

## Spatial Cluster Analysis of Structures in Approximate A Zones at Varying Flood Depths

2/21/2022

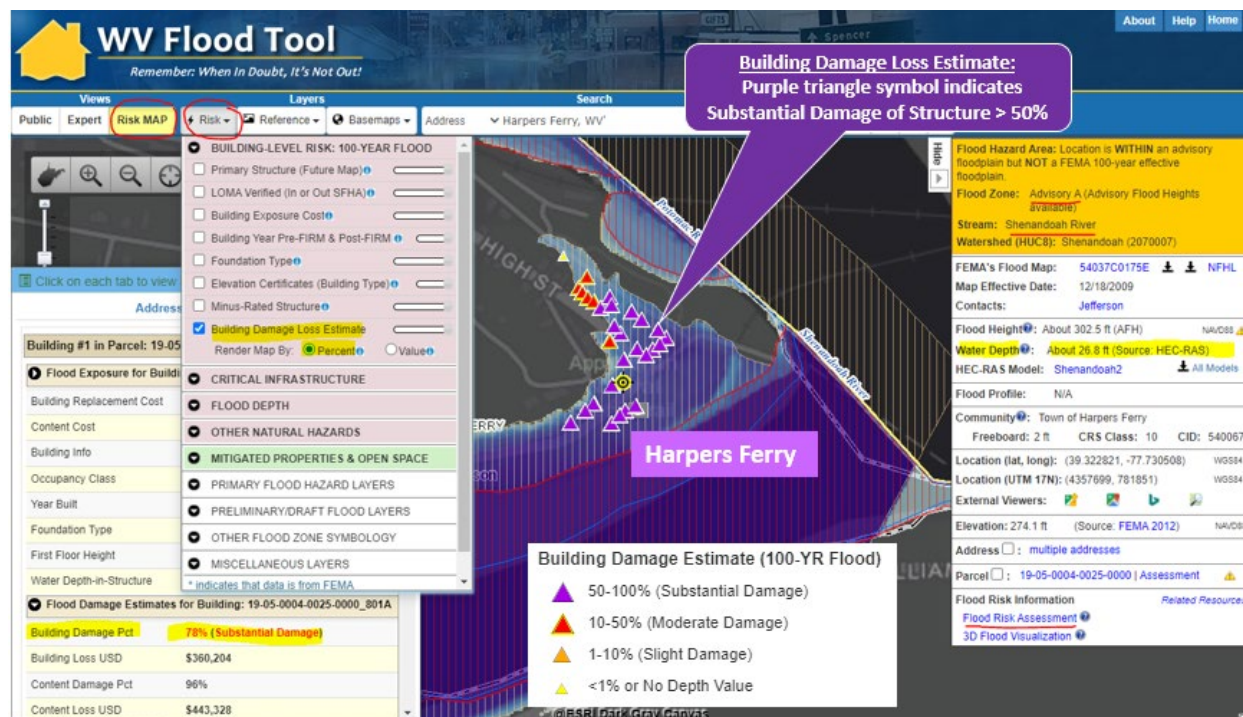
Kurt Donaldson, WV GIS Technical Center, WVU

**Objective:** Evaluate potential Approximate A Zone rivers/streams for more comprehensive Detailed Flood Studies where clusters of buildings with high damage potential exist. Building-level risk assessment data from the TEIF/TEAL Statewide Risk Assessment project and the best available flood depth grids were utilized to perform a spatial cluster analysis of structures in the A Zones based on *high* (1) building counts, (2) building dollar exposure, (3) building damage dollar exposure estimates, and (4) substantially damaged estimates. The cluster analysis identifies a higher density (or higher development) of structures located in the Approximate A Zone.

**Methodology:** Spatial Cluster Analysis of structures in Approximate A Zones was performed for flood depths of  $\geq 5$  Feet,  $\geq 10$  Feet, and  $\geq 15$  Feet. The structure density per stream mile was not calculated except for visual viewing on the WV Flood Tool. The building-level risk assessment factors below were utilized for ranking clusters of Approximate A Zone structures as candidates for Detailed Flood Studies.

- Building Count
- Building Dollar (\$) Exposure
- Building Damage Dollar (\$) Loss Estimates
- Substantially Damaged Loss (%) Estimates

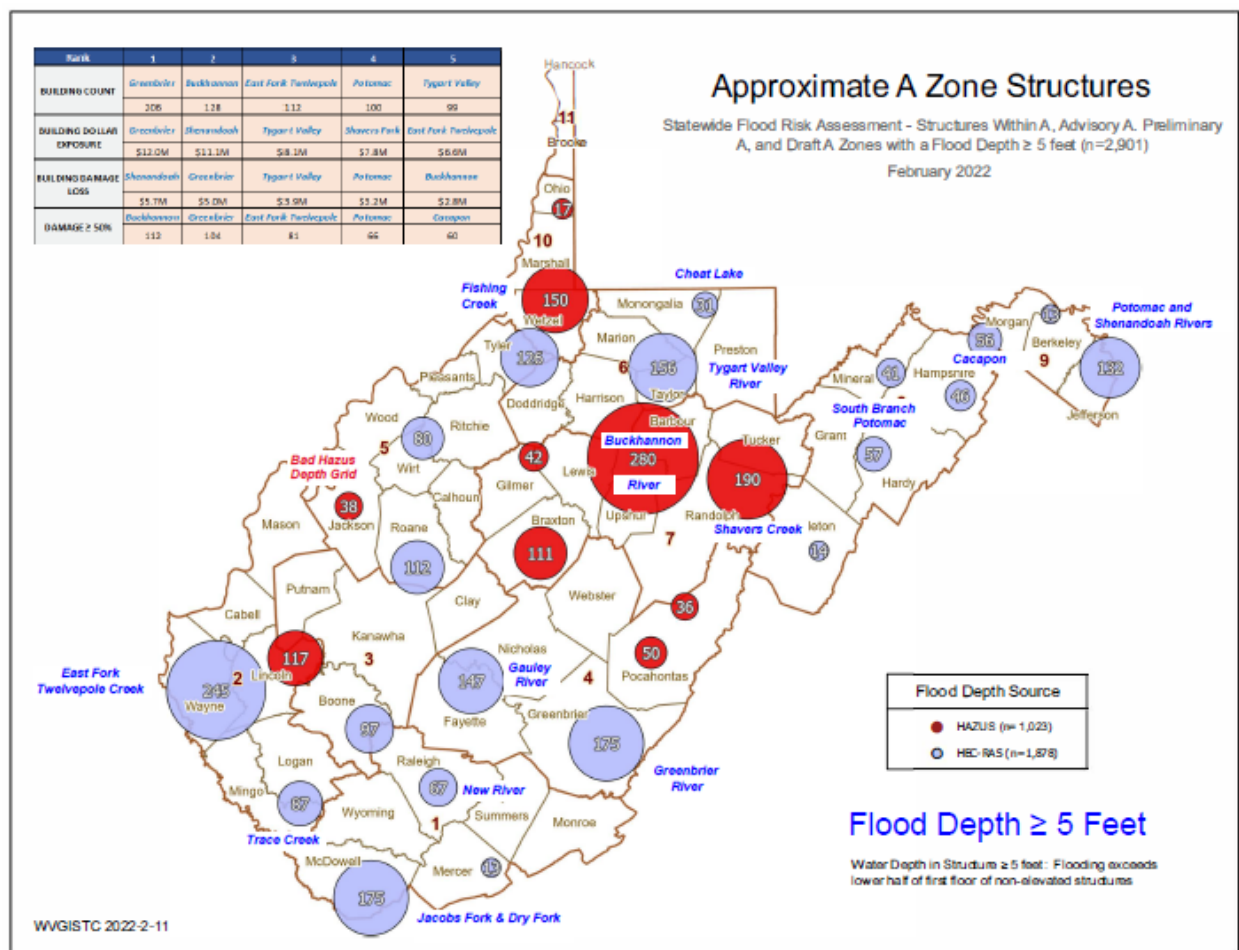
**WV Flood Tool's Risk MAP View – Building Damage Loss Estimate Percent Layer:** In the Risk MAP View of the WV Flood Tool, the risk assessment layer, **Building Damage Loss Estimate (%)**, provides a relationship between high flood depths and flood loss estimates of substantially damaged structures (> 50% damage). High building-level damage percentages typically correlate to structures in Approximate A Zones with high base flood depths for a 1% annual chance flood.

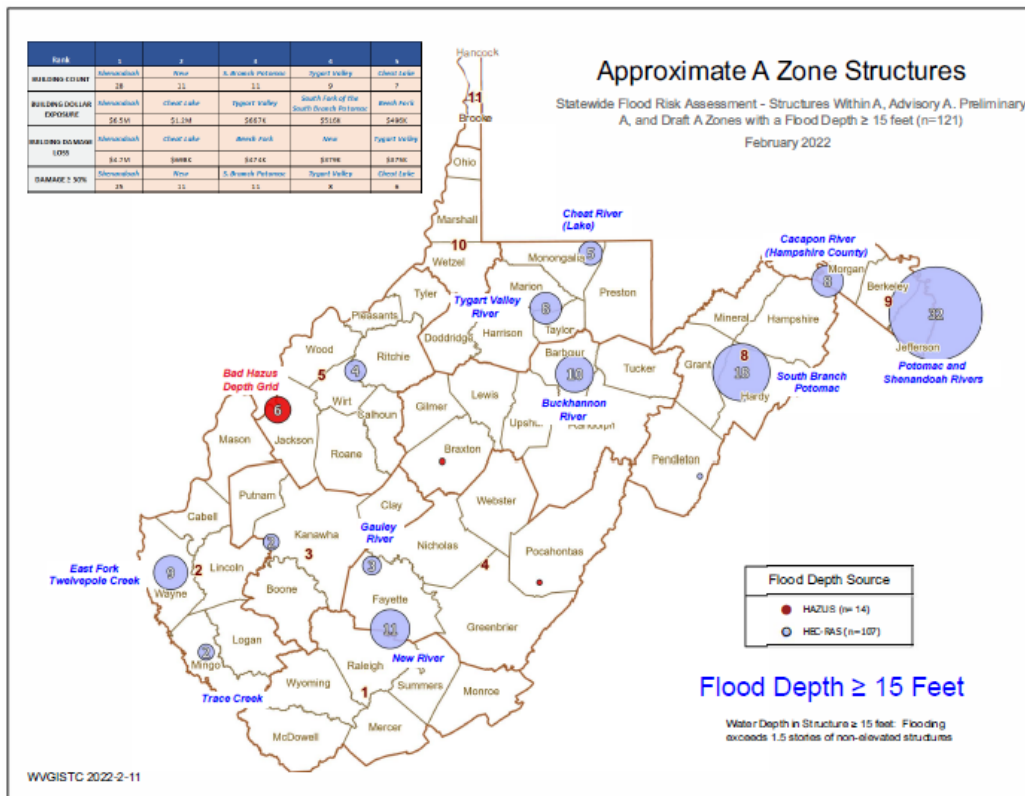
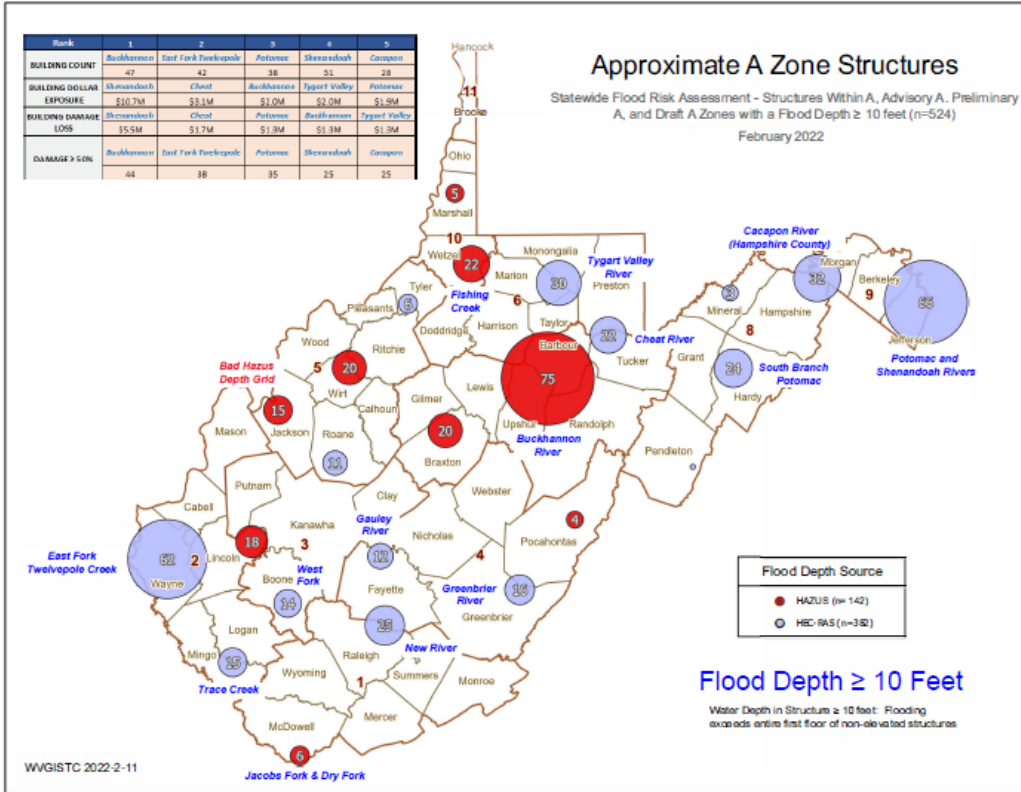


**Depth Grids:** Where no model-backed HEC-RAS depth grids existed for Approximate A Zones, the less accurate Hazus depth grid was used. Refer to [Advisory A Zone status graphic](#).

