Weather 101

Damage Surveys and the Enhanced Fujita Scale

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NWS Nashville

Outline

- When do damage surveys occur?
- Tornado vs straight line winds
- Enhanced Fujita Scale history
- How to use the Enhanced Fujita Scale
- How tornadoes receive their rating

Post Storm Priorities

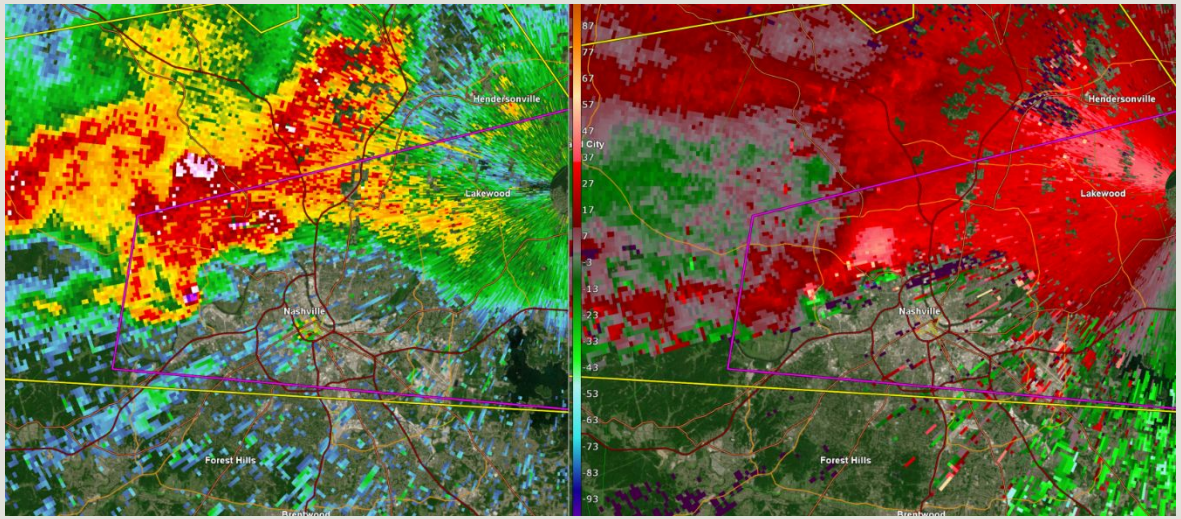
- Provide support to post storm recovery efforts
- Gather additional storm reports and follow up on significant damage reports
- Coordinate damage surveys with EMA
- Complete initial surveys and provide public statement
- Fulfill any media requests
- Perform post-event radar analysis and determine if any other surveys need to be completed

How is a Final Determination Made?

- The determination of whether damage was caused by a tornado and if so, the strength of the tornado, is made by considering all evidence

Eye Witness Reports +
Radar Evidence +
Damage Evidence =

Final Conclusion



Straight Line vs Tornado Damage

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  - Damage direction is unidirectional
  - Usually widespread with the exception of microbursts

