Flood Frequency

Frequency: Probability that a flood of a specific size will be equaled or exceeded in any given year.

5-, 10-, 20-, 25-, 50-, 100-, and 500-year flood elevations (above sea level) refer to expected water levels of the 20%, 10%, 5%, 4%, 2%, 1%, and 0.2% annual chance flood events.

FEMA			
Flood Recurrence Interval and Flood Size	Annual Probability	Cumulative Probability - Flooding at least once over 30 years	FEMA Risk Description
	0.2% + 1 ft.		Risk
500 yr (1 in 500)	**0.2%**	**6%**	**Moderate Risk**
100 yr (1 in 100) Plus confidence error	1%+		
100 yr (1 in 100)	**1%**	**26%**	**High Risk**
50 yr (1 in 50)	2%	45%	High Risk
25 yr (1 in 25)	4%	71%	High Risk
10 yr (1 in 10)	10%	96%	High Risk

Climate scenarios generated from BFE + 1 ft. or 1%+ Recurrence interval

First Street Foundation (FSF)			
Flood Recurrence Interval and Flood Size (2022, 2037, 2052)*	Annual Probability (flooding at least 1 cm)	Cumulative Probability - Flooding at least once over 30 years	First Street Risk Description
500 yr (1 in 500)	**0.2%**	**>0%**	**Any Risk**
100 yr (1 in 100)	**1%**	**>26%**	**Substantial Risk**
20 yr (1 in 20)	5%	> 85%	
5 yr (1 in 5)	20%	>99%	Almost Certain Risk

Climate scenarios available for 3 flood depth years (2022-today, 2037-15 years, 2052-30 years)