**A Zone Structure Cluster Analysis:** Zone A structure vulnerability and spatial density analyses were performed for three flood depths at  $\geq 5$  feet,  $\geq 10$  feet, and  $\geq 15$  feet.

- [Zone A Cluster Analysis Graphics](#): Flood Depths for  $\geq 5$  feet,  $\geq 10$  feet, and  $\geq 15$  feet
- [Spreadsheet Flood Source Tables](#): Summary Building-Level Risk Assessment Factors per River/Stream Cluster and Top Building Flood Depths per River/Stream
- [Report](#): Methodology and map links to potential candidates for AE Zone Detailed Studies
- [BLRA](#): Statewide Building-Level Risk Assessment (BLRA) source geodatabase for cluster analysis





*Findings:* Refer to the graphics, spreadsheet table, and WV Flood Tool when evaluating the TEIF data for this analysis.

### **Flood Depth ≥ 5 Feet**

Approximate A Zone Structures with **Flood Depth ≥ 5 Feet**. Water Depth in Structure ≥ 5 feet: Flooding exceeds lower half of first floor of non-elevated structures.

- **Greenbrier River:** Greenbrier River in Greenbrier County is ranked first as having the highest Building Count (206) and Building Dollar Exposure (\$12M). Greenbrier River is ranked second for Building Damage Loss Estimate (\$5.0M) and Substantially Damaged Structures Estimate (104)
- Other Rivers/Streams of Interest: **Buckhannon, East Fork Twelvepole, Potomac, Tygart Valley, Shenandoah, Shavers Fork, Cacapon, and West Fork.**
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### **Flood Depth ≥ 10 Feet**

Approximate A Zone Structures with **Flood Depth ≥ 10 Feet**. Water Depth in Structure ≥ 10 feet: Flooding exceeds entire first floor of non-elevated structures.

- **Buckhannon River:** Buckhannon River in Barbour and Upshur counties is ranked first with the highest Building Count (47) and Substantially Damaged Loss Estimate (44).
- **Shenandoah River** (Harpers Ferry): Shenandoah River is ranked first in Building Dollar Exposure (\$10.7M) and Building Damage Loss Estimate (\$5.5M).
- Other Rivers/Streams of Interest: **East Fork Twelvepole, Potomac, Cacapon, Cheat, Tygart Valley, and West Fork.**

### **Flood Depth ≥ 15 Feet**

Approximate A Zone Structures with **Flood Depth ≥ 15 Feet**. Water Depth in Structure ≥ 15 feet: Flooding exceeds 1.5 stories of non-elevated structures.

- **Shenandoah River** (Harpers Ferry): Shenandoah River is ranked first in all risk factors: Building County (28), Building Dollar Exposure (\$6.5M), Building Damage Loss Estimate (\$4.7M), and Substantially Damaged Loss Estimate (25).
- Other Rivers/Streams of Interest: **New, South Branch Potomac, Tygart Valley, Cheat Lake, South Fork of the South Branch Potomac, and Beech Fork.**

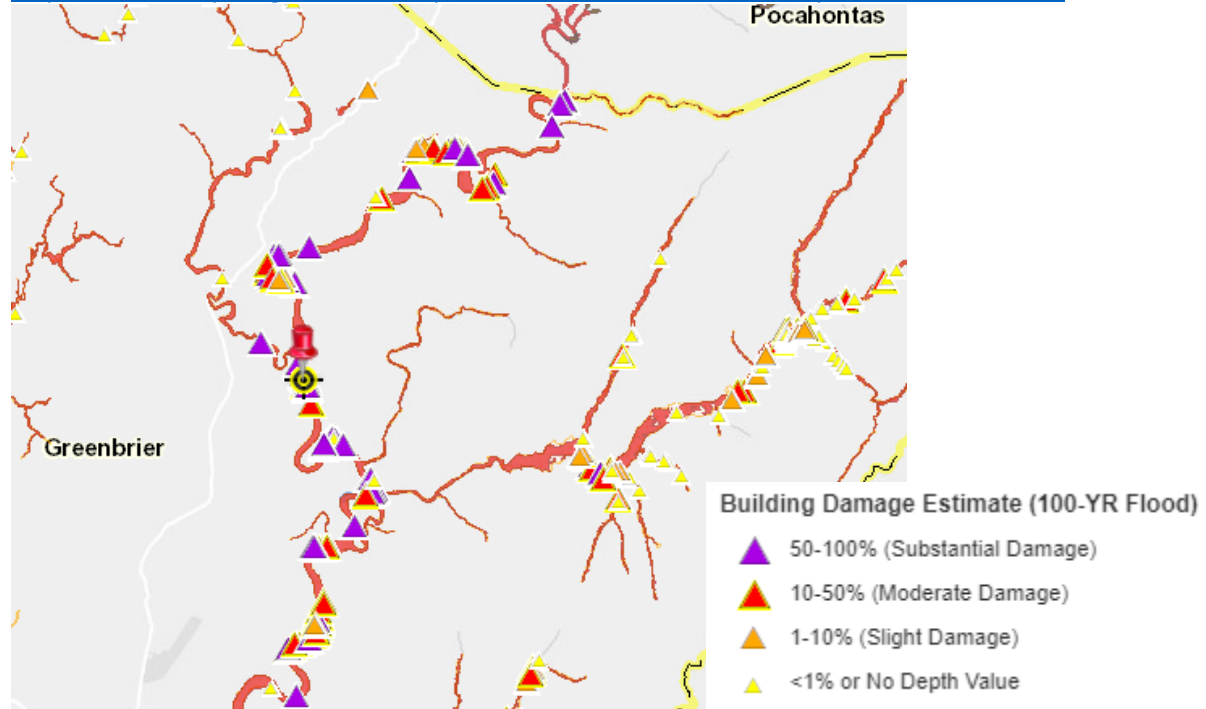
*Zone A Candidates for Detailed Studies.* Using spatial cluster and building-level risk analyses, below is a list of A Zones with map links to the WV Flood Tool to consider for detailed flood studies.

- |                                 |  |
|---------------------------------|--|
| • Beech Fork Lake Dam backwater | • New River                              |
| • Buckhannon River              | • Patteson Creek                         |
| • Cacapon River                 | • Potomac River                          |
| • Cheat Lake Dam backwater      | • Shavers Fork                           |
| • Cheat River                   | • Shenandoah River                       |
| • Dry Fork                      | • South Branch Potomac River             |
| • East Fork Twelvepole Creek    | • South Fork of the South Branch Potomac |
| • Fishing Creek                 | • Trace Creek                            |
| • Gauley River                  | • Tygart Valley River                    |
| • Greenbrier River              | • West Fork                              |
| • Jacobs Fork                   |  |



**Greenbrier River** (Greenbrier County) Approximate A Zone Cluster of High Damaged Structures  
High building county for Depth > 5 feet. High damage loss structures are located over a long distance of the Greenbrier River in Greenbrier County.

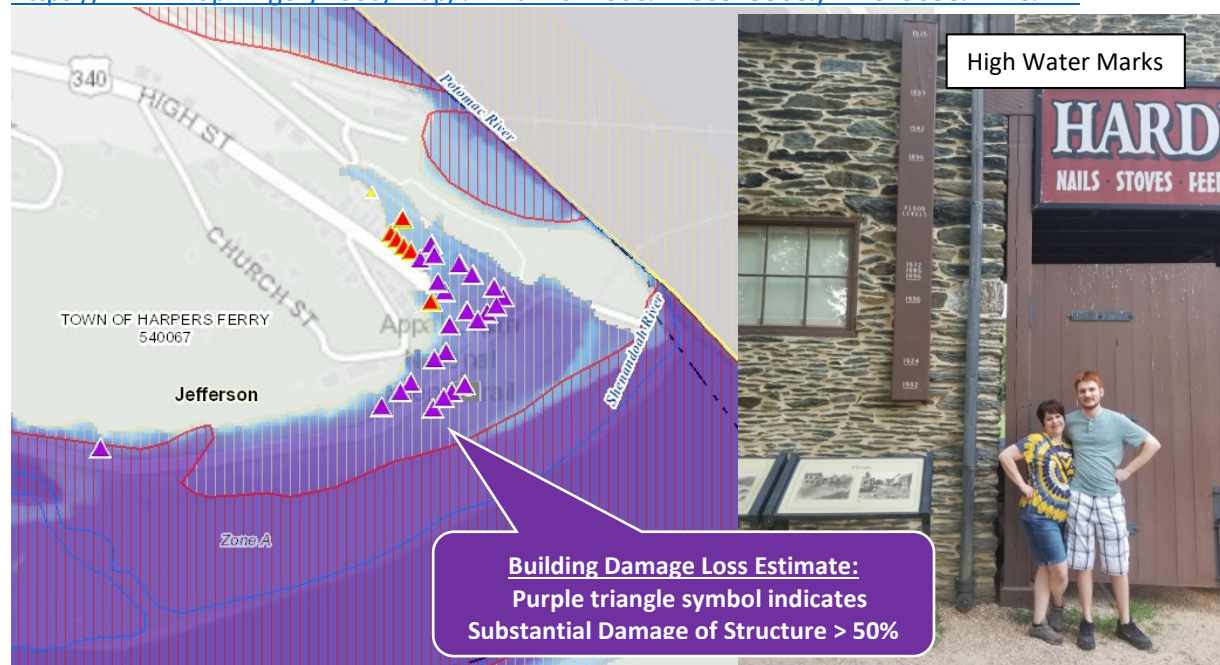
<https://www.mapwv.gov/flood/map/?wkid=102100&x=-8943985&y=4572143&l=5&v=2>