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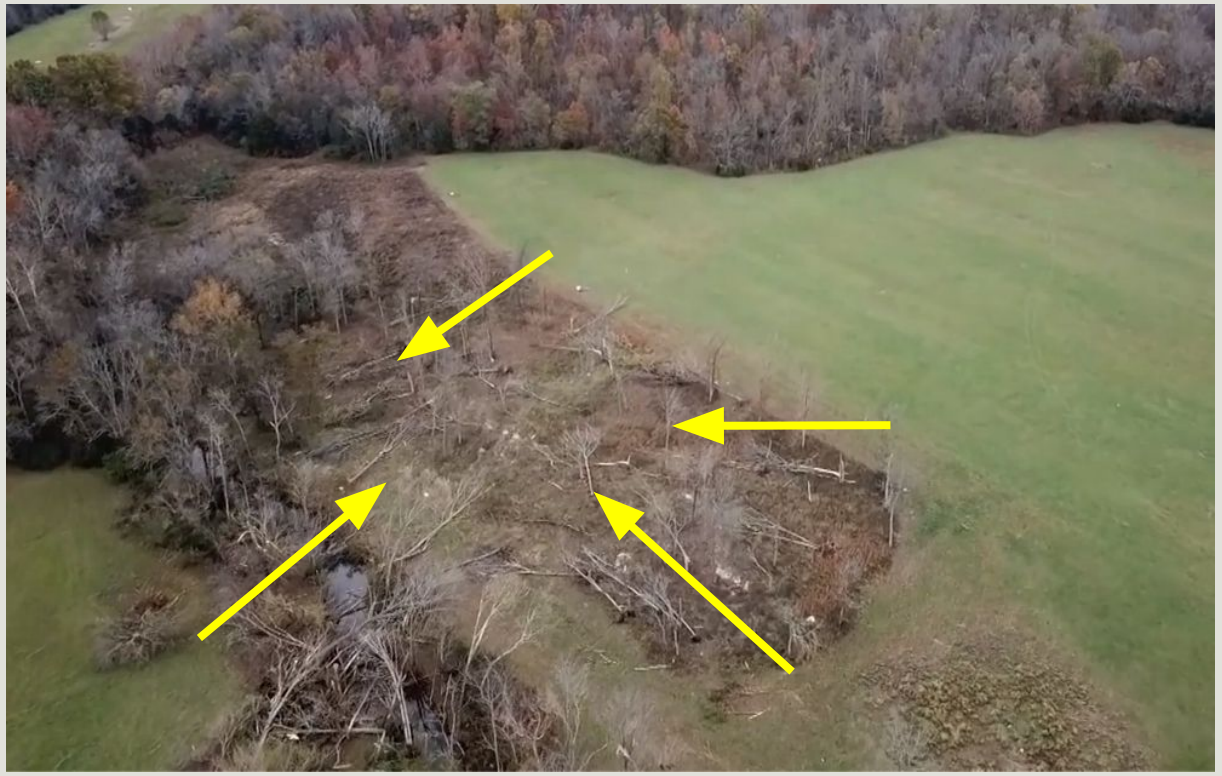
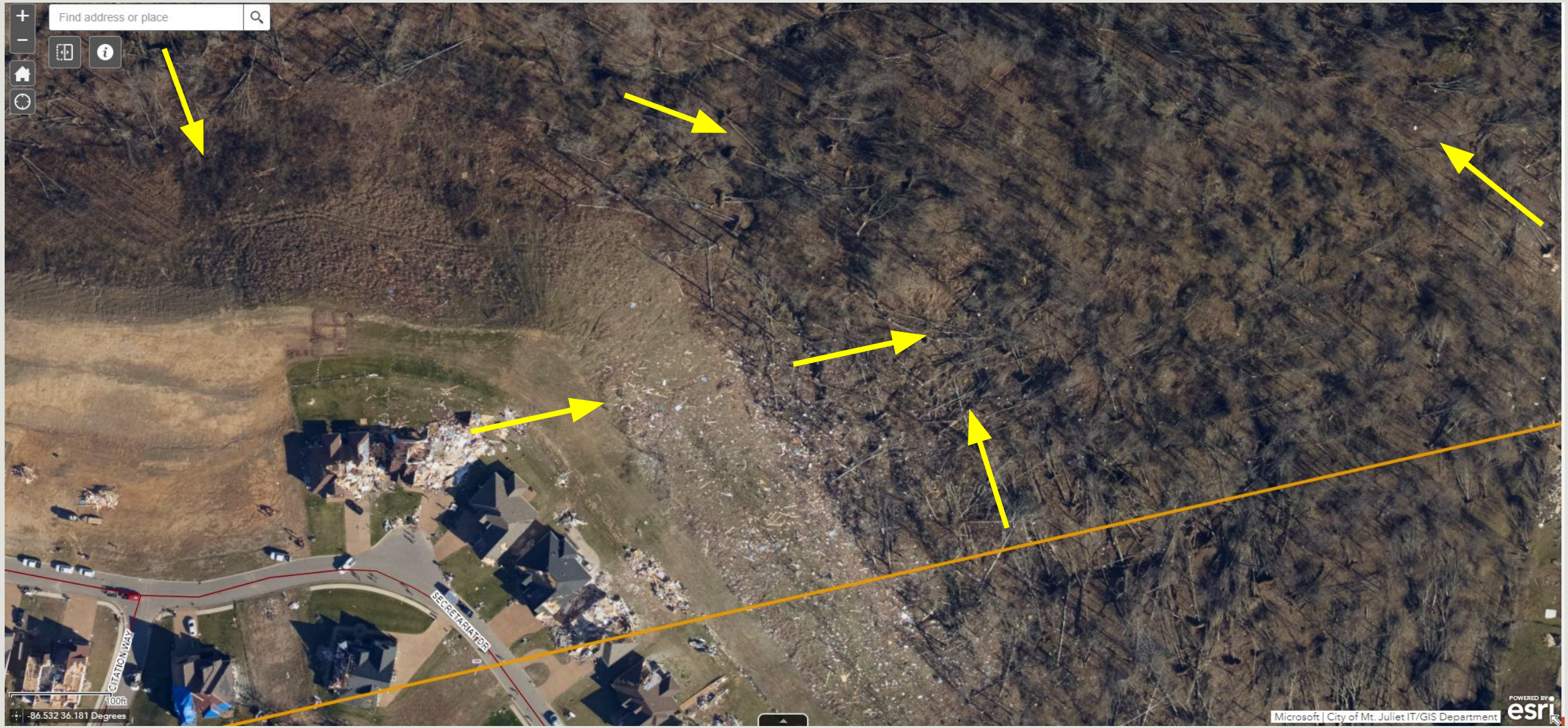
- Tornado Damage
  - Concentrated path of damage
  - Convergent damage pattern