2022 Flood Study Sources: **FEMA** and **First Street Foundation** (FSF)

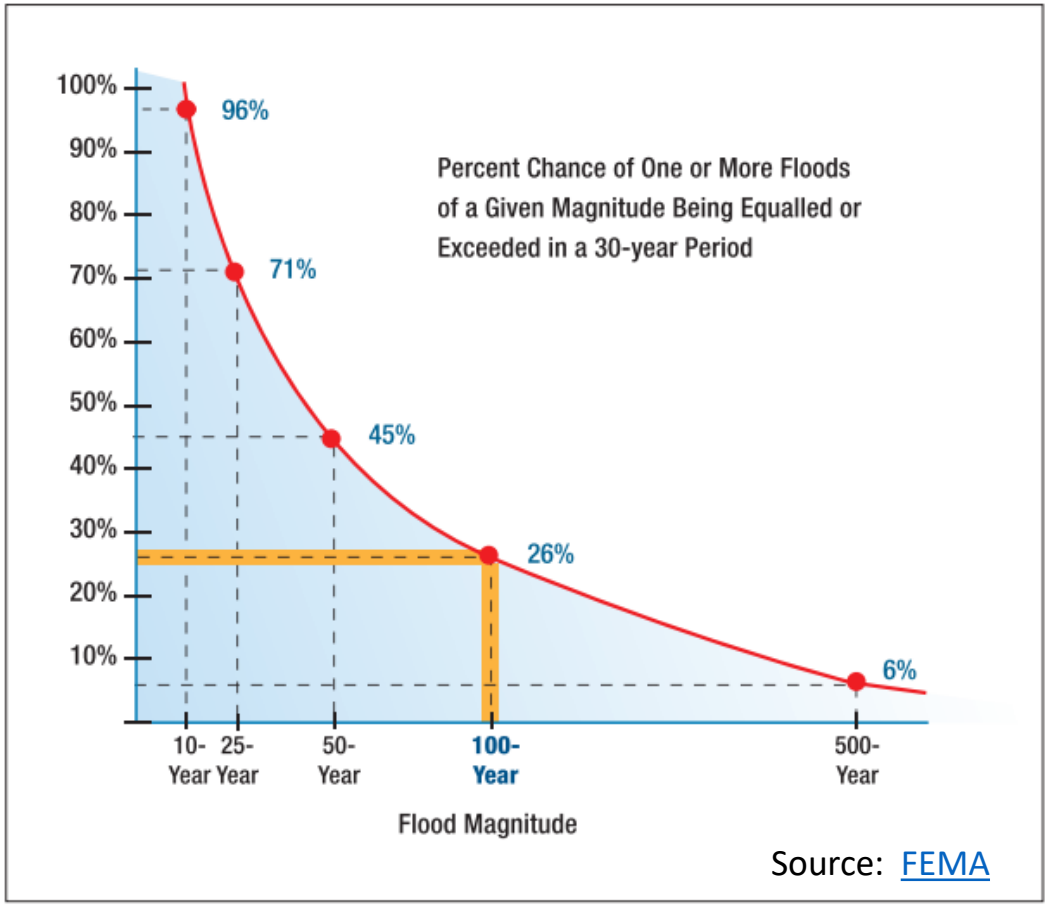
Flood Characteristics

Flood Characteristics Impacting Community

- *Frequency:* Probability that a flood of a specific size will be equaled or exceeded in any given year
  - 5-, 10-, 20-, 25-, 50-, 100-, and 500-year flood elevations (above sea level) refer to expected water levels of the 20%, 10%, 5%, 4%, 2%, 1%, and 0.2% annual chance flood events. A 1000-yr flood has a 0.1% chance of happening in any given year.
  - FEMA's 1%+ flood elevations measures how high the 100-year flood could be given the statistical uncertainties in flood modeling. It represents the upper 84-percent confidence limit of the statistical error for calculating the 1-percent annual chance event.
  - The relative frequency of any given flood (e.g., 5-year or 10-year) serves as a useful reference point when selecting a mitigation options and evaluating cost effectiveness.
- *Depth:* Flood depth or water surface elevation above the ground surface
  - Critical during design considerations, as it is often the primary factor in evaluating the potential for flood damage
  - Flood depth sources include flood models and high water marks which measure the degree of flooding
- *Velocity: S*peed at which the floodwaters are flowing
  - *Flowing water often causes erosion and scour, as well as debris impacts and hydrodynamic forces.*
  - FEMA's detailed engineering studies provide river/stream flows
- *Duration*: Measure of how long water remains above normal levels.
  - Prolonged contact with floodwaters may make some mitigation measures, including dry flood-proofing, inappropriate because of the increased chance of seepage and potential structural failure.
  - Long periods of inundation are more likely to cause greater damage to structural members and finishes than short periods of flooding.
- *Rate of Floodwater Rise and Fall*: Floodwater that rises very quickly with little or now warning
  - Steep topography and locations with small drainage areas may experience flash flooding in which floodwater can rise very quickly with little or no warning.
  - High-velocity water flows usually accompany flash floods and preclude certain types of flood mitigation measures, especially those requiring human intervention
  - Rapid rates of the rise and fall of floodwater can also lead to unequal hydrostatic pressures on a building. The probability of unequal hydrostatic pressures increases when building exteriors are designed to be watertight
- *Historical Information*: Use past information like the high-water marks of the 2016 Flood as an indication of the nature and severity of effects likely to occur during future events.

Source: FEMA 2013

Flood Models and Studies



Relationship between flood recurrence intervals and the probability of an event occurring within a given period