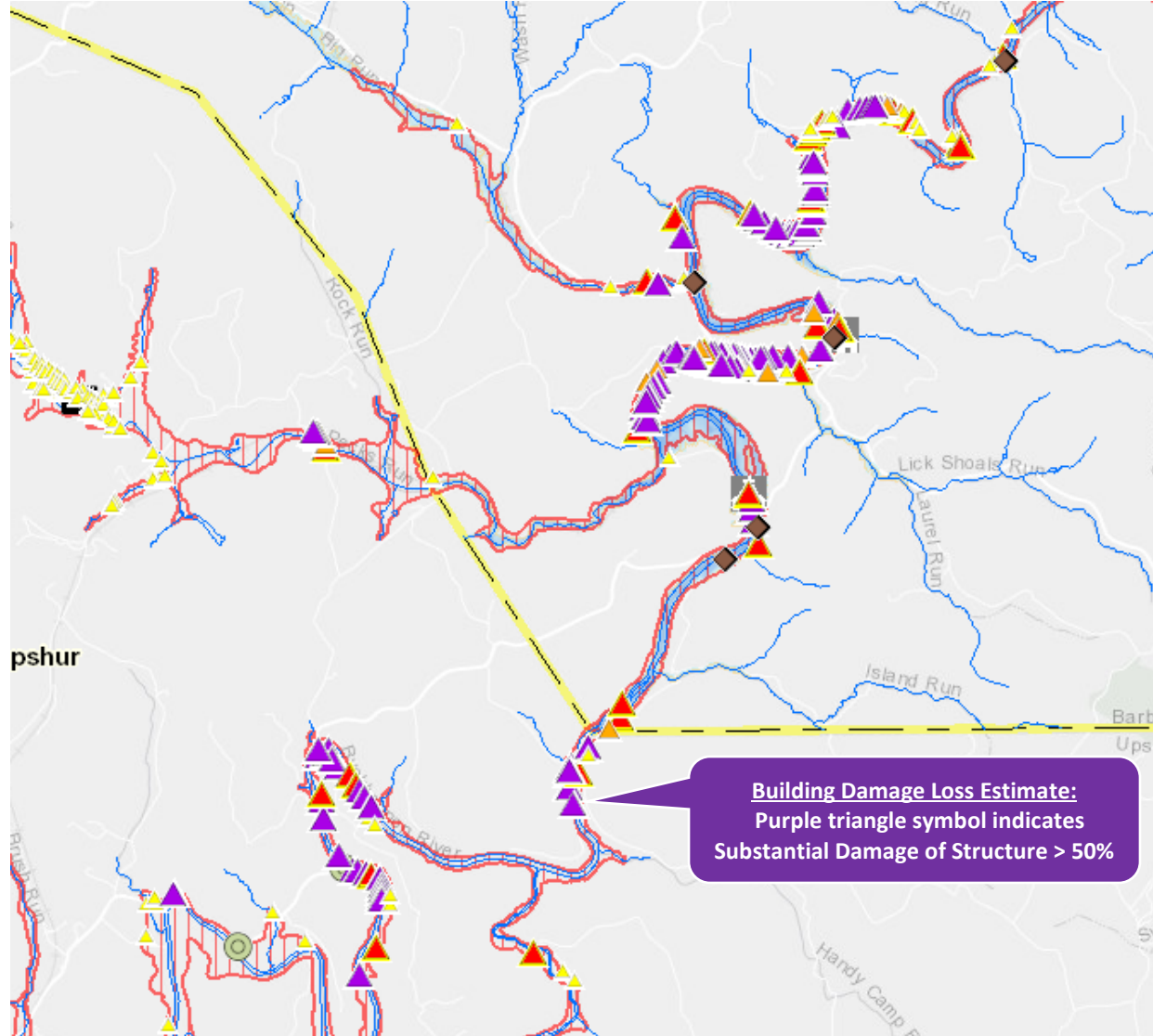
**Shenandoah River** (Harpers Ferry) Zone A Cluster

A high-value wastewater treatment plant is associated with the high building exposure values of this Zone A cluster. Building 19-05-0004-0025-0000\_744 has high-water marks on building side.

<https://www.mapwv.gov/flood/map/?wkid=102100&x=-8652936&y=4767965&l=11&v=2>



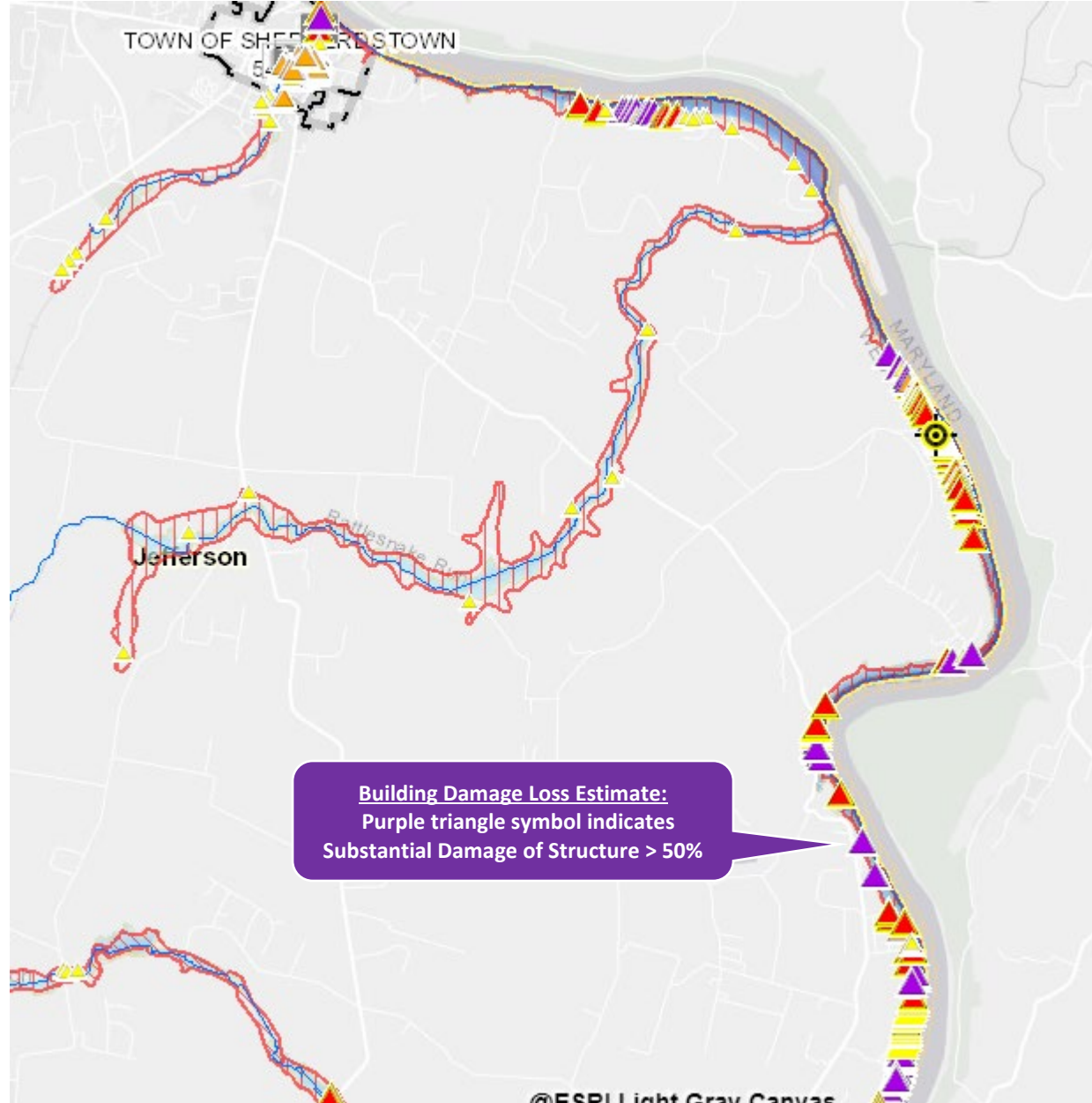
**Buckhannon River (Barbour / Upshur Counties) Zone A Cluster of High Damaged Structure Estimates**  
<https://www.mapwv.gov/flood/map/?wkid=102100&x=-8919535&y=4727392&l=6&v=2>



**Building Damage Estimate (100-YR Flood)**

- ▲ 50-100% (Substantial Damage)
- ▲ 10-50% (Moderate Damage)
- ▲ 1-10% (Slight Damage)
- ▲ <1% or No Depth Value

**Potomac River Zone A Cluster in Jefferson County between Shepherdstown and Harpers Ferry**  
<https://www.mapwv.gov/flood/map/?wkid=102100&x=-8919535&y=4727392&l=6&v=2>



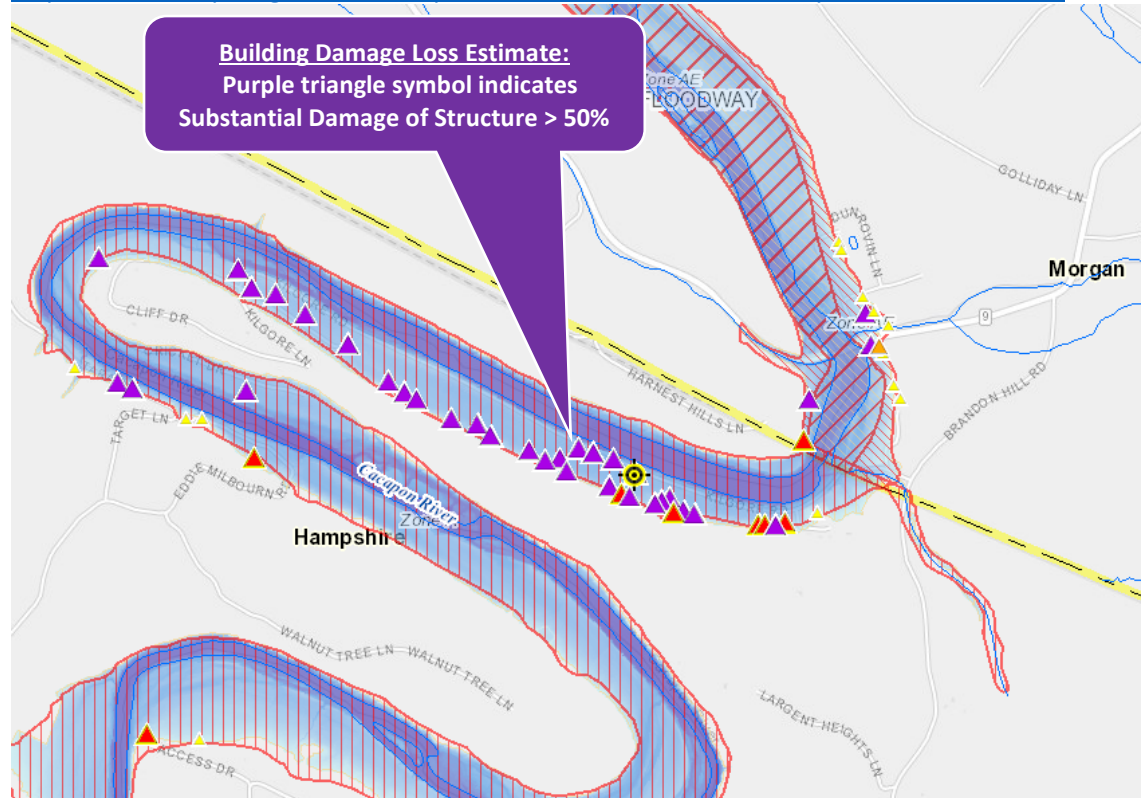
**Building Damage Estimate (100-YR Flood)**

- ▲ 50-100% (Substantial Damage)
- ▲ 10-50% (Moderate Damage)
- ▲ 1-10% (Slight Damage)
- ▲ <1% or No Depth Value



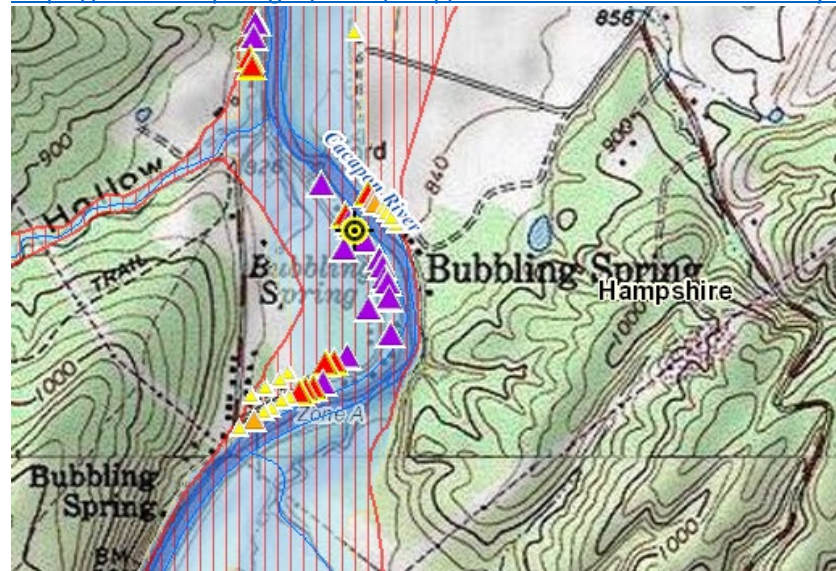
**Cacapon River** Zone A Cluster at Hampshire-Morgan County border. Detailed AE in Morgan County but not Hampshire County where density of vulnerable structures located in Zone A. Extend detailed study on Cacapon at Morgan-Hampshire county border south into Hardy County.

