

D-R-A-F-T

WV Flood Risk Explorer Technical Documentation – 5/21/2024

Please see data dictionaries below beginning on page #.

Introduction

The **WV Flood Risk Explorer** is part of a suite of flood risk assessment, visualization, and mitigation tracking tools known as the WV Flood Resiliency Framework for empowering communities and agencies across the state with the knowledge they need to better prepare for future floods. This online application is an interactive tool that shows which communities in West Virginia are most at risk from riverine flooding. It includes data about flood characteristics, physical / human vulnerabilities, and mitigation measures, all available at eight geographic levels. Benefits of using The WV Flood Risk Explore include support for mitigation planning, hazard mitigation assistance, and risk communication, ultimately ensuring that limited resources are channeled effectively for flood reduction efforts.

8 Aggregate Levels or Geographic Scales. Depending on the purpose and scales of analysis, users can explore property flood risk data at multiple aggregate or geographic scale levels: validating floodplain management practices at the incorporated/unincorporated scales; identifying mitigation actions at the community level, hazard mitigation planning at the county or regional scales, resiliency planning at the statewide scale, initial Risk MAP discovery phase at the watershed scale, or loss of property and life at the river/stream scale.

8 Aggregate or Geographic Scale Levels

- Statewide
- 11 Regional Councils
- 55 Counties
- 284 Communities
- 55 Unincorporated Areas
- 229 Incorporated Places
- 33 Watersheds
- 155 Named Streams (Top 2%)

FLOOD RISK ASSESSMENT METHODOLOGY

West Virginia is unique in that it maintains a detailed inventory of nearly 98,000 primary structures in the high-risk flood zones of the state. Building-level risk assessments (BLRA) for each structure to include building dollar exposure and damage loss estimates are displayed for each structure on the WV Flood Tool's RiskMAP View.

While the **WV Flood Tool** shows flood characteristics, exposure, vulnerability, loss estimates, and mitigation measures at the property level, the **WV Flood Risk Explorer** aggregates hazard data to indicate the communities most at risk of riverine flooding. The WV Flood Risk Explorer quantifies flood risk by various indicators that are grouped into the following categories: floodplain characteristics, building exposure, building characteristics, critical infrastructure, community assets, damage estimates, people / social factors, and other hazards. The cumulative risk assessment includes damage loss and population displacement models computed from FEMA's Hazus methodology. Also incorporated in the risk assessment is a social vulnerability index, developed for West Virginia based on eight socioeconomic and demographic indicators. Most of the flood risk indicators are measured for a major storm like the 1% annual chance (100-yr) flood event.

Indicator Rankings and Flags. There are 29 primary flood risk indicators from the incorporated place to regional geographic scale, and six indicators for the watershed and stream scales. Using the inclusive percent ranking function, flood indicator rankings are computed for each flood risk variable and for every geographic level. Percentile ranking values range from 0 to 1, with the higher values indicating greater vulnerability. During the percent ranking calculations, the incorporated place and watershed scales with less than 10 and 100 buildings, respectively, are excluded from any ratio calculations. For each geographic scale, the percentiles of each risk variable are then summed and an overall percentile ranking computed for each of the eight geographic scales. Flags of each indicator variable are calculated for the top 10% (90th percentile) and top 20% (80th percentile) of each geographic level to support different scales of analysis.

Data Dictionaries and Export Function. Data dictionaries describe the contents, format, and structure of the databases for the Risk Indicators and Supplemental Assessment Information. All general and flood risk data sets can be downloaded to a spreadsheet file using the Export Data function.

Risk Assessment Reports. Various web reports are generated for each geographic scale. Pre-defined report types are as follows.

- Single Geographic Entity (all scales)
 - Risk Indicator Report – Only the Top 20% Risk Indicators shown.
 - Risk Indicator Report – All Risk Indicators
 - Full Risk Assessment Report – All Risk Indicators and Supplemental Information
 - Building-Level Report (Top Building Rankings – Value, Depth, Damage, Minus-Rated)

- Comparison Risk Indicator Report (all scales). Compares selected geographic unit with highest to lowest risk communities.

Shared links allow users to share web reports by geographic scale and report type. Web reports include hyperlinks to additional floor risk information. The syntax of the shared URL link must contain the (1) report type, (2) geographic feature identifier (CID, FIPS, HUC8, or Stream Name), and (3) scale level (M-Municipalities/Incorporated Place, U-Unincorporated Area, CID-Community, C-County, R-Regional Council, ST-WV-State, W-Watershed, S-Stream/River).