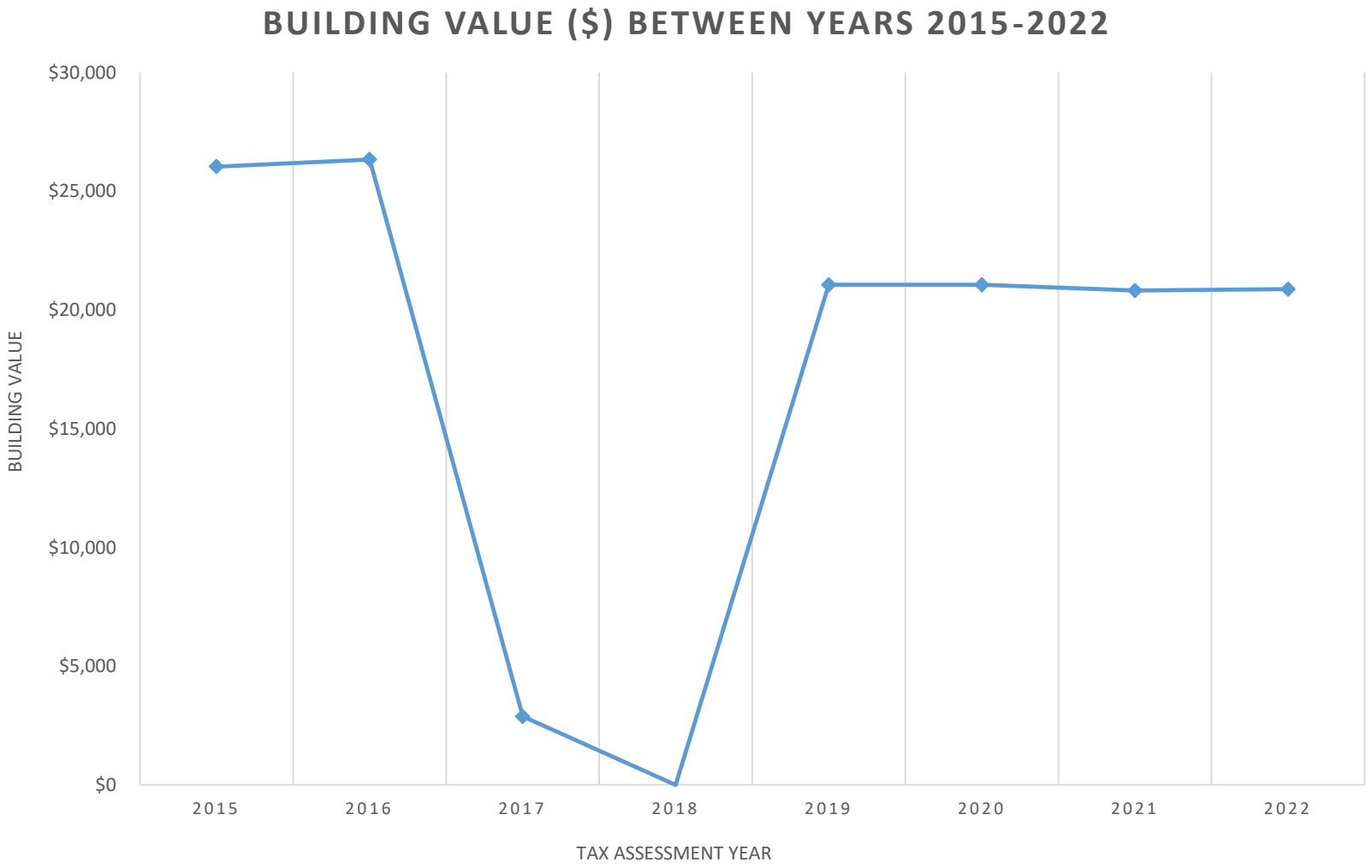
Rainelle New Reconstruction

First Floor Height ABOVE 2016 Flood HWM; 1-percent chance (100-yr) flood

First Floor Height BELOW 1%+, 0.2-percent chance (500-yr) floods

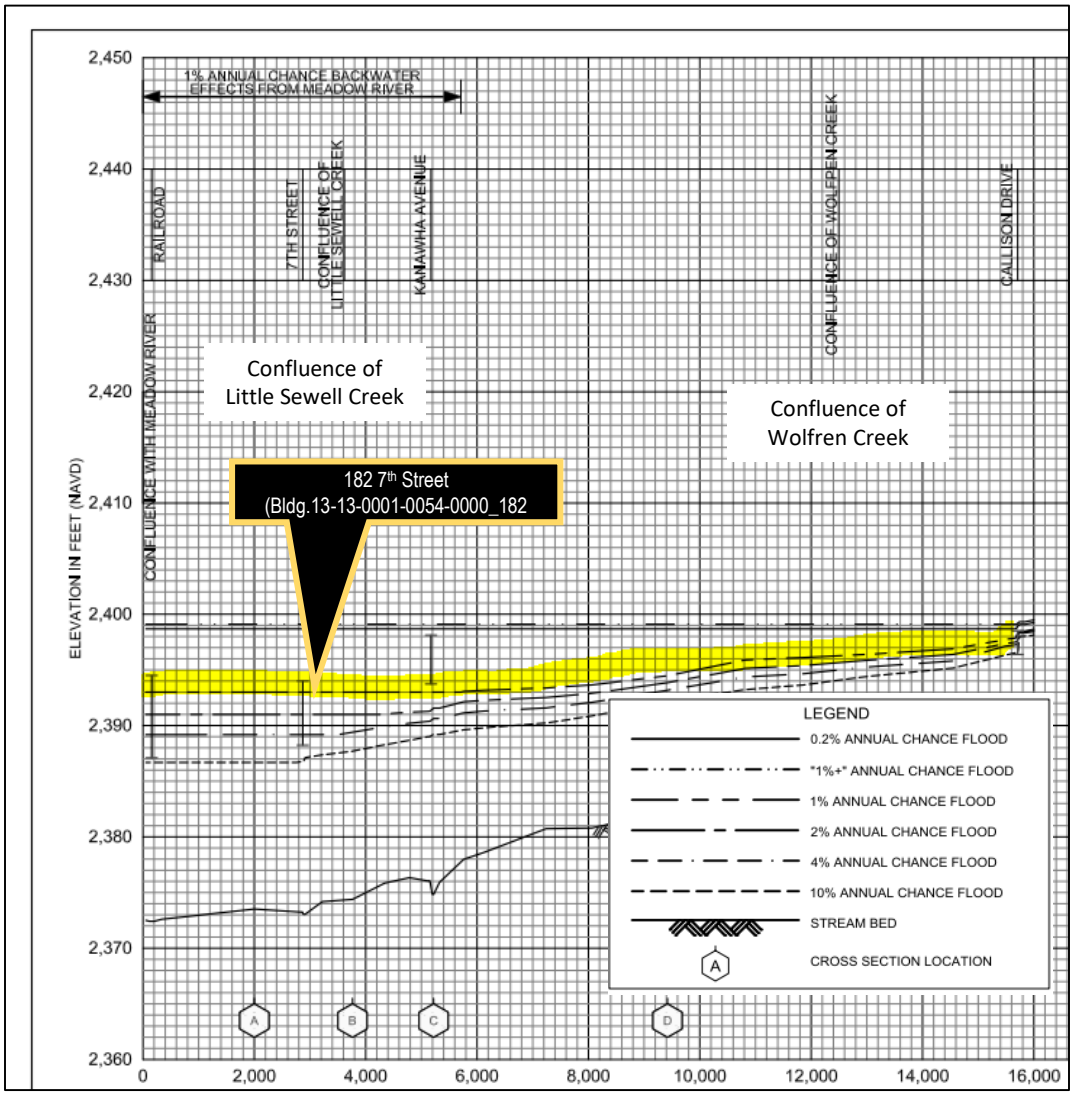
FLOOD DEPTHS: FEMA First Street Foundation (FSF) USGS 2016 Flood High Water Mark