Tornado



March 2-3, 2020- Damage Pattern



History of the Enhanced Fujita Scale

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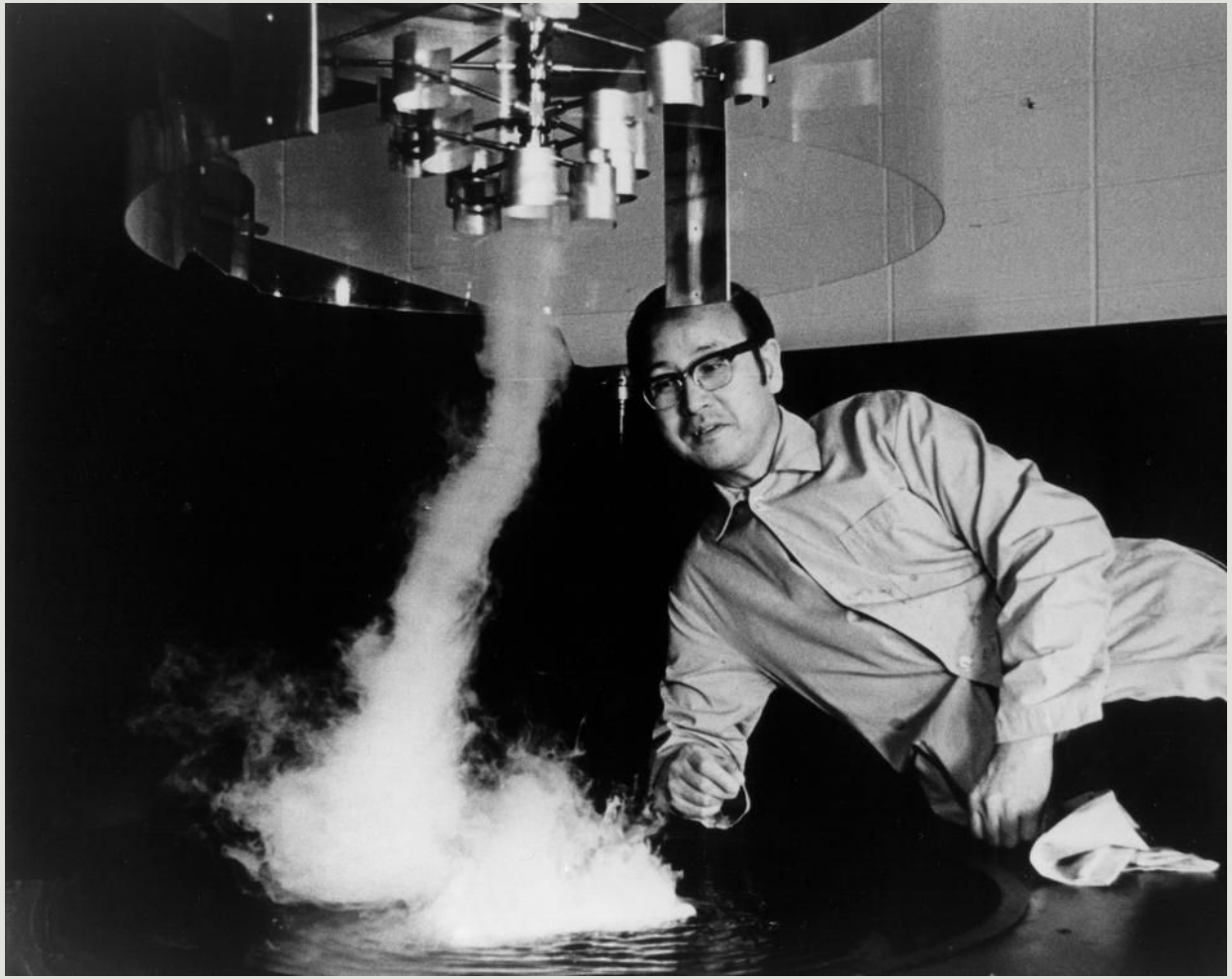