Figure 1. Flood Risk Assessment Categories and Risk Indicators.

		CATEGORY	INDICATOR
		Overall Flood Risk	(1) FLOODPLAIN CHARACTERISTICS
Floodplain Length			
Floodplain Depth ^{1 2}			
Flood Disaster Frequency			
(2) BUILDING EXPOSURE	Building Floodplain Count ^{1 2}		
	Building Floodway Count ^{1 2}		
	Building Floodplain Ratio		
	Building Density ^{1 2}		
(3) BUILDING CHARACTERISTICS	Building Value ^{1 2}		
	Mobile Home		
	Basement		
	One Story		
(4) CRITICAL INFRASTRUCTURE	Building Year*		
	Essential Facilities		
	Roads Inundated		
(5) COMMUNITY ASSETS	Historical Assets		
	Non-Historical Assets		
(6) DAMAGE ESTIMATES	Substantial Damage Estimates* ^{1 2}		
	Previous Claims		
	Repetitive Loss		
(7) PEOPLE / SOCIAL	Population in Floodplain		
	Population Displaced		
	WV Social Vulnerability Index		
(8) OTHER HAZARDS	Dam/Levee Failure		
	Landslides		
	Karst		

* Multiple Indicators

¹ River/Stream Indicator

² Watershed Indicator

FLOOD RISK CATEGORIES AND INDICATORS

FLOODPLAIN CHARACTERISTICS. Flood risk indicators of the **floodplain characteristics** category measure the area, length, and depth of high-risk flood zones. This category also includes the frequency of declared flood disasters since 1953 to measure flood risk.

- **Floodplain Area:** Total acreage of Special Flood Hazard Area (used for unincorporated place and larger scales); or ratio of Special Flood Hazard Area to total community area (used for incorporated place scale).
- **Floodplain Length:** Total length in miles of Special Flood Hazard Area (used for unincorporated place and larger scales); or ratio of Special Flood Hazard Area to total community area (used for incorporated place scale).
- **Medium Flood Depth:** Medium value of flood depths of all primary structures inventoried in the high-risk flood zones.
- **Flood Disaster Frequency:** Number of-declared flood disasters in a county since 1953.

BUILDING EXPOSURE. The category **building exposure** counts primary structures in the high-risk Special Flood Hazard Area and Regulatory Floodway. It also identifies building densities by the ratios of buildings in high-risk flood areas to total buildings or to specific geographic areas. All buildings inventoried in the high-risk flood zones, or 1% annual chance (100-yr) floodplain, are verified as primary structures using various reference data sets: tax parcel assessments, E-911 addresses, aerial imagery, building pictures, elevation certificates, etc. Building counts of less than 10 structures are excluded from risk assessments at the incorporated place scale.

- **Building Floodplain Count:** Building count in Special Flood Hazard Area.
- **Building Floodway Count:** Building count in Regulatory Floodway.
- **Building Floodplain Ratio:** Percentage of floodplain buildings to total buildings
- **Building Density:** Density of floodplain buildings to total acres (or building per mile for rivers/streams)

BUILDING CHARACTERISTICS. This group of risk indicators is associated with **building characteristics**, such as the median appraisal dollar value of all primary structures in high-risk floodplains susceptible to flooding. Additionally, this category includes building property factors more vulnerable to flood risk, like the percentages of floodplain buildings that are manufactured homes, one-story structures, PRE-FIRM structures, or have subgrade basements. Although building stock type and value properties are primarily determined from tax assessment data (building value, occupancy class, foundation type, story, building year, and area), the Building-Level Risk Assessment (BLRA) database allows for the default tax assessment data values to be replaced with more accurate user-defined values from other data sources. The building year and date of the initial Flood Insurance Rate Map (FIRM) identifies the Pre- or Post-FIRM status of structures. The last risk factor of this category is minus-rated POST-FIRM structures, a percentage of structures that may not have been mitigated properly according to local floodplain management ordinances. Note that all the detailed building attributes of this category are collected for all primary structures in the Special Flood Hazard Area, or 1% annual chance (100-yr) floodplain.