Building 13-13-0001-0054-0000_182



Sewell Creek Flood Study Profile

2022 Preliminary 1% Base Flood (100-Yr) Elevation 1850.7 ft for Building 13-17-0009-0026-0000_138



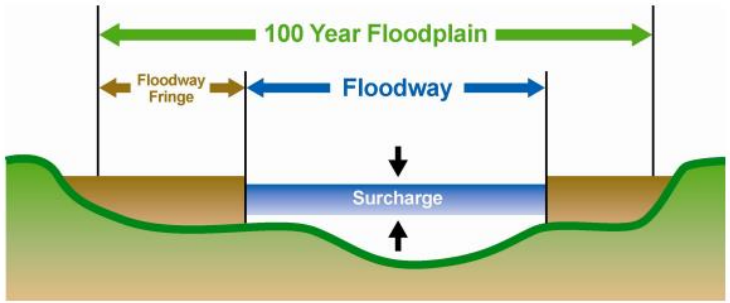
Sewell Creek 2022 Flood Study Profile

New 2022 FEMA Maps

Only the **floodway** or main channel of the **2012 FEMA flood maps** was mapped and not the **floodway fringe** of the 1% chance (100-yr) floodplain.

The **2022 base flood elevation** (100-yr) for a majority of Rainelle between 1st and 14th Streets is **2,393 feet**. A similar base flood elevation was mapped for the **1987 flood maps** for structures northwest of Main Street (U.S. 60).

The "1-percent plus" is a measure of how high the 1% flood even could be given the statistical uncertainties in flood modeling. The backwater flooding from Meadow River results in more uncertainty of the flood model and thus a wider confidence level. The **1%+ flood elevation** is **six feet higher** than 1% elevation and same as the 02%.

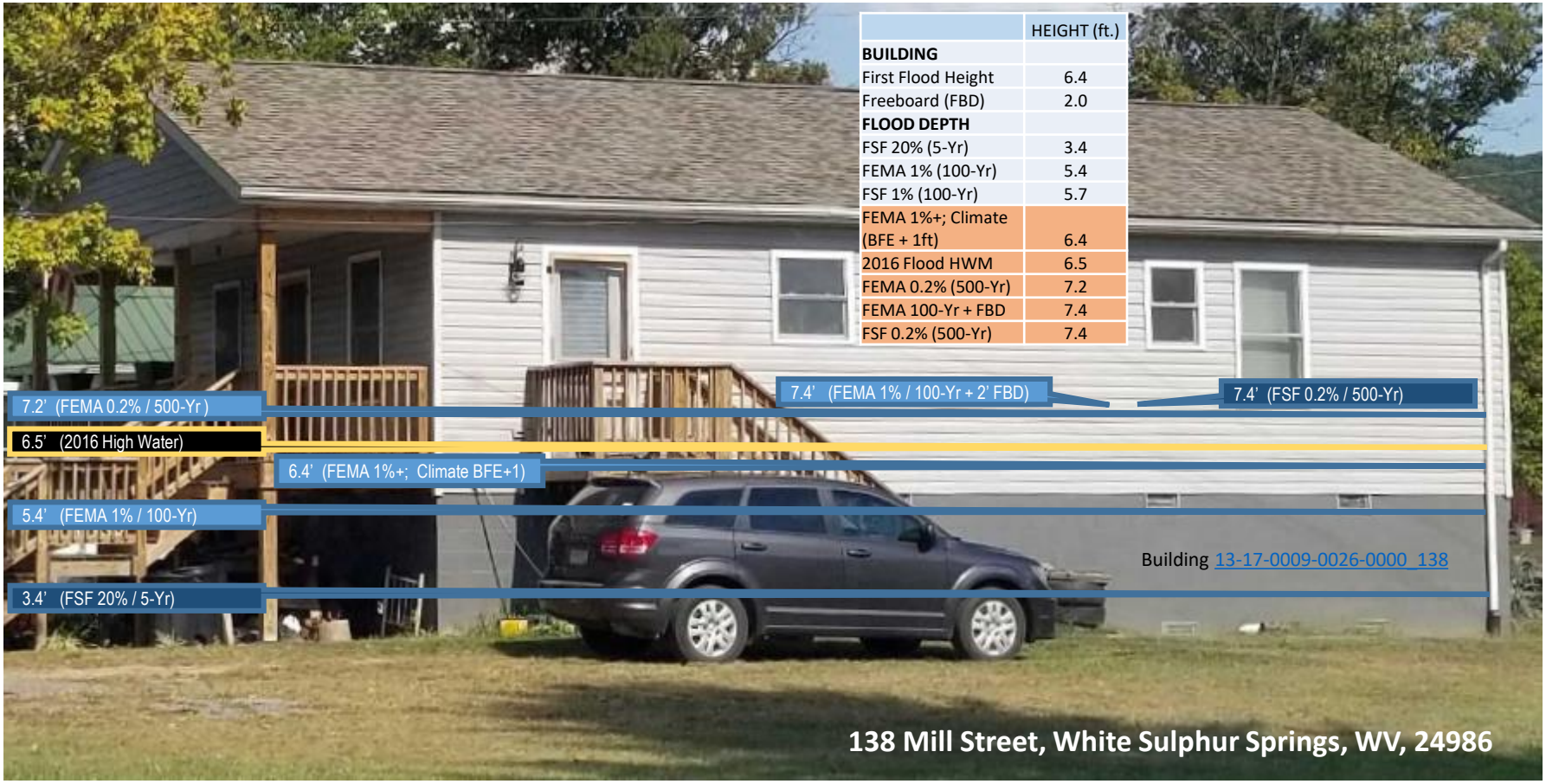


The "Regulatory Floodway" is the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height. Source: FEMA