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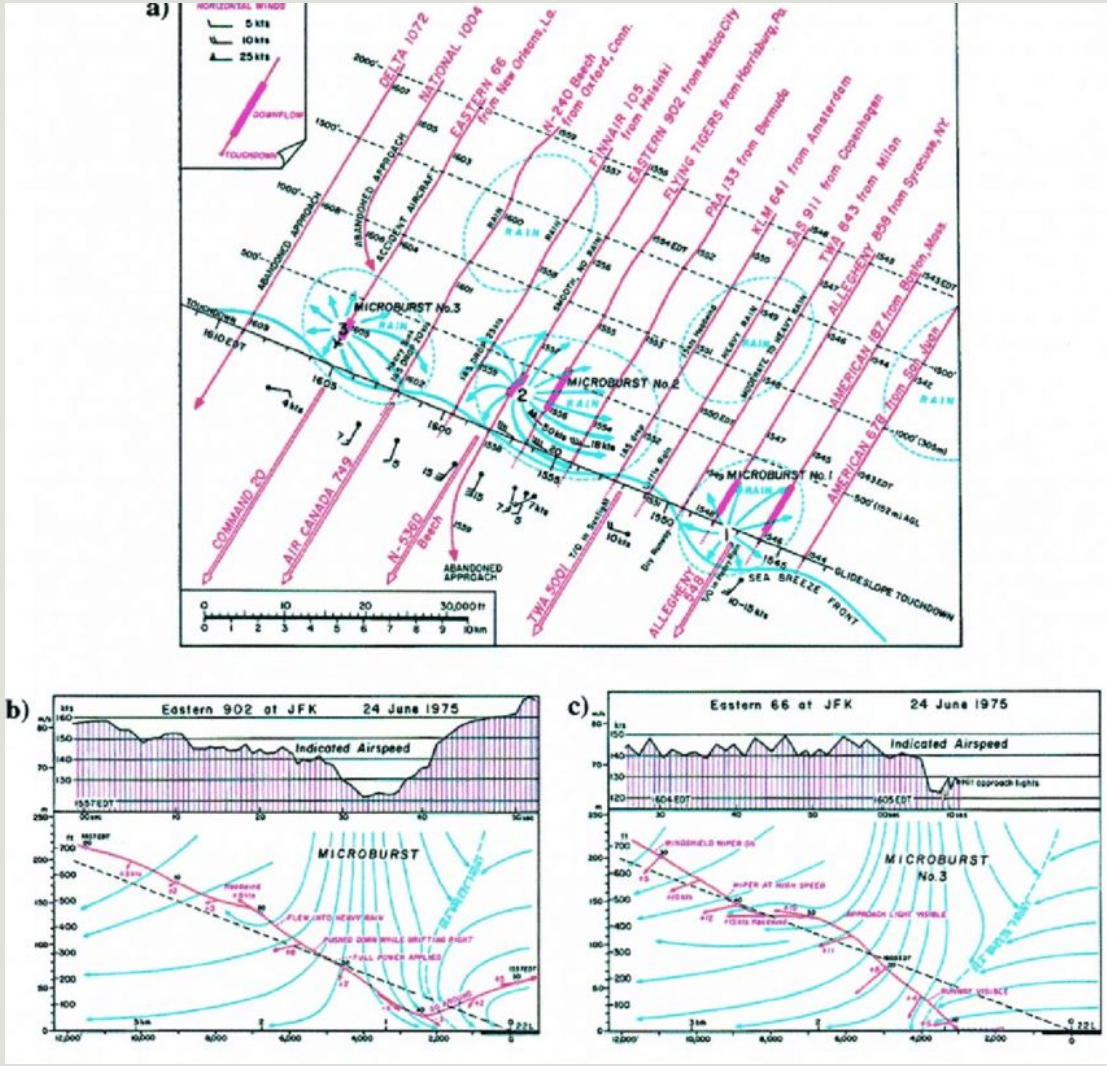