- **Building Value:** Median of appraised values from the most recent tax assessment data or other building value data sources for tax-exempt structures.
- **Mobile Home Ratio:** Percentage of manufactured buildings (occupancy code RES2) among all single-family structures.
- **Subgrade Basement Ratio:** Percentage of primary structures with subgrade basements.
- **One-Story Building Ratio:** Percentage of one-story structures.
- **Pre-FIRM Building Ratio:** Percentage of Pre-FIRM buildings.
- **Post-FIRM Building Ratio:** Percentage of minus rated Post-FIRM buildings.

CRITICAL INFRASTRUCTURE. The **critical infrastructure** category includes risk indicators for essential facilities and roadways, both community lifelines that enable the continuous operations of critical business and government functions during and after a disaster.

- **Essential Facilities:** Number of essential facilities in the in the high, moderate, and reduced risk flood zones. Providing critical services to the community, essential facilities include police and fire stations, E-911 emergency operations centers, schools, hospitals, and nursing homes.
- **Roads Inundated Ratio:** Percentage of roads inundated by flood waters of 1 foot or more by a major 1% annual chance (100-yr) flood event.

COMMUNITY ASSETS. Community assets are historical structures listed on the National Register of Historic Places, government facilities (federal, state, local), emergency medical services (EMS), religious organizations, utilities, postsecondary educational facilities, or other buildings of significance that contribute to the built environment of a community. The **community assets** category is comprised of historical and non-historical assets in the Special Flood Hazard Area, or 100-yr floodplain.

- **Historical Assets:** Number of historical community assets listed on the National Register of Historic Places, the official list of the Nation’s historic places worthy of preservation, and includes buildings identified within National Register Areas constructed before 1930.
- **Non-Historical Assets:** Number of non-historical community assets including utilities (water, sewage, gas, electric, or phone), post-secondary educational facilities, emergency medical services (EMS), government buildings providing public services, and facilities hosting religious services.

DAMAGE ESTIMATES. This category of risk indicators measures building damage by estimation models and recorded flood insurance claims. Substantially damaged building risk indicators estimate the number and ratio of primary structures where the damage exceeds 50% of the building value. Damage loss estimates are calculated using FEMA’s Hazus methodology and the best available depth grids for a 1% annual chance event. Other risk indicators of the **damage estimates** category are FEMA data sets that include previous NFIP flood claims and repetitive loss structures.

- **Substantial Damage Count:** Estimated number of primary structures substantially damaged from a 1% annual chance (100-yr) flood.
- **Substantial Damage Ratio:** Percentage of substantially damaged structures to total floodplain structures.
- **Previous Damage Claims:** Number of previous flood-related insurance claims for a community.
- **Repetitive Loss Structures:** Number of NFIP-insured structures that have had at least 2 paid flood losses of more than \$1,000 each in any 10-year period since 1978.

PEOPLE / SOCIAL. This group of risk indicators measures various **people and social** vulnerabilities. Population in the floodplain is computed at the building level by identifying the type of residential building (single family, apartment, et.) and corresponding number of units, then multiplied by the average household size from community-level Census statistics. Population displacement is calculated for those residential structures where the flood depth exceeds 1 foot. Additionally, short-term shelter needs for up to three weeks are computed using FEMA’s Hazus methodology, in which the above-mentioned displaced population is combined with Census income and age data to generate the shelter model estimates.

Population risk indicators calculate the population percentage residing in the high-risk flood zones and population percentage displaced by a 1% annual chance flood event. A WV Social Vulnerability Index (SVI) of eight socioeconomic and demographic indicators measures a population’s vulnerability to flood hazard. The select SVI indicators are economic factors (Poverty Rate, Unemployment Rate), population characteristics (Vulnerable Ages Rate, Disability Rate, Population without a High School Education, Population Change), and housing (Median Housing Unit Value, Mobile Homes as Percentage of Housing).

- **Population in Floodplain:** Percentage of population residing in the high-risk Special Flood Hazard Area to total population.
- **Population Displaced:** Estimated percentage of population displaced by a major storm of a 1% annual chance (100-yr) probability.
- **WV Social Vulnerability Index:** Social vulnerability index developed for West Virginia based on eight socioeconomic and demographic indicators.

RISK FACTORS: DESCRIPTION, RATIONALE, RECOMMENDATIONS, DATA SOURCES

FLOODPLAIN AREA (Acres)

Acreage of Special Flood Hazard Area (SFHA), or 1%-annual-chance (100-yr) floodplain. Note that the following areas are excluded in the total acreage: Open water lakes > 10 acres; Large riverbank-to-bank > 500 ft.; Federal lands > 10 acres.