<https://www.mapwv.gov/flood/map/?wkid=102100&x=-8726461&y=4790357&l=8&v=2>



**Cacapon River** (Bubbling Spring - Hampshire County)

<https://www.mapwv.gov/flood/map/?wkid=102100&x=-8733549&y=4758133&l=8&v=2>

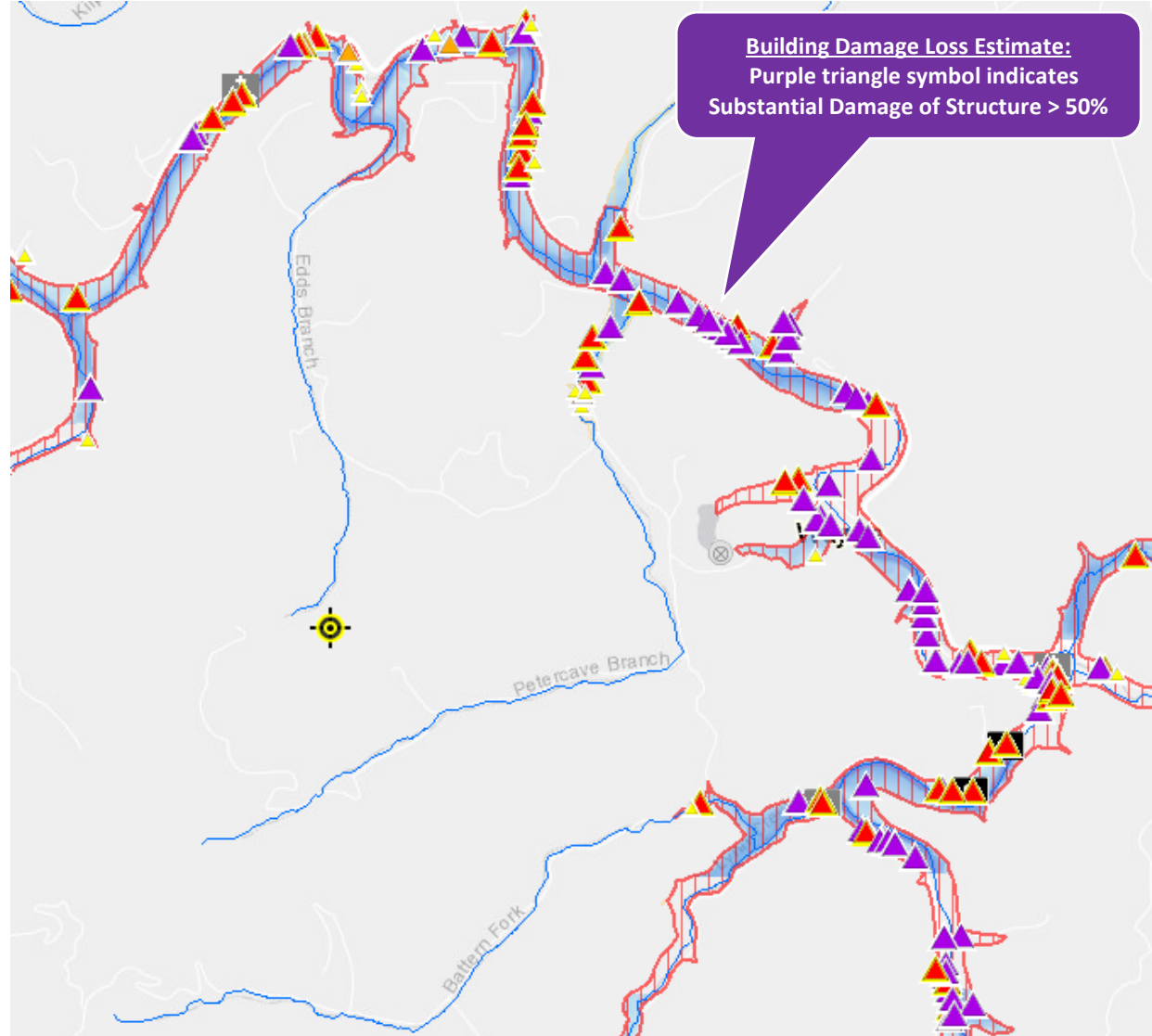




**East Fork Twelvepole Creek (Wayne County) Zone A Cluster**

<https://www.mapwv.gov/flood/map/?wkid=102100&x=-9172551&y=4605140&l=7&v=2>

Google Street View: <https://goo.gl/maps/VdmcqvGhgFkfWWCo9>



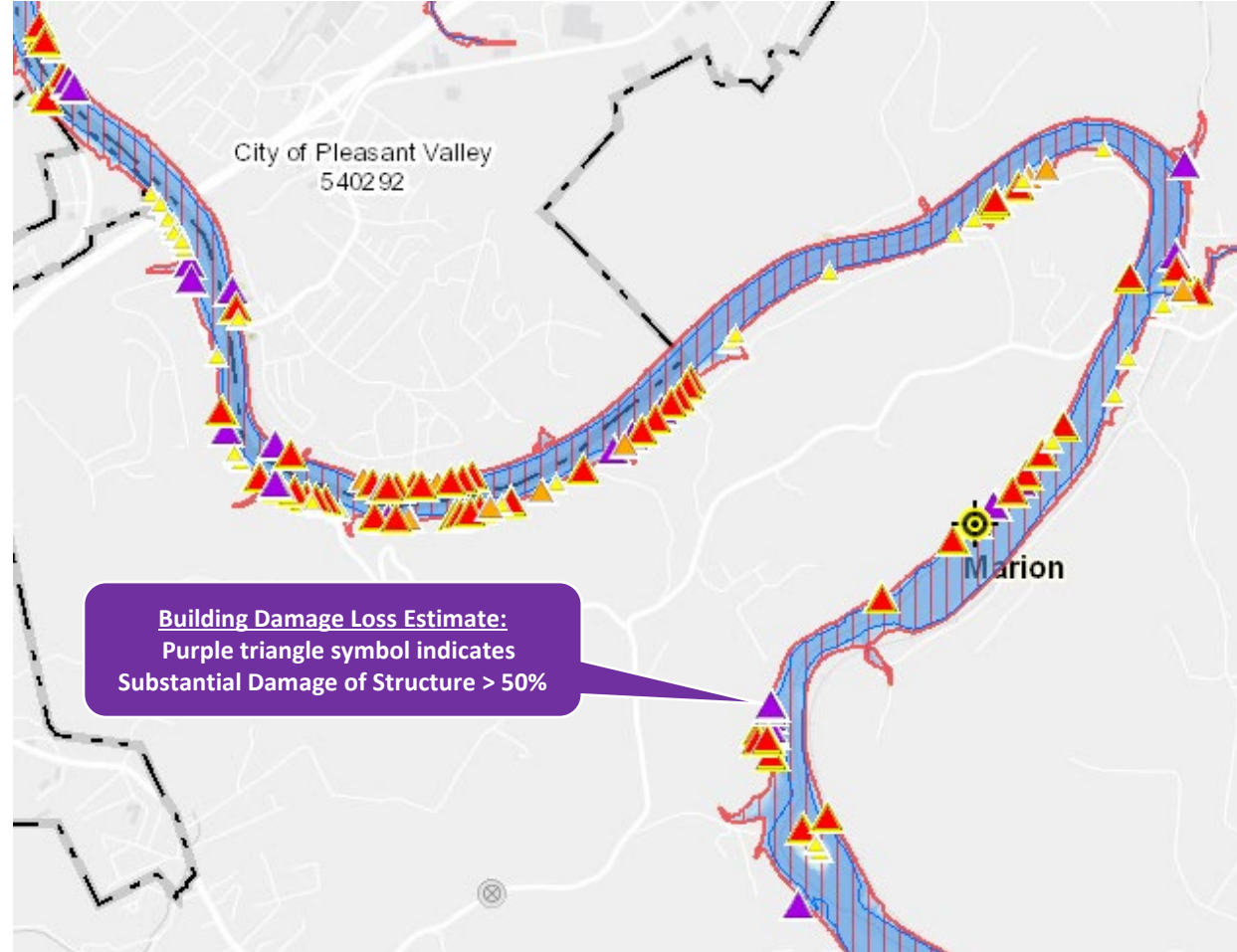
**Building Damage Estimate (100-YR Flood)**

- ▲ 50-100% (Substantial Damage)
- ▲ 10-50% (Moderate Damage)
- ▲ 1-10% (Slight Damage)
- ▲ <1% or No Depth Value



**Tygart Valley River (Marion County) Zone A Cluster**

<https://www.mapwv.gov/flood/map/?wkid=102100&x=-8921129&y=4783263&l=7&v=2>

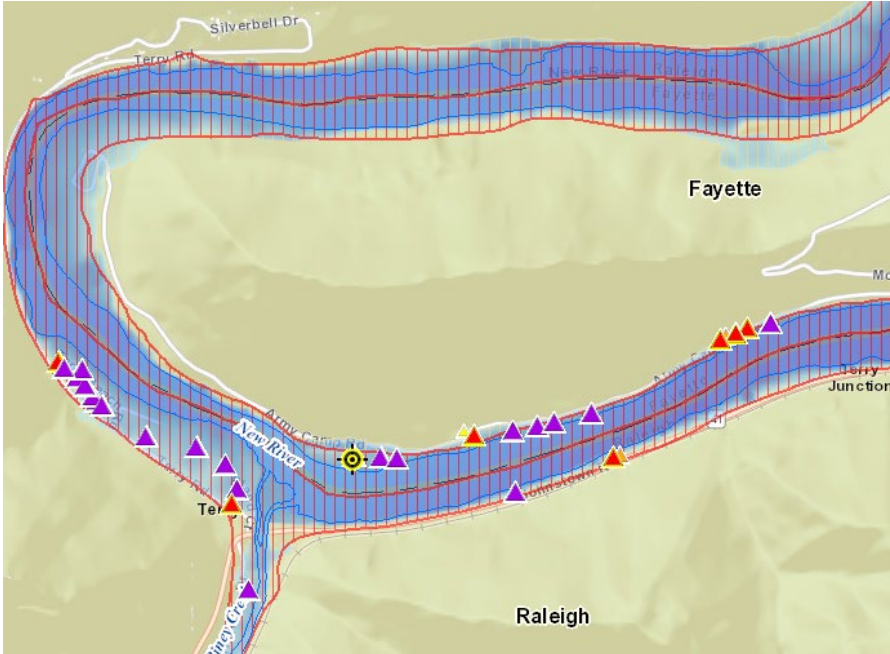


**Building Damage Estimate (100-YR Flood)**

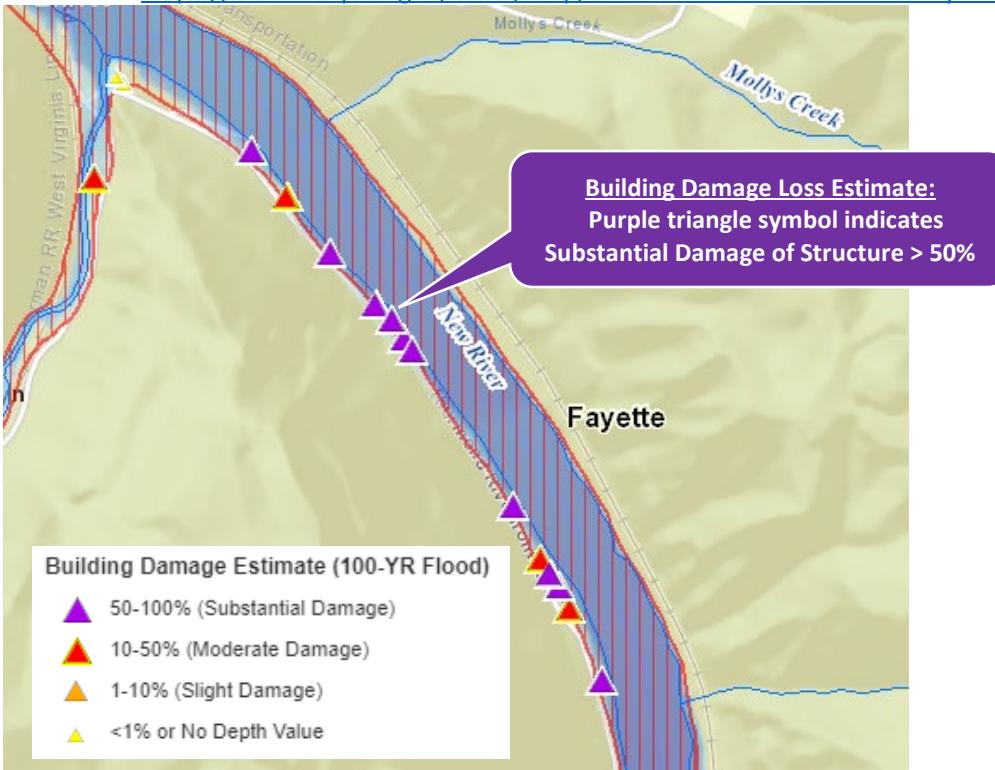
- ▲ 50-100% (Substantial Damage)
- ▲ 10-50% (Moderate Damage)
- ▲ 1-10% (Slight Damage)
- ▲ <1% or No Depth Value