WSS New Reconstruction

First Floor Height (FFH) ABOVE 1-percent chance (100-yr) flood

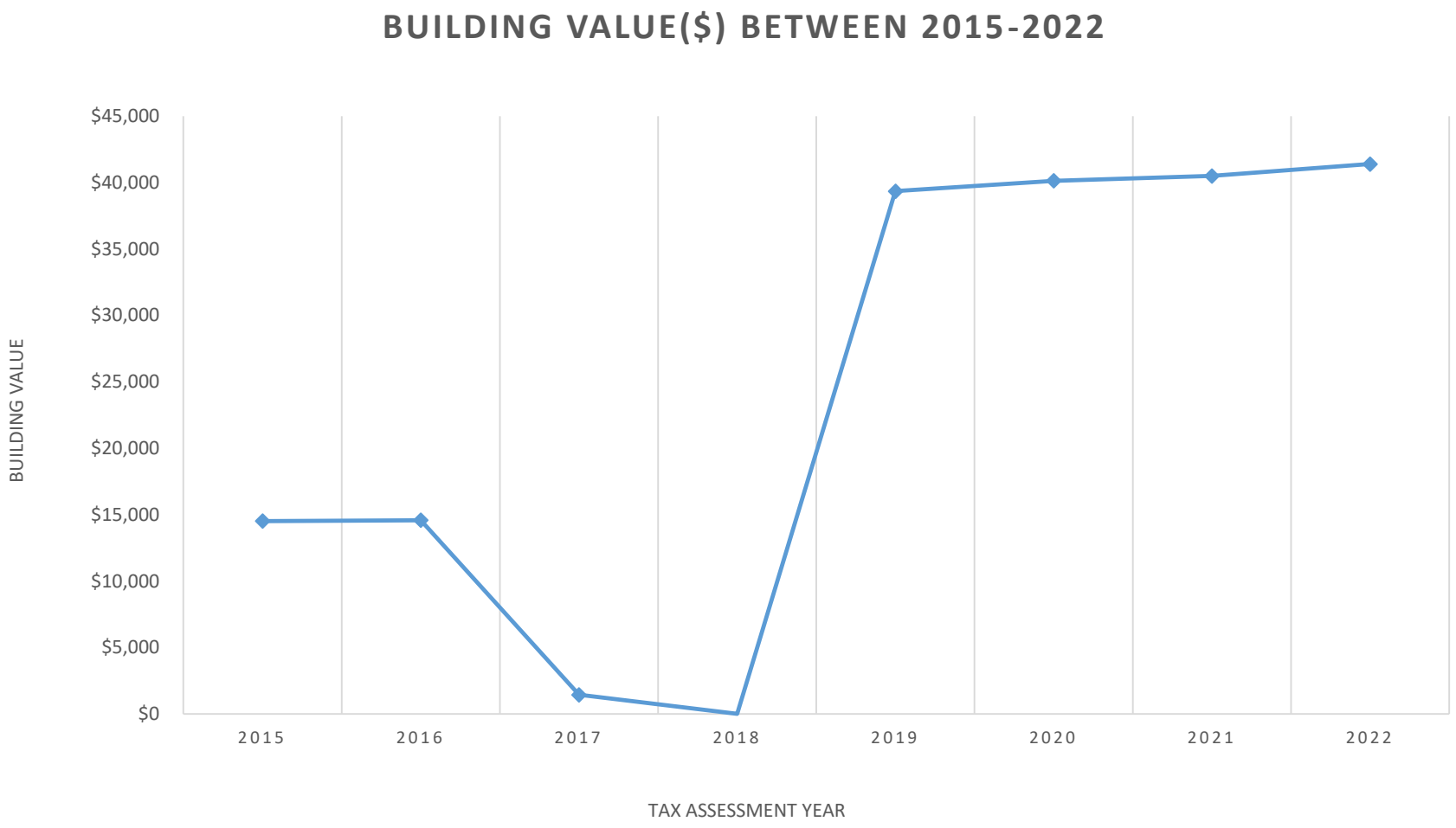
First Floor BELOW 2016 HWM; 1%+,0.2-percent chance (500-yr) floods



	HEIGHT (ft.)
BUILDING	
First Flood Height	6.4
Freeboard (FBD)	2.0
FLOOD DEPTH	
FSF 20% (5-Yr)	3.4
FEMA 1% (100-Yr)	5.4
FSF 1% (100-Yr)	5.7
FEMA 1%+; Climate (BFE + 1ft)	6.4
2016 Flood HWM	6.5
FEMA 0.2% (500-Yr)	7.2
FEMA 100-Yr + FBD	7.4
FSF 0.2% (500-Yr)	7.4