Rationale	Recommendations
<p>For unincorporated areas and at the county level, it may be more challenging for communities larger in geographic size to enforce their floodplain management ordinance. Often larger jurisdictions have more acres and miles of floodplain extent than compared to smaller communities. In smaller communities, the floodplain area is compacted and thus new development in the floodplain should be easier to monitor than larger rural areas or countywide.</p>	<p>Larger jurisdictions must be vigilant in monitoring and permitting new development for an expansive geographic area that includes a large amount floodplain area and miles.</p>
<p>Data Sources: FEMA FIRMs; Streams and Waterbodies (USGS NHD 24K), Public Lands (USGS PAD-US)</p>	

FLOODPLAIN AREA RATIO (%)

Special Flood Hazard Area (SFHA) acreage to Total Community Area.

Rationale	Recommendations
<p>At the community level, incorporated places with a higher ratio of floodplain area to community area face more significant challenges for development. Small towns in which a high percentage of their total incorporated land is in the Special Flood Hazard Area (SFHA) often have a higher flood exposure than other communities. Essential facilities and other significant structures that provide critical services to the community are often located in high-risk floodplains of smaller communities.</p>	<p>Smaller jurisdictions must be vigilant in relocating critical facilities away from the floodplain along with enforcing its floodplain management ordinance for any development.</p> <p>Although expensive to build and maintain, engineering flood mitigation structures like levees, floodwalls, and dams protect vulnerable flood-prone communities.</p>
<p>Data Sources: FEMA FIRMs; Streams and Waterbodies (USGS NHD 24K), Public Lands (USGS PAD-US)</p>	

FLOODPLAIN LENGTH (Miles)

The total river/stream length in miles of high-risk 1%-annual-chance (100-year) floodplains. Same rationale and recommendations as *Floodplain Area* indicator.

Rationale	Recommendations
<p>For unincorporated areas and at the county level, it may be more challenging for communities larger in geographic size to enforce their floodplain management ordinance. Often larger jurisdictions have more acres and miles of floodplain extent than compared to smaller communities. In smaller communities, the floodplain area is compacted and thus new development in the floodplain should be easier to monitor than larger rural areas or countywide.</p>	<p>Larger jurisdictions must be vigilant in monitoring and permitting new development for an expansive geographic area that includes a large amount floodplain area and miles.</p>
<p>Data Sources: FEMA FIRMs; Streams and Waterbodies (USGS NHD 24K), Public Lands (USGS PAD-US)</p>	

FLOODPLAIN LENGTH RATIO (%)

Floodplain Length (miles) Distance to Community Area Ratio. Units are miles per square meter. Same rationale and recommendations as *Floodplain Area Ratio* indicator.

Rationale	Recommendations
<p>For unincorporated areas and at the county level, it may be more challenging for communities larger in geographic size to enforce their floodplain management ordinance. Often larger jurisdictions have more acres and miles of floodplain extent than compared to smaller communities. In smaller communities, the floodplain area is compacted and thus new development in the floodplain should be easier to monitor than larger rural areas or countywide.</p>	<p>Larger jurisdictions must be vigilant in monitoring and permitting new development for an expansive geographic area that includes a large amount floodplain area and miles.</p>
<p>Data Sources: FEMA FIRMs; Streams and Waterbodies (USGS NHD 24K), Public Lands (USGS PAD-US)</p>	

MEDIUM FLOOD DEPTH (Feet)

Medium value of flood depths of all primary structures inventoried in the high-risk flood zones.

Rationale	Recommendations
The depth of floodwater around a structure is by far the most critical element to be considered in planning and designing flood proofing measures. The floodwater depth largely determines the strength and stability requirements for the structure as a whole and for individual structural elements below the design flood level. Source: USACE .	Mitigation measures such as elevation and wet floodproofing are not economically effective for very deep flood depths greater than 12 feet. Source USACE . Dry floodproofing is not recommended where the depth of water under base flood conditions is greater than 3 feet and base flood velocities exceed 5 feet per second. Source FEMA .
Data Sources: WV BLRA; FEMA model-backed depth grids; Hazus-generated depth grids. Notes: In some cases, depth grid anomalies or map errors may result in high flood depths of select structures and thus should be validated.	