### New River (Fayette-Raleigh County Border) Zone A Cluster

Location 1: <https://www.mapwv.gov/flood/map/?wkid=102100&x=-9026921&y=4558340&l=8&v=2>

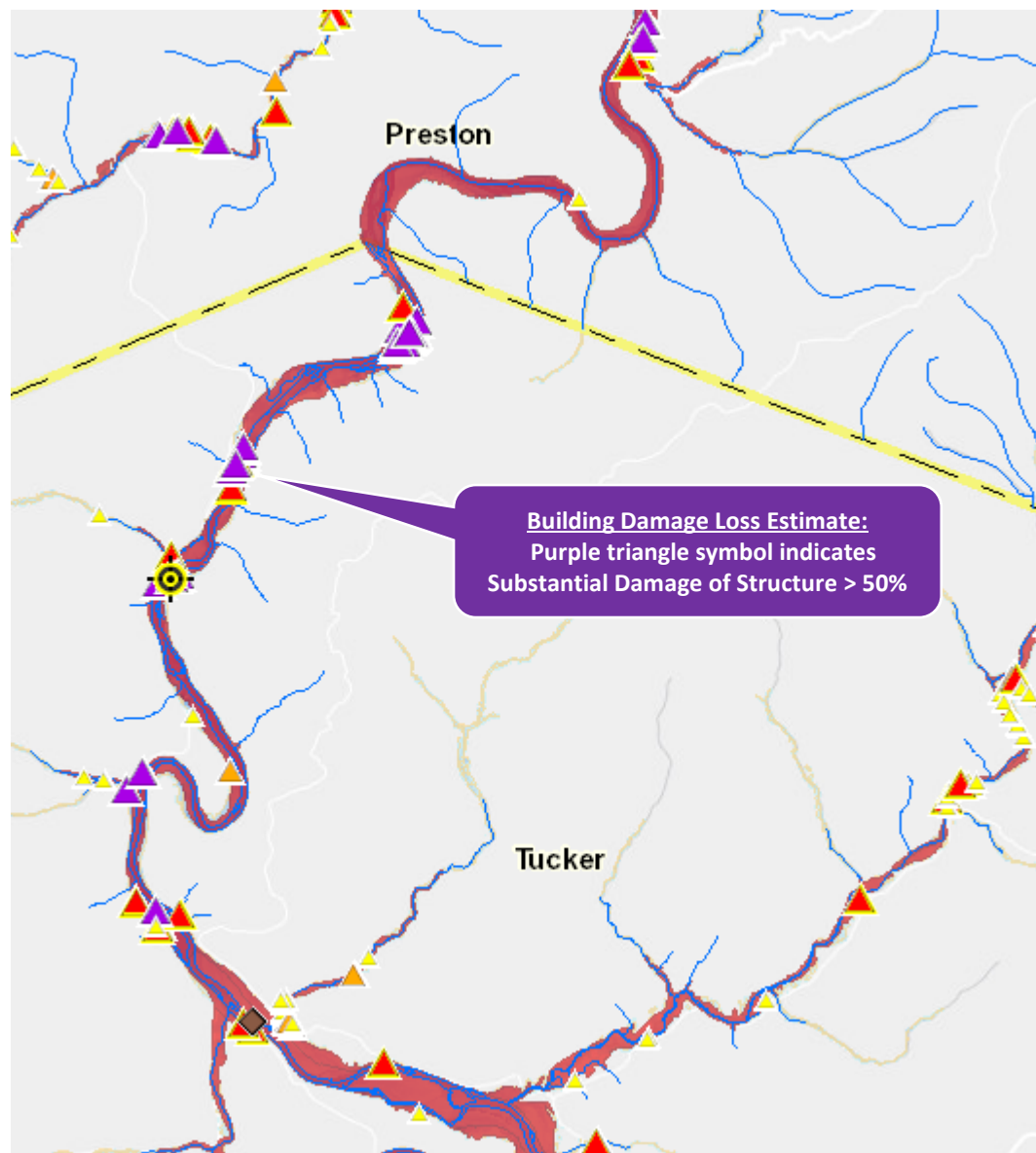


Location 2: <https://www.mapwv.gov/flood/map/?wkid=102100&x=-9024733&y=4572211&l=9&v=2>



Cheat River (Tucker County). Extend detailed study of Cheat River in Preston County southward into Tucker County.

<https://www.mapwv.gov/flood/map/?wkid=102100&x=-8874572&y=4754020&l=5&v=2>



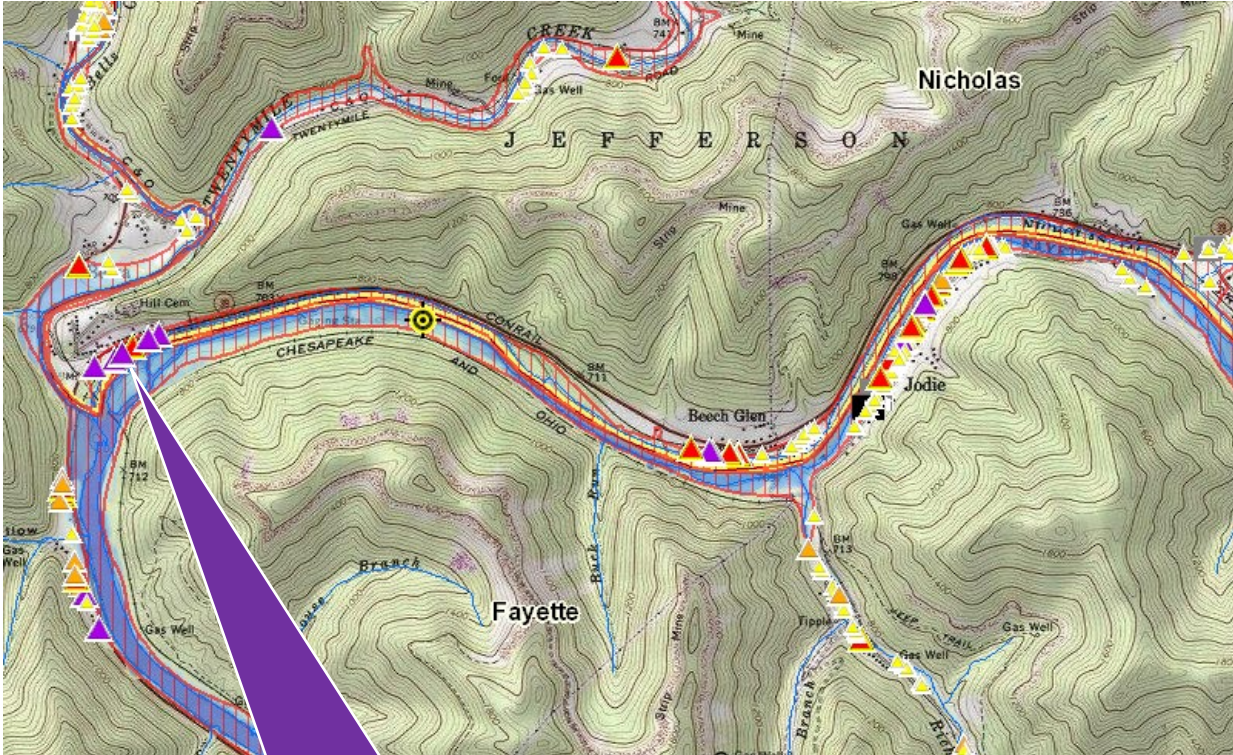
**Building Damage Estimate (100-YR Flood)**

- ▲ 50-100% (Substantial Damage)
- ▲ 10-50% (Moderate Damage)
- ▲ 1-10% (Slight Damage)
- ▲ <1% or No Depth Value



**Gauley River (Nicholas-Fayette County Border) Zone A Cluster**

<https://www.mapwv.gov/flood/map/?wkid=102100&x=-9036214&y=4612356&l=7&v=2>



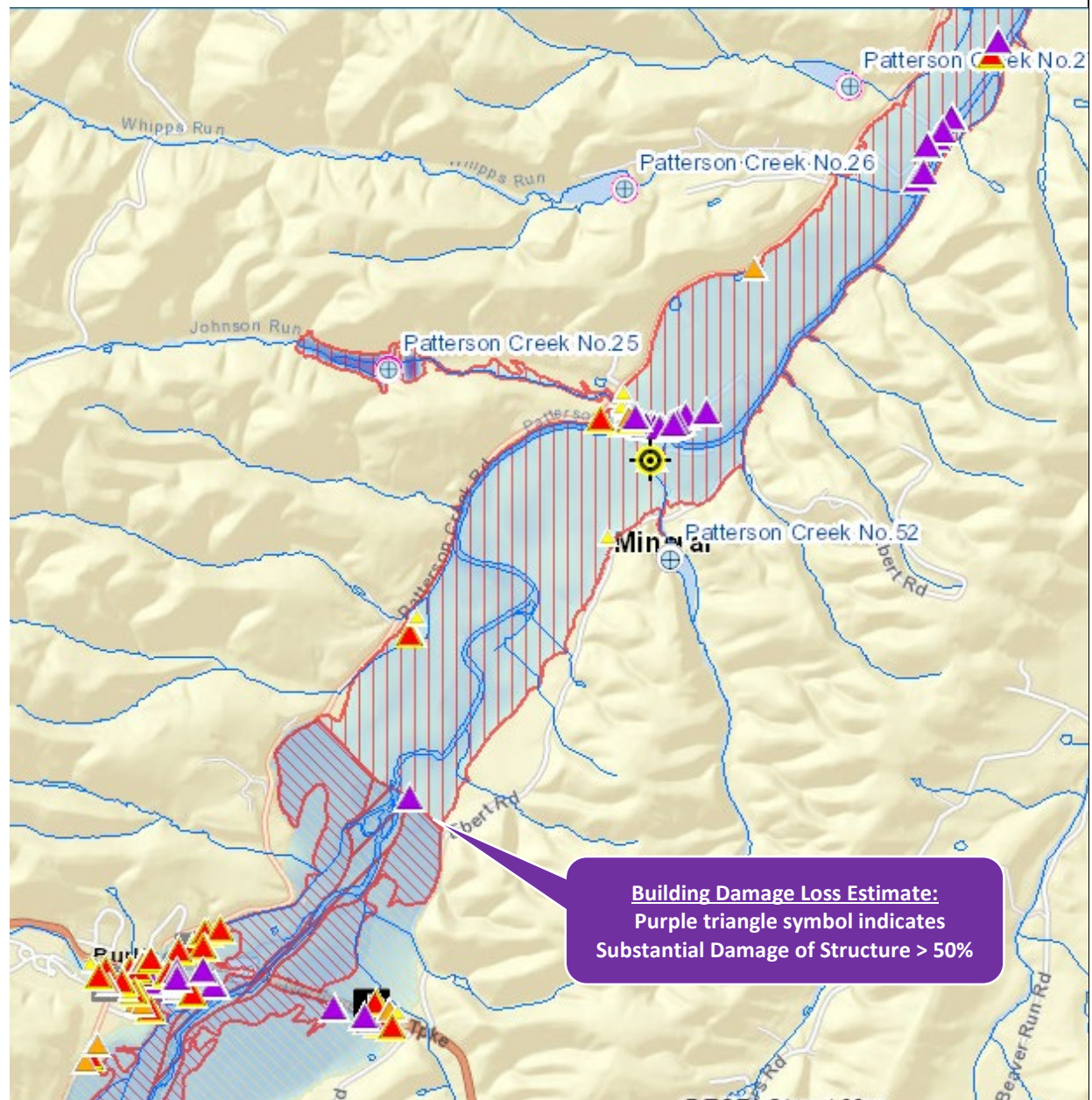
**Building Damage Loss Estimate:**  
Purple triangle symbol indicates  
Substantial Damage of Structure > 50%

