.23		Upper Great Seneca Creek - Goshen Branch	0.74
	Northwest Branch - Bel Pre Creek	9.74		Lower Patuxent River - Rocky Gorge	0.59
	Quarry Branch*	9.61		Lower Brighton Dam	0.53
	Watts Branch	8.01		Bennett Creek	0.52
4	Little Seneca Creek	7.68		Little Seneca Creek - Bucklodge Branch	0.47
	Paint Branch	7.47		Little Monocacy River	0.46
	Northwest Branch - Right Fork	6.82		Upper Hawlings River	0.46
	Lower Great Seneca Creek	5.13		Lower Dry Seneca Creek	0.45
	Little Paint Branch	4.37		Upper Brighton Dam	0.40
	Middle Great Seneca Creek - Cabin Branch	3.98		Lower Hawlings River	0.40
	Rock Run	3.12		Upper Great Seneca Creek - Wildcat Branch	0.35
	Upper Rock Creek - North Branch	3.06		Little Seneca Creek - Ten Mile Creek	0.32
	Rock Creek D.C.	2.96		Little Bennett Creek	0.26
	Upper Great Seneca Creek	1.95		Monocacy Direct	0.04
	Lower Seneca Creek	1.67		Fahrney Branch	0.00
	Upper Rock Creek - Mill Creek	1.45		South Branch Patapsco	0.00
	Horsepen Branch	1.45			

Note:

a. Maximum of Flood Exposure Score is the maximum of the sum of flood exposure

* This watershed is not recommended for detailed modeling as the high score is due to the location of a single critical facility (Dickerson Power Plant Intake). Watershed-scale detailed hydraulic modeling is not appropriate for determining flood vulnerabilities at a single facility. See Section 4.4.2 of the Historic Flood Conditions & Data Gaps TM (Volume 3) for further discussion.

REFERENCES

Jacobs, 2020. *WSSC Climate Change Vulnerability Assessment Adaptation and Mitigation Plan (CCVAAMP) Linear Assets Future Flood Screening Analysis – Preliminary 100-year 2065 Flood Zone Development Background Technical Memorandum*. December 23, 2020.

Jacobs, 2023. *Historic Flood Conditions & Data Gaps Technical Memorandum.* May 5, 2023.