FLOOD DISASTER FREQUENCY (#)

Number of-declared flood disasters in a county since 1953.

Rationale	Recommendations
Previous disasters and frequency indicate potential for future risk. In addition, the recentness of flood disasters has proven to increase communities' willingness to seek mitigation activities. In West Virginia, many flood control structures (e.g., dams, levees, flood walls) built in the 20th Century have decreased the number of major flood disasters.	A major disaster declaration provides a wide range of federal assistance programs for individuals and public infrastructure, including funds for both emergency and permanent work. Historical flooding including high water marks should be incorporated into communities' flood reduction efforts to include areas of mitigation interest. Research of flood fatality locations and risk behavior of past major floods should be studied as well.
Data Sources: FEMA's Disaster Declarations for States and Counties online database . Incident subcategories include "flood" or "severe storms" or "hurricanes".	

BUILDING COUNT IN SFHA (#)

All primary insurable structures in the effective 100-year Floodplain or Special Flood Hazard Area (SFHA).

Rationale	Recommendations
<p>The higher number of buildings in the floodplain indicates higher physical and human exposure to riverine flooding. More structures also correlate to higher debris totals and displaced people from a major storm.</p> <p>If a building owner has a mortgage from a federally regulated lender and the property is in the Special Flood Hazard Area, then the building owner is required by Federal law to carry flood insurance.</p> <p>The building count in the SFHA is a programming variable required for those communities participating in FEMA’s Community Rating System (CRS) program.</p>	<p>Communities with a high floodplain building count should actively engage property owners about flood insurance and minimizing flood losses of property owners. See Floodsmart.gov for more information.</p> <p>Communities can become more resilient to flooding by exceeding the minimum NFIP requirements. Higher building standards adopted by local communities may include increasing the freeboard of the base flood elevation; or encourage property owners to build to the higher 500-year flood elevation or historical high-water mark.</p> <p>Floodplain managers and emergency planners should pre-load at-risk structures into substantial damage estimator software. Local officials should review early warning systems as well as short-term shelters located outside the floodplain and away from inundated roads.</p> <p>State and county leaders should prioritize pre-disaster planning for communities with many flood-prone buildings.</p>
<p>Data Sources: Effective and Advisory Floodplains for 1% Annual-Chance event; WV BLRA</p>	

BUILDING COUNT IN FLOODWAY (#)	
Primary structures located in the Regulatory Floodway of 100-Year Floodplain	
Rationale	Recommendations
<p>High flood velocities and deep flood depths increase the likelihood of physical damage and loss of life.</p> <p>Structures in the floodway require the purchase of mandatory flood insurance for federally-backed loans.</p> <p>Restricted development. Before a local permit can be issued for proposed development in the floodway, a “No-Rise/No Impact” certification must be submitted by a professional engineer licensed in West Virginia to ensure a proposed project won’t increase flood levels.</p>	<p>Community floodplain management ordinances often recommend not constructing closed foundations or solid perimeter walls where flood velocities exceed 5 feet per second. Source: Kershaw County, SC. Nonstructural mitigation measures are not recommended either where high flood velocities exceed 6 feet per second or where debris impacts may occur. Source USACE. FEMA recommends open foundations (e.g., piers, posts, columns, pilings) for riverine SFHAs where flow velocities are expected to exceed 10 feet per second. Source FEMA.</p>
Data Sources: Effective and Advisory Floodplains for 1% Annual-Chance event; WV BLRA	

BUILDING FLOODPLAIN RATIO (%)	
Percentage of floodplain buildings to total buildings	
Rationale	Recommendations
A higher ratio of buildings in the floodplain to total buildings signifies a greater physical and human exposure to flooding	See building count in SFHA.
Data Sources: Effective and Advisory Floodplains for 1% Annual-Chance event; WV BLRA Note: Building counts of less than 10 structures are excluded from risk assessments at the incorporated place scale.	

BUILDING DENSITY (Buildings per acre)	
Percentage of floodplain buildings to total buildings	
Rationale	Recommendations
A higher ratio of buildings in the floodplain to total buildings signifies a greater physical and human exposure to flooding	See building count in SFHA.
Data Sources: Effective and Advisory Floodplains for 1% Annual-Chance event; WV BLRA Note: Building counts of less than 10 structures are excluded from risk assessments at the incorporated place scale.	

More Rationale and Recommendations to follow.