**Building Damage Estimate (100-YR Flood)**

- ▲ 50-100% (Substantial Damage)
- ▲ 10-50% (Moderate Damage)
- ▲ 1-10% (Slight Damage)
- ▲ <1% or No Depth Value

**Patterson Creek (Mineral County) Zone A Cluster. Extend AE Zone northward**

<https://www.mapwv.gov/flood/map/?wkid=102100&x=-8782165&y=4772918&l=7&v=2>



**Building Damage Estimate (100-YR Flood)**

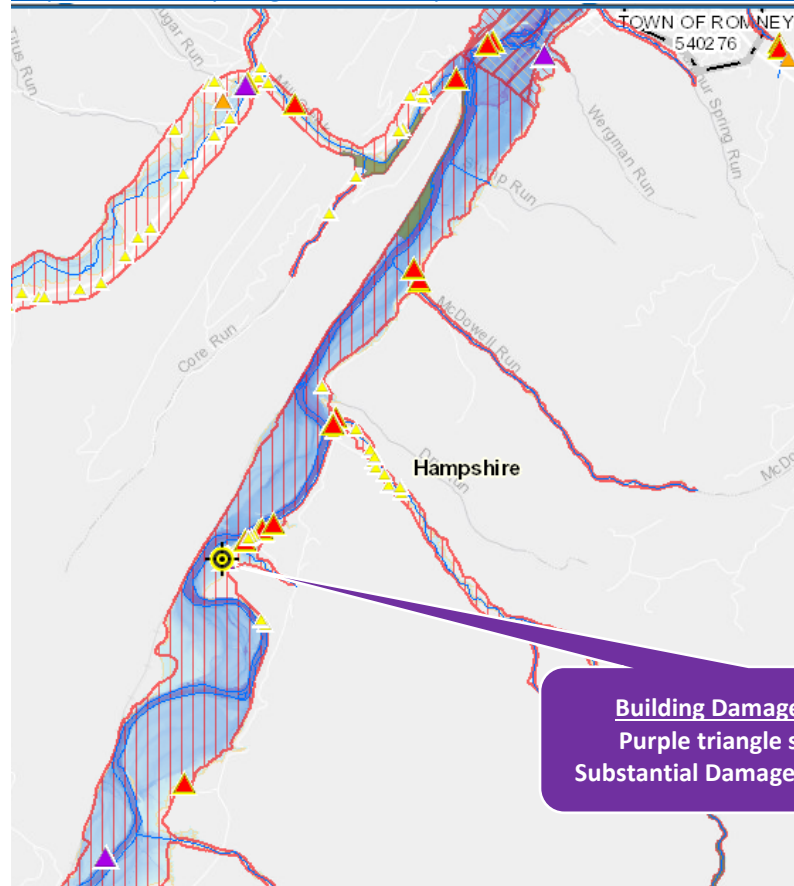
- ▲ 50-100% (Substantial Damage)
- ▲ 10-50% (Moderate Damage)
- ▲ 1-10% (Slight Damage)
- ▲ <1% or No Depth Value



### South Branch Potomac (Hampshire County) Zone A Cluster

Extend Detailed AE Zone south of Romney

<https://www.mapwv.gov/flood/map/?wkid=102100&x=-8773513&y=4763240&l=6&v=2>

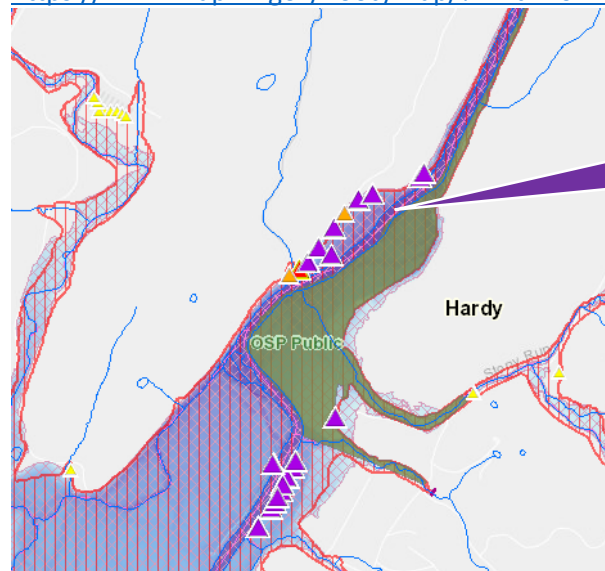


**Building Damage Loss Estimate:**  
Purple triangle symbol indicates  
Substantial Damage of Structure > 50%

### South Branch Potomac Zone A Cluster

Location 2: Hardy County (north of Moorefield)

<https://www.mapwv.gov/flood/map/?wkid=102100&x=-8785721&y=4741525&l=7&v=2>



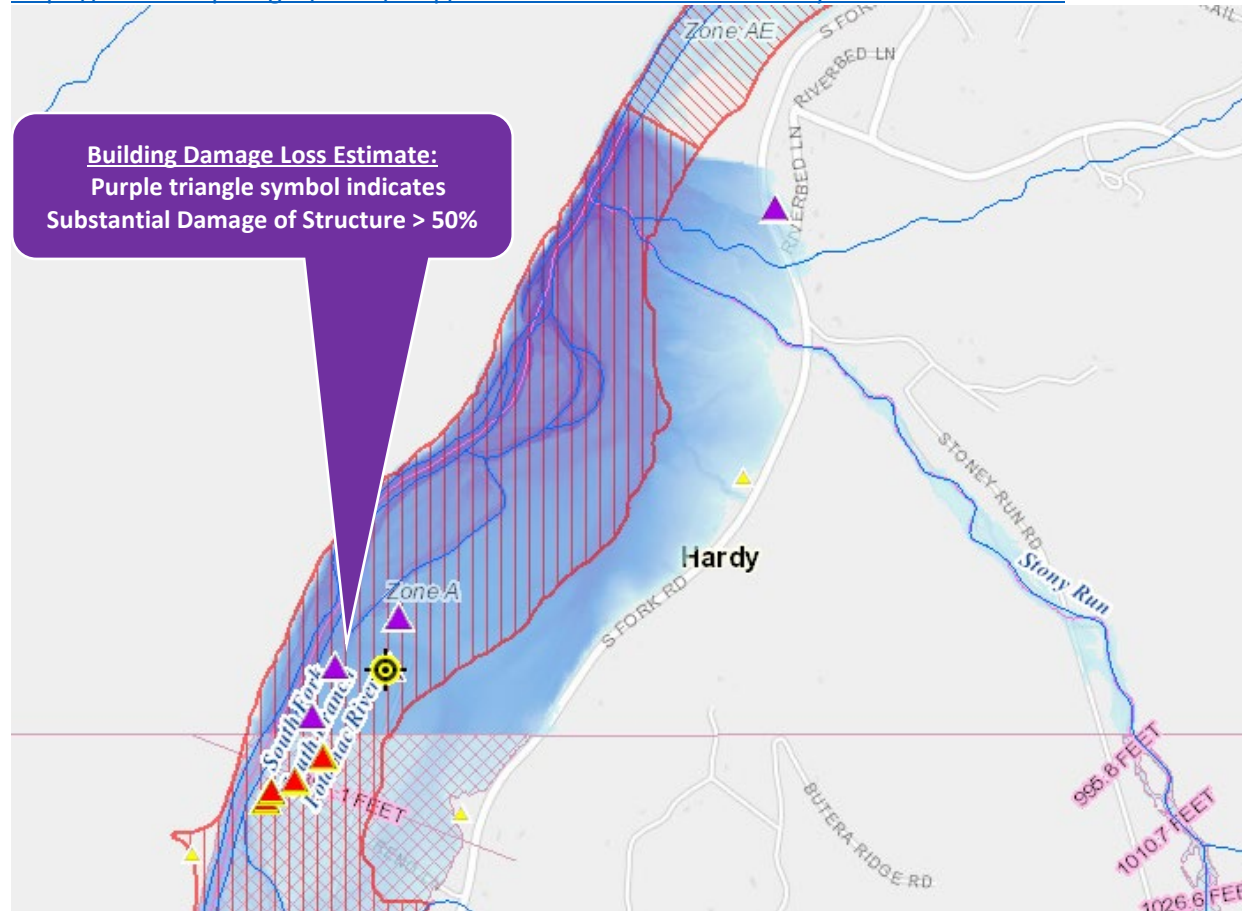
**Building Damage Loss Estimate:**  
Purple triangle symbol indicates  
Substantial Damage of Structure > 50%

#### Building Damage Estimate (100-YR Flood)

- ▲ 50-100% (Substantial Damage)
- ▲ 10-50% (Moderate Damage)
- ▲ 1-10% (Slight Damage)
- ▲ <1% or No Depth Value

**South Fork of the South Branch Potomac River (Hardy County) Zone A Cluster.** Unfinished Draft NFHL study south of Moorefield because of certification of levees.

<https://www.mapwv.gov/flood/map/?wkid=102100&x=-8790188&y=4721848&l=8&v=2>



**Building Damage Estimate (100-YR Flood)**

- ▲ 50-100% (Substantial Damage)
- ▲ 10-50% (Moderate Damage)
- ▲ 1-10% (Slight Damage)
- ▲ <1% or No Depth Value



**Trace Creek (Mingo County) Zone A Cluster**

<https://www.mapwv.gov/flood/map/?wkid=102100&x=-9148646&y=4547355&l=9&v=2>

Google Street View: <https://goo.gl/maps/6chE1k5XsTFLyg22A>



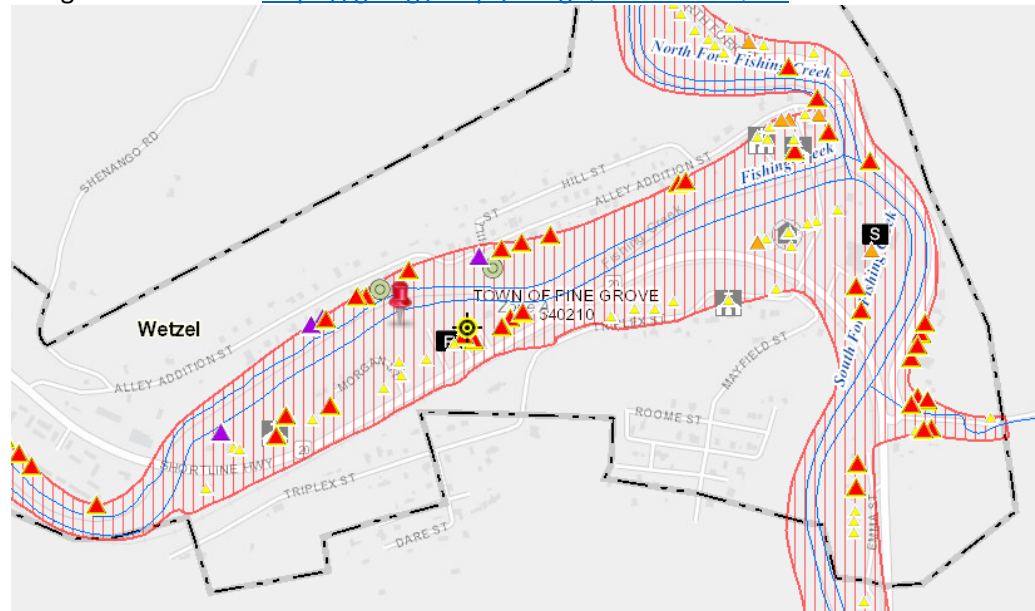
**Building Damage Estimate (100-YR Flood)**

- ▲ 50-100% (Substantial Damage)
- ▲ 10-50% (Moderate Damage)
- ▲ 1-10% (Slight Damage)
- ▲ <1% or No Depth Value