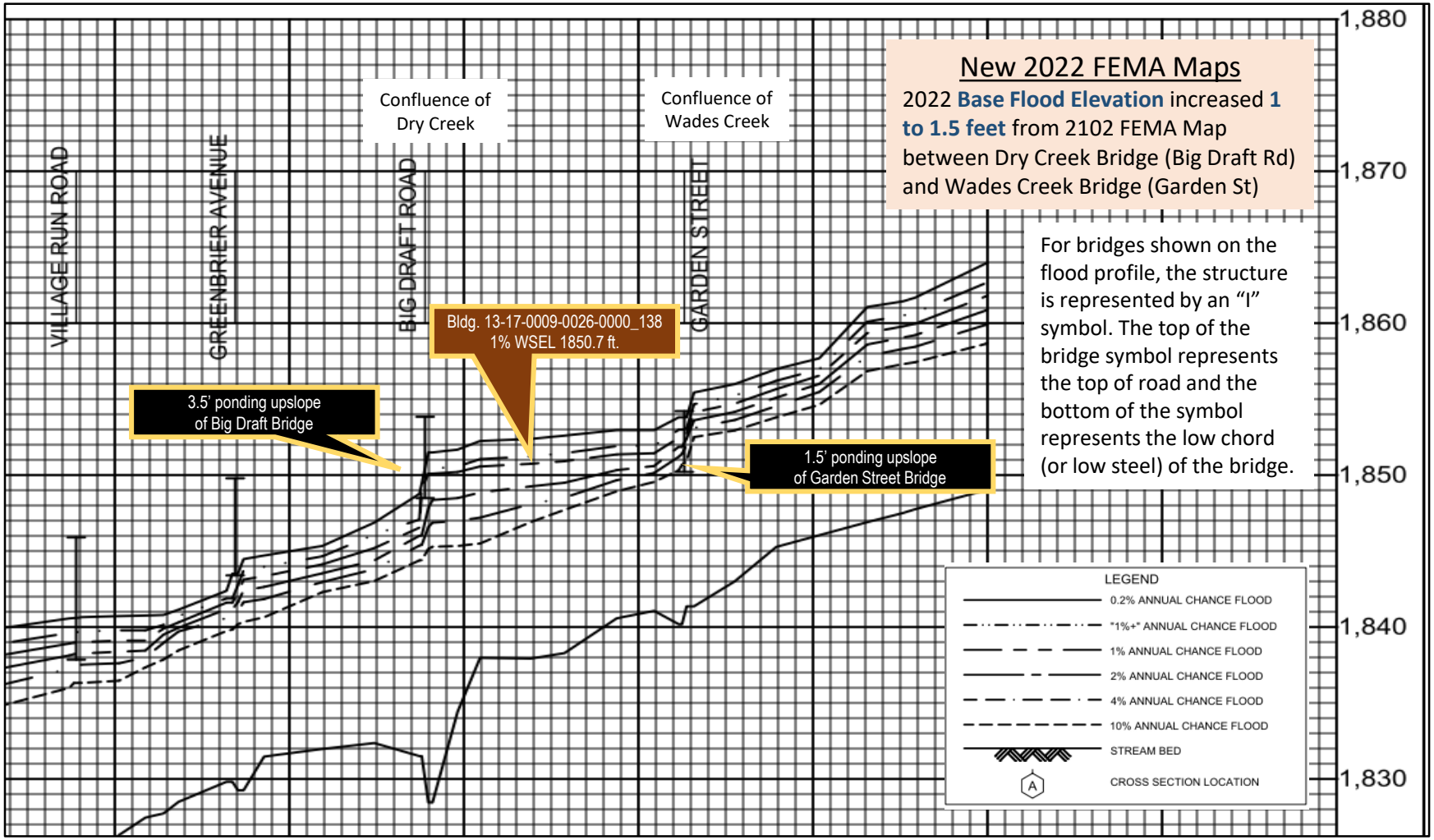
FLOOD DEPTHS: FEMA First Street Foundation (FSF) USGS 2016 Flood High Water Mark

Building 13-17-0009-0026-0000_138



Howard Creek Flood Study Profile

2022 Preliminary 1% Base Flood (100-Yr) Elevation 1850.7 ft for Building 13-17-0009-0026-0000_138



New 2022 FEMA Maps

2022 **Base Flood Elevation** increased **1 to 1.5 feet** from 2102 FEMA Map between Dry Creek Bridge (Big Draft Rd) and Wades Creek Bridge (Garden St)

For bridges shown on the flood profile, the structure is represented by an "I" symbol. The top of the bridge symbol represents the top of road and the bottom of the symbol represents the low chord (or low steel) of the bridge.

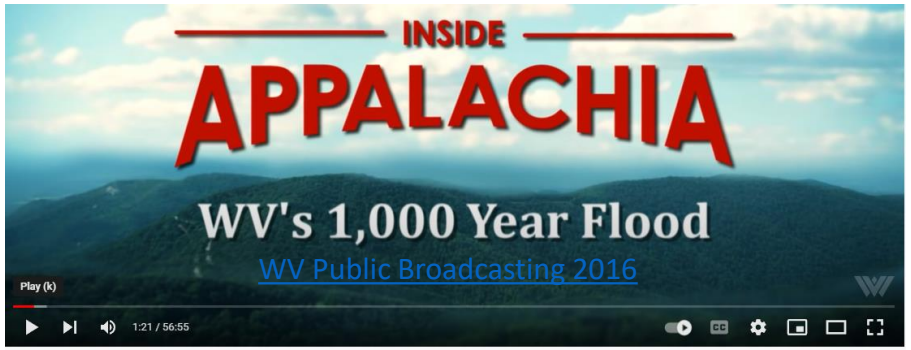
https://data.wvgis.wvu.edu/pub/NSF/FloodProfiles/54025CV002B.pdf#page=43

FEMA FIS Technical Reference 2019

Thousand Year Flood?