### Fishing Creek (Pine Grove, Wetzel County) Zone A Cluster

<https://www.mapwv.gov/flood/map/?wkid=102100&x=-8981728&y=4802636&l=9&v=2>

Google Street View: <https://goo.gl/maps/V9FgQH5bWcD9LQCZ6>



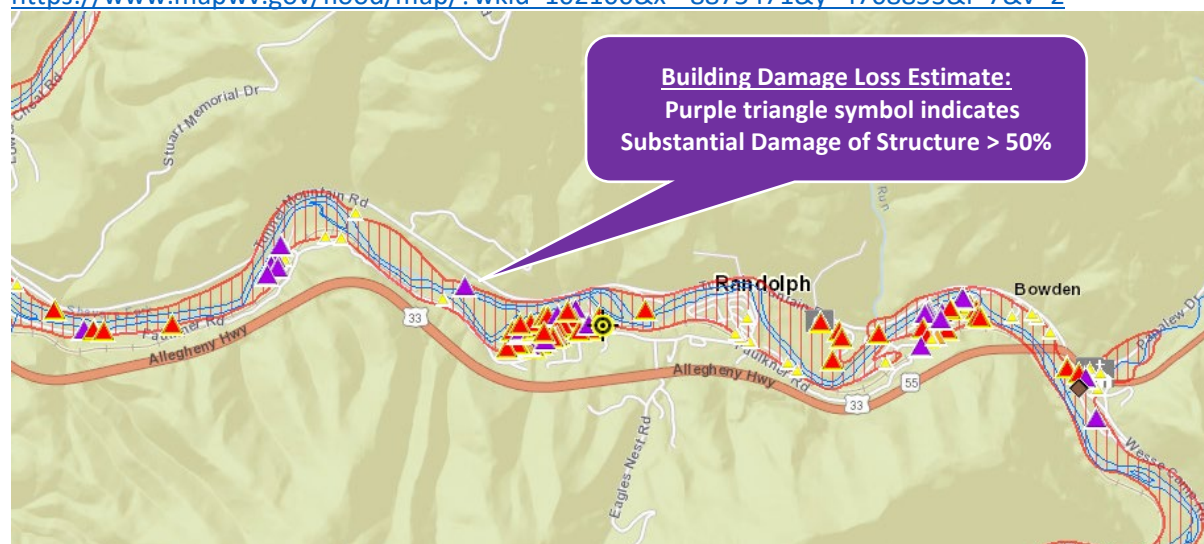
### Building Damage Estimate (100-YR Flood)

-  50-100% (Substantial Damage)
-  10-50% (Moderate Damage)
-  1-10% (Slight Damage)
-  <1% or No Depth Value



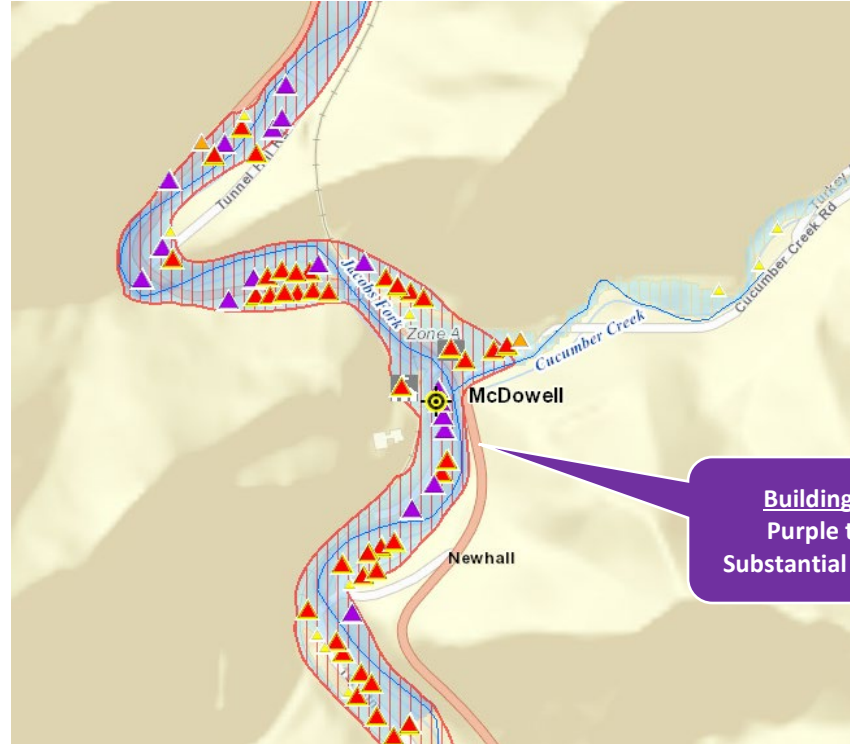
### Shavers Fork (Randolph County) Zone A Cluster

<https://www.mapwv.gov/flood/map/?wkid=102100&x=-8875471&y=4708853&l=7&v=2>



### Jacobs Fork (McDowell County) Zone A Cluster

<https://www.mapwv.gov/flood/map/?wkid=102100&x=-9085812&y=4476043&l=9&v=2>

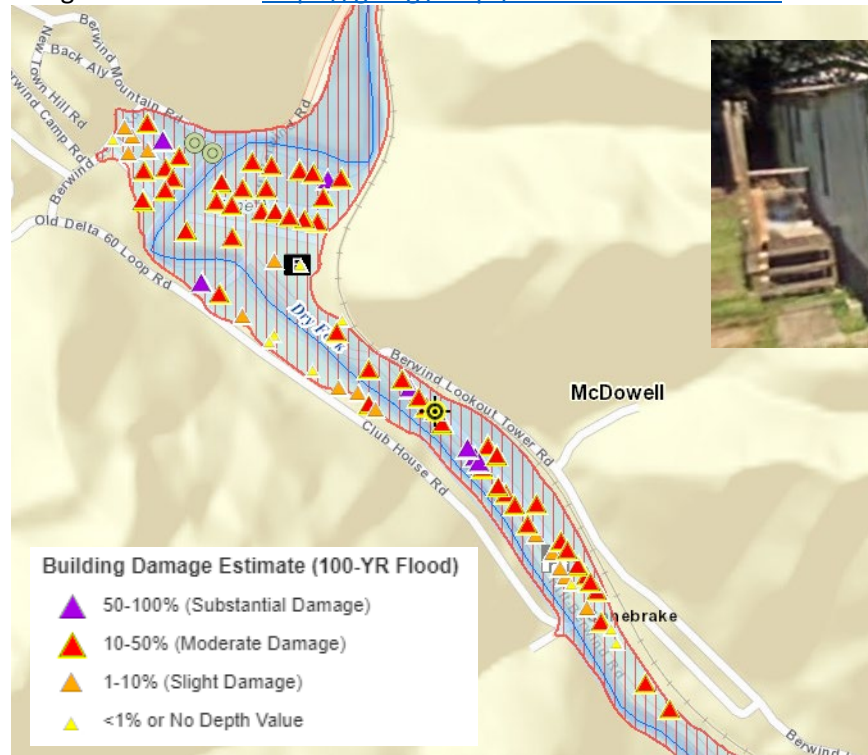


**Building Damage Loss Estimate:**  
Purple triangle symbol indicates  
Substantial Damage of Structure > 50%

### Dry Fork (McDowell County) Zone A Cluster

<https://www.mapwv.gov/flood/map/?wkid=102100&x=-9090459&y=4476268&l=9&v=2>

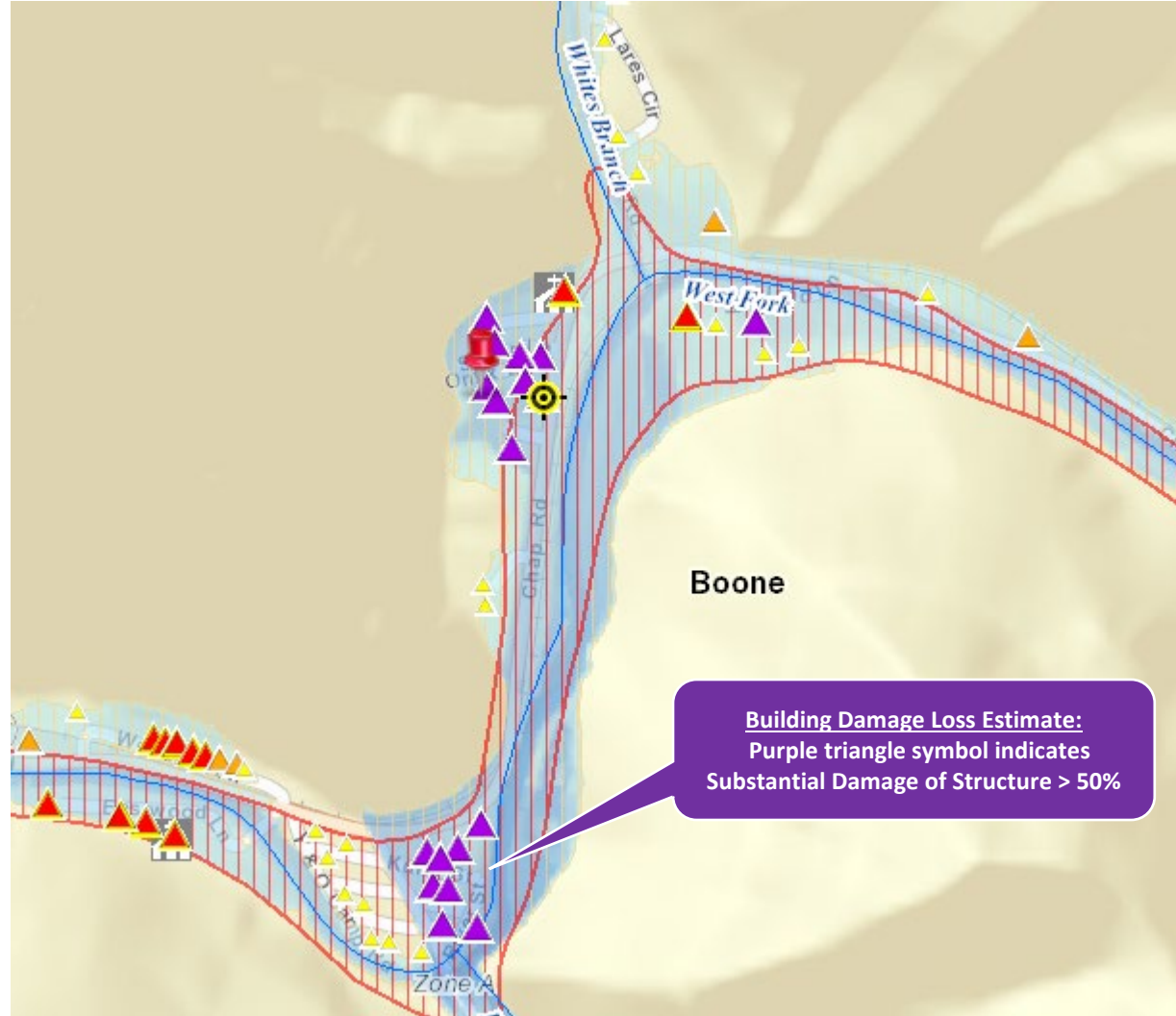
Google Street View: <https://goo.gl/maps/vMRBvDh14TeA1YXEA>





**West Fork (Boone County) Zone A Cluster**

<https://www.mapwv.gov/flood/map/?wkid=102100&x=-9094902&y=4575960&l=9&v=2>



**Building Damage Estimate (100-YR Flood)**

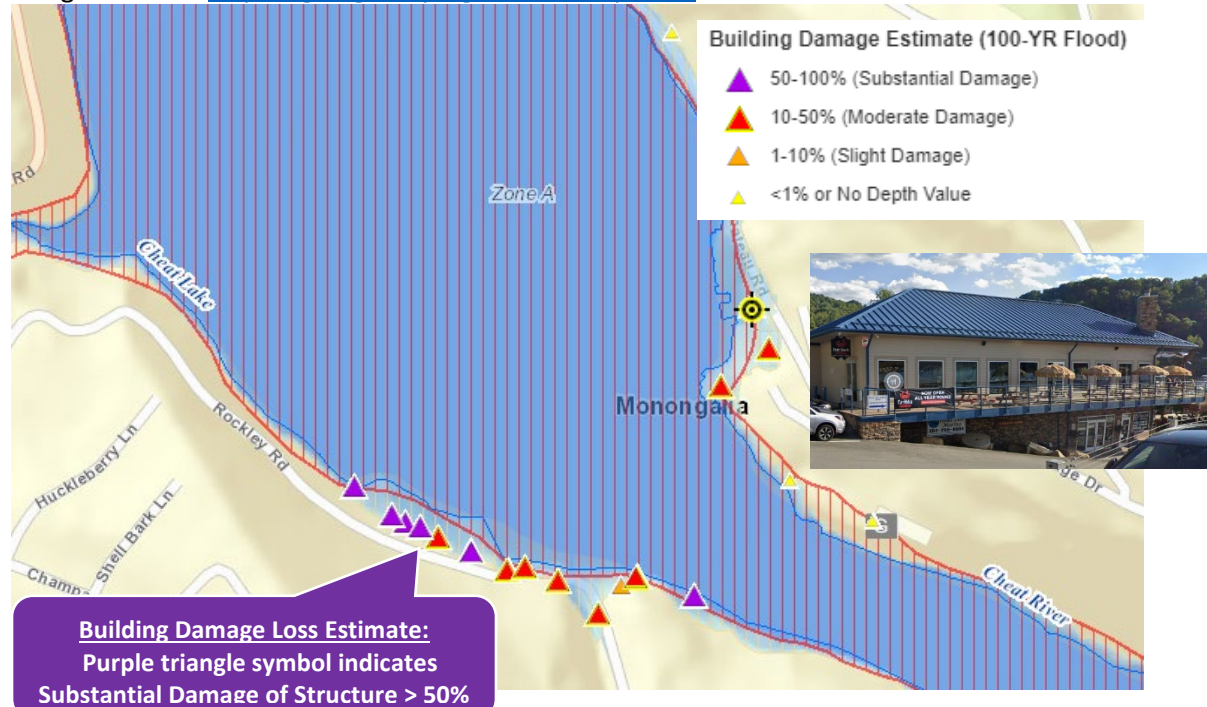
- ▲ 50-100% (Substantial Damage)
- ▲ 10-50% (Moderate Damage)
- ▲ 1-10% (Slight Damage)
- ▲ <1% or No Depth Value



**Cheat Lake** (Monongalia County) Zone A Cluster. Expensive homes and businesses surrounding Cheat Lake backwater showing risk in Effective/Advisory A flood zones. Flood source is the **Cheat River**.

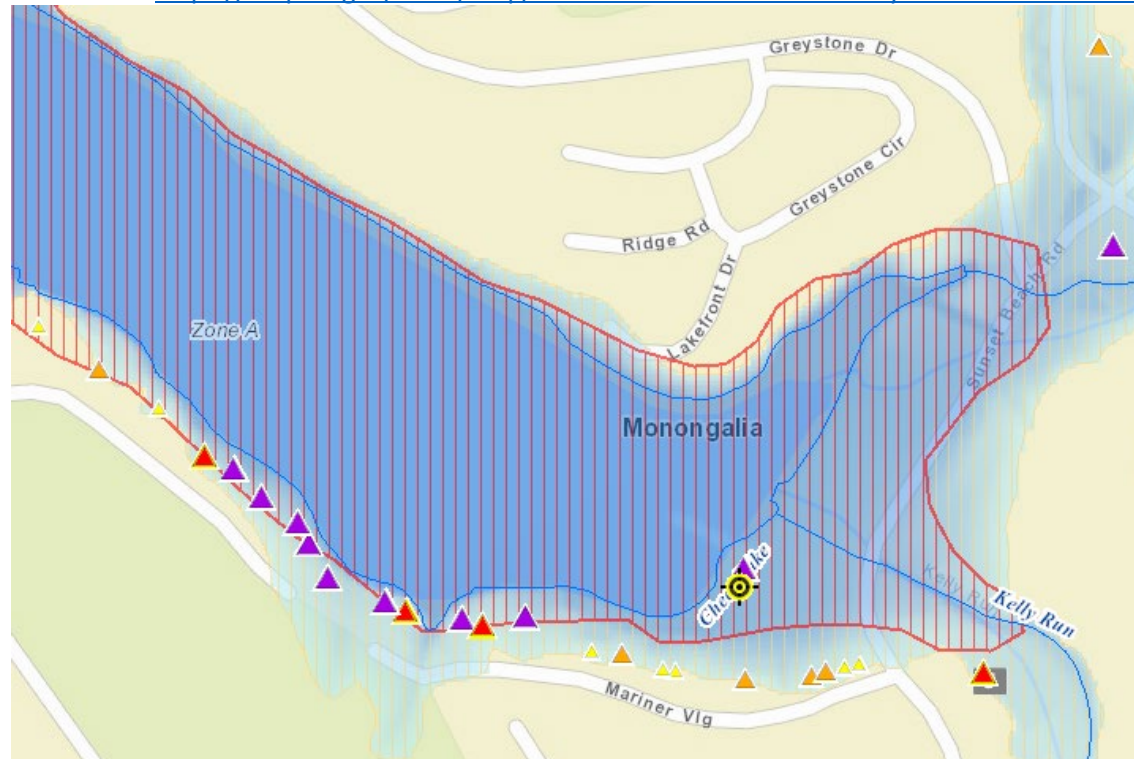
Location 1: <https://mapwv.gov/flood/map/?wkid=102100&x=-8888987&y=4816745&l=9&v=2>

Google Picture: <https://goo.gl/maps/gJLfo8dse7aqBNRJ6>



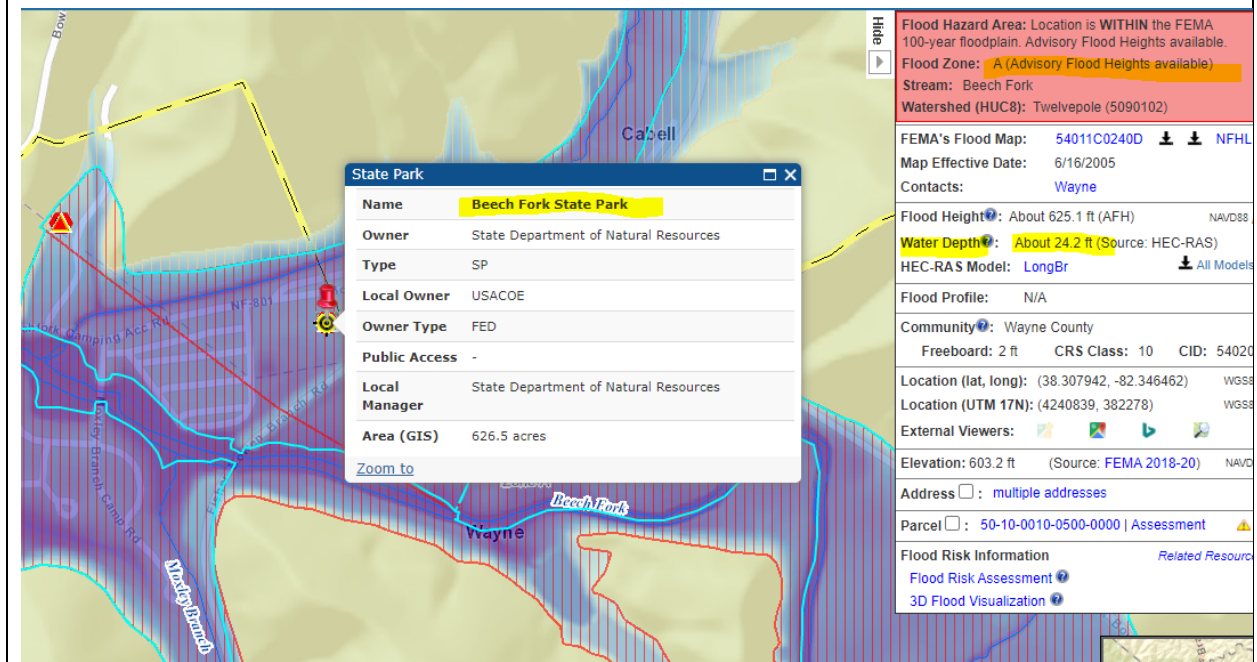
**Cheat Lake** (Monongalia County) Zone A Cluster. Structure in backwater of Lake Lynn Dam.

Location 2: <https://mapwv.gov/flood/map/?wkid=102100&x=-8889823&y=4819241&l=10&v=2>



**Beech Fork Lake** (Wayne County). High water flood depth in the A Zone backwater of Beech Fork Lake Dam for high-valued structure in State Park.

<https://mapwv.gov/flood/map/?wkid=102100&x=-9166766&y=4623020&l=9&v=2>



*Highest Building Flood Depth for Approximate A Zone Rivers/Streams.* Sorted on building flood depth. Click on Flood Tool map link to view location.

River/Stream Name	Flood Depth Value (ft.)	Web Link	County	Flood Depth Source	Hazard Occupancy Code	Building Exposure (\$)	Notes
Shenandoah River	33.0	<a href="#">FT</a>	JEFFERSON COUNTY	HEC-RAS	COM8	532,300	
South Branch Potomac	28.5	<a href="#">FT</a>	HARDY COUNTY	HEC-RAS	RES2	1,710	Low value. May not be a primary structure
Gauley River	24.3	<a href="#">FT</a>	FAYETTE COUNTY	HEC-RAS	RES1	9,000	Vacant building? Major building value drop from 2016 flood. See Assessment History.
Beech Fork	24.2	<a href="#">FT</a>	WAYNE COUNTY	HEC-RAS	GOV1	496,266	Mapping issue?
New River	20.6	<a href="#">FT</a>	FAYETTE COUNTY	HEC-RAS	RES1	18,100	
Cedar Run	20.0	<a href="#">FT</a>	JACKSON COUNTY	HAZUS	RES1	31,700	Mapping Issue (Hazus Depth Grid removed)
Tygart Valley River	20.0	<a href="#">FT</a>	TAYLOR COUNTY	HEC-RAS	GOV1	35,000	Pumping Station?
South Fork of the South Branch Potomac River	20.0	<a href="#">FT</a>	HARDY COUNTY	HEC-RAS	RES1	34,500	Cabin (elevated?)
Lower Right Fork	19.5	<a href="#">FT</a>	WAYNE COUNTY	HEC-RAS	RES1	7,700	
Cheat River	19.3	<a href="#">FT</a>	TUCKER COUNTY	HEC-RAS	RES2	13,000	
Trace Fork	18.3	<a href="#">FT</a>	MINGO COUNTY	HEC-RAS	RES1	106,100	
Pole Run	18.0	<a href="#">FT</a>	JACKSON COUNTY	HAZUS	RES1	46,100	Mapping Issue (Hazus Depth Grid removed)
Hughes River	18.0	<a href="#">FT</a>	WIRT COUNTY	HAZUS	RES1	33,400	Elevated?
Potomac River	17.8	<a href="#">FT</a>	JEFFERSON COUNTY	HEC-RAS	RES1	59,600	
Coles Run	17.7	<a href="#">FT</a>	MONONGALIA COUNTY	HEC-RAS	COM8	305,810	
East Fork Twelvepole Creek	17.5	<a href="#">FT</a>	WAYNE COUNTY	HEC-RAS	RES2	12,000	Inhabitable?
Sandy Creek	17.4	<a href="#">FT</a>	TAYLOR COUNTY	HEC-RAS	RES1	216,600	
Crooked Creek	17.1	<a href="#">FT</a>	KANAWHA COUNTY	HEC-RAS	RES1	91,400	<a href="https://goo.gl/maps/ntR9DvwtEhnhcgDJ6">https://goo.gl/maps/ntR9DvwtEhnhcgDJ6</a>
Little Otter Creek	17.0	<a href="#">FT</a>	BRAXTON COUNTY	HAZUS	RES1	58,500	Hazus depth grid mapping issue
Hawes Run	17.0	<a href="#">FT</a>	PENDLETON COUNTY	HEC-RAS	RES1	158,100	
Cacapon River	16.4	<a href="#">FT</a>	HAMPSHIRE COUNTY	HEC-RAS	RES1	42,000	
Middle Fork River	16.0	<a href="#">FT</a>	UPSHUR COUNTY	HAZUS	RES2	52,100	Carport. Hazus depth grid
Laurel Run	15.9	<a href="#">FT</a>	RITCHIE COUNTY	HEC-RAS	RES1	1,400	Low value. May not be a primary structure.
Lynn Creek	15.6	<a href="#">FT</a>	WAYNE COUNTY	HEC-RAS	RES1	31,700	
Buckhannon River	15.4	<a href="#">FT</a>	BARBOUR COUNTY	HEC-RAS	REL1	118,920	
South Fork Hughes River	15.2	<a href="#">FT</a>	RITCHIE COUNTY	HEC-RAS	RES2	7,200	Carport
Turkey Run	15.0	<a href="#">FT</a>	JACKSON COUNTY	HAZUS	RES1	82,500	Hazus depth grid mapping issue
Greenbrier River (Lower Reach)	15.0	<a href="#">FT</a>	POCAHONTAS COUNTY	HAZUS	RES1	76,100	Farm