WVNSTV 2021

WVNSTV 2022



Inside Appalachia: WV's 1,000 Year Flood

"Inside Appalachia: WV's 1000 Year Flood" – WV Public Broadcasting

Some websites like MH3WV clarify it as a 1,000-year rainfall event according to the NWS

"The National Weather Service called the June 2016 flooding in southern West Virginia an exceptional meteorological event, a vicious line-up of storms that came in simultaneously from the northeast and the southeast. Almost 8 inches of rain fell in some spots in just 12 to 18 hours. That amount of rain in such a short time period is something expected once in 1,000 years, according to the NWS.

Thousand Year Flood?

The Thousand-Year Flood: White Sulphur Springs Revisited

681 views • 1 year ago

WVNS 59News

June 23, 2021 marks five **years** since torrential rainfall caused catastrophic flooding and killed 23 people in southern **West** ...

CC

2016 West Virginia 1000 year flood Official Tribute...Live at Ground Zero White Sulphur Springs

22K views • 6 years ago

Sk8Gr8 Sports

By Tyler Hagemo at Cutting Edge Skating School.

FB Viral Video of 2016 West Virginia 1000 Year Flood-Ground Zero Live Footage

1.4K views • 6 years ago

Sk8Gr8 Sports

Hardest hit part of **WV 1000 year flood**-The bodies of three more victims of **West Virginia**'s historic flooding were found overnight, ...

Inside Appalachia: WV's 1,000 Year Flood

174K views • 6 years ago

West Virginia Public Broadcasting

The National Weather Service called the June 2016 flooding in southern **West Virginia** an exceptional meteorological event, ...

John Wyatt Rainelle, WV | Keith Thompson Beckley, WV | Alan Rose Evacuation Volunteer | Heather... 7 moments

The Thousand Year Flood Revisited - Part 7

19 views • 3 years ago

WVNS 59News

The **Greenbrier** Resort and the PGA Tour event.

CC

1,000-Year Flood?

A Thousand-year Downpour or Rainfall is different than a Thousand-year Flood

What is a 1,000-year flood?

The term "1,000-year flood" means that, statistically speaking, a flood of that magnitude (or greater) has a 1 in 1,000 chance of occurring in any given year. In terms of probability, the 1,000-year flood has a 0.1% chance of happening in any given year. These statistical values are based on observed data.

How can a 1,000-year rainfall not result in a 1,000-year flood?

It comes down to a number of factors, including the pattern of movement of the rainstorm in each particular watershed, the conditions of the soil and plant matter in the watershed, and the timing of the rainstorm in one watershed versus other watersheds. For example, if the ground is already saturated before a rainstorm, much of the rain will run off into streams, but if the ground is dry, it will soak up more of the rain and the runoff will be less significant.

Source: USGS | NOAA Climate.gov | NWS Blacksburg

*In the immediate aftermath of the June 2016 flood, **USGS** and the **Federal Emergency Management Agency** (FEMA) initiated a cooperative study to evaluate the flood's magnitude, extent, and probability of occurrence.*

1,000-Year Flood?

THE FLOOD IN JUNE 2016 WAS NOT A RARE, "1 IN 1,000 YEAR EVENT." ALTHOUGH THE AMOUNT OF RAIN THAT FELL WAS UNUSUAL, RAINFALL AND FLOODING ARE DIFFERENT.

FINDING 3: THE FLOOD IN JUNE 2016 WAS NOT A RARE, "1 IN 1,000 YEAR EVENT." ALTHOUGH THE AMOUNT OF RAIN THAT FELL WAS UNUSUAL, RAINFALL AND FLOODING ARE DIFFERENT.

- Individual watershed and storm characteristics help explain how a rainfall event with one frequency can cause a flood event with a different frequency. These characteristics include the duration and intensity of the rainfall, the spatial extent of the rainfall, and the size, slope, and shape of the watershed.
- The thunderstorms of June 23 and 24, 2016 produced different amounts of rainfall across the region. The National Weather Service estimated that the rainfall received by the hardest hit areas has a 1-in-1,000 chance of happening each year. However, many people took this to mean the flooding is a "thousand-year" event.
- Most of the June 2016 peak flows examined by USGS were found to be much more likely than a "1,000 year event." In fact, the most extreme flooding was found to have 0.2% chance of happening in any given year (1 in 500) to a 5% chance (1 in 20).

TABLE 1. The annual chance of the flows recorded during the 2016 storm. The 100 year flood has a 1% chance of happening each year. Everything in this table with a value greater than 1% could happen more frequently.

STREAM GAGE LOCATION	ANNUAL CHANCE
GREENBRIER RIVER AT ALDERSON	1.2%
GREENBRIER RIVER AT HILLDALE	1.6%
WILLIAMS RIVER AT DYER	0.5%
GAULEY RIVER AT CAMDEN-ON-GAULEY	1.3%
CRANBERRY RIVER NEAR RICHWOOD	5.0%
GAULEY RIVER NEAR CRAIGSVILLE	0.9%
MEADOW RIVER AT NALLEN	0.2%
ANGLINS CREEK NEAR NALLEN	2.4%
PETERS CREEK NEAR LOCKWOOD	4.8%
ELK RIVER BELOW WEBSTER SPRINGS	1.4%

Most of the June 2016 peak flows examined by USGS were found to be much more likely than a "1,000 year event." In fact, the most extreme flooding was found to have 0.2% chance of happening in any given year (1 in 500) to a 5% chance (1 in 20).

Source: FEMA

1,000-Year Flood?

THE LATEST DATA SHOW THAT THE LEVEL OF FLOODING THAT OCCURRED IN 2016 COULD HAPPEN **MORE FREQUENTLY** THAN PREVIOUSLY THOUGHT. IN MANY AREAS, THAT EVENT HAS AT LEAST A 1% CHANCE OF HAPPENING EACH YEAR IN THE FUTURE.

FINDING 4: THE LATEST DATA SHOW THAT THE LEVEL OF FLOODING THAT OCCURRED IN 2016 COULD HAPPEN MORE FREQUENTLY THAN PREVIOUSLY THOUGHT. IN MANY AREAS, THAT EVENT HAS AT LEAST A 1% CHANCE OF HAPPENING EACH YEAR IN THE F

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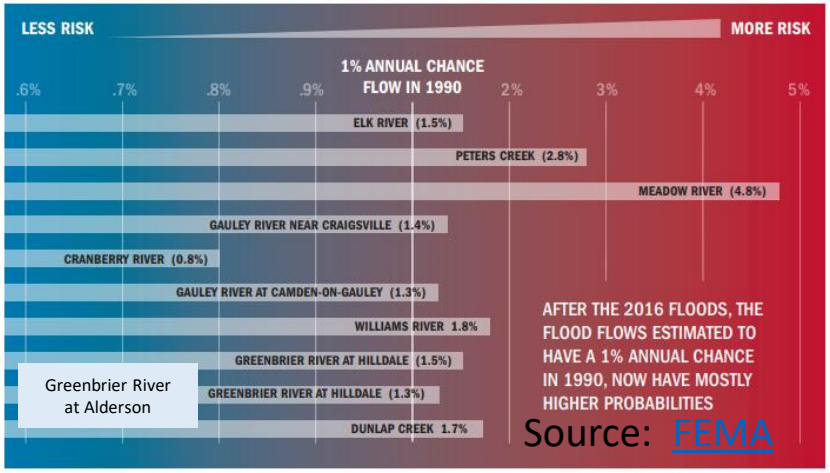
USGS Study: Three annual exceedance probability (AEP) curves calculated using the Expected Moments Algorithm (EMA) method were used to **compare 100-year (AEP 0.0100) annual peak stream flows** at 12 streamflow-gaging stations, measured from initiation of the period of record (POR) at each streamflow-gaging station through 1990, 2015, and 2016.

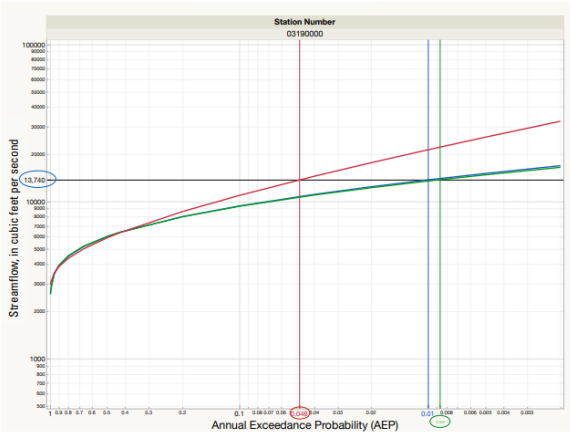


Source: FEMA

FIGURE 11: This chart shows how the probability of a 100-year-flow at each stream gage based on 1990 data has changed when information from 2016 is included. For all but one of the gages analyzed, what used to have a 1% chance of happening each year, now has a greater chance of happening each year. In other words, what was considered the "100 year flow" could now be called the "21 year flow" for the gage at the Meadow River at Nallen or the "77 year flow" for the Greenbrier River at Alderson.

For all but one of the gages analyzed, what used to have a 1% chance of happening each year, now has a greater chance of happening each year. In other words, what was considered the "100 year flow (1%)" could now be called the "21 year flow (4.8%)" for the gage at the Meadow River (watershed for Rainelle) at Nallen or the "77 year flow (1.3%)" for the Greenbrier River at Alderson (watershed for White Sulphur Springs).

03190000 Meadow River at Nallen, West Virginia



A 100-year streamflow (AEP 0.010) of 13,740 ft^3/s in 1990 (blue curve), is equivalent to an 111-year streamflow (AEP 0.009) in 2015 (green curve), and to a 21-year streamflow (AEP 0.048) in 2016 (red curve).

Figure 1-8. Annual exceedance probabilities in relation to streamflow for U.S. Geological Survey streamflow-gaging station 03190000, Meadow River at Nallen, West Virginia, for the period of record through 1990, 2015, and 2016.

Source: USGS Report | AEP Meadow River | Pubs Site