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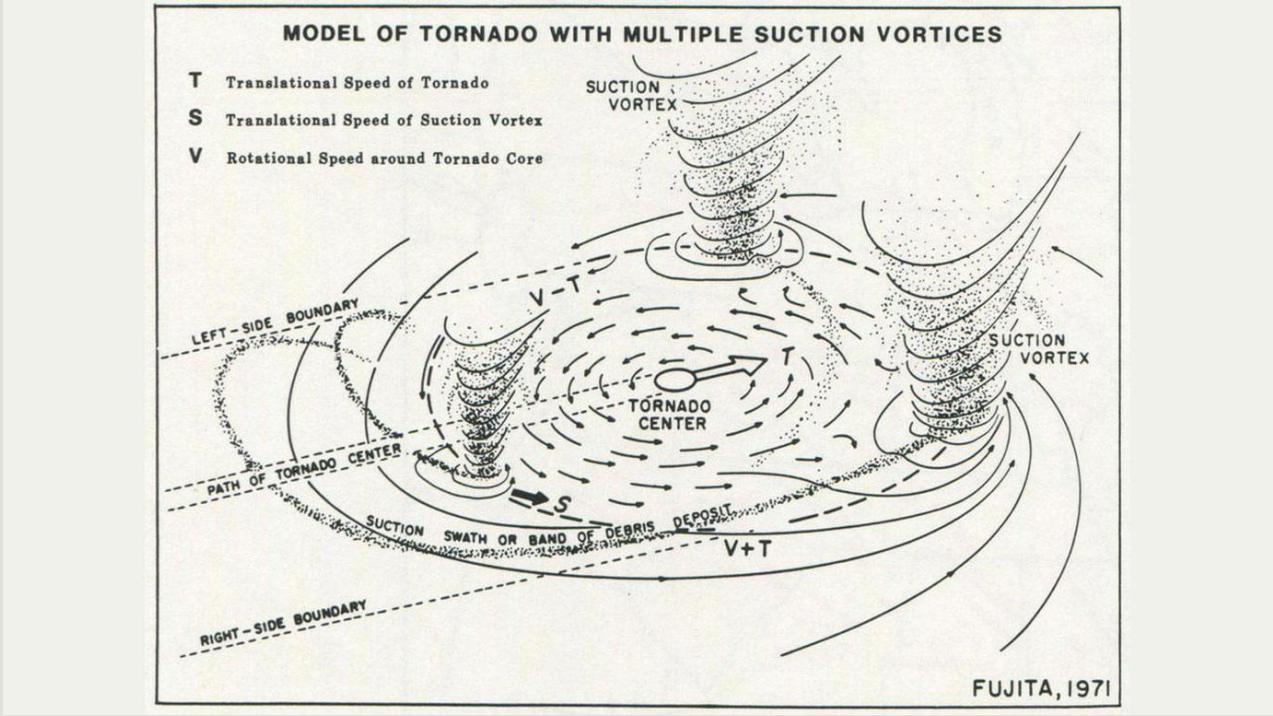
  - Developed a model for multi-vortex tornadoes



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- Fujita Scale became the official scale used in the U.S in the early 1970s
- Fujita Scale was updated to adjust wind speeds and renamed Enhanced Fujita Scale in 2007

Adjustment of the Fujita Scale

- Fujita scale was updated in 2007 by a team of meteorologists and engineers
- Original wind speeds were found to be too high
- Additional damage indicators were added
- Another update of the enhanced Fujita scale is expected in the next few years

FUJITA SCALE		
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)
0	40-72	45-78
1	73-112	79-117
2	113-157	118-161
3	158-207	162-209
4	208-260	210-261
5	261-318	262-317

OPERATIONAL EF SCALE	
EF Number	3 Second Gust (mph)
0	65-85
1	86-110
2	111-135
3	136-165
4	166-200
5	Over 200

How Does the Enhanced Fujita Scale Work?

- **The Enhanced Fujita Scale is a set of wind estimates based on damage**
- *Damage indicators*- What was damaged?

4. MANUFACTURED HOME – DOUBLE WIDE (MHDW)

Typical Construction

- Steel undercarriage supported on concrete block piers
- Multi-unit connection at roof, floor, and end walls
- Frame straps and ground anchors spaced at 10 – 12 ft apart
- Flat, gable, or hip roof shape
- Asphalt shingles or metal roof panels
- Plywood/OSB roof decking
- Wood rafter or shallow joist construction
- Metal, vinyl, or wood siding

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- *Degree of Damage*- How much damage was done?

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DOD*	Damage description
1	Threshold of visible damage
2	Loss of shingles or other roof covering (<20%)
3	Damaged porches or carports
4	Broken windows
5	Uplift of roof deck and loss of significant roof covering material (>20%)
6	Complete uplift of roof; most walls remain standing
7	Unit slides off CMU block piers
8	Removal of entire roof structure leaving most walls standing
9	Complete destruction of roof and walls leaving undercarriage in place
10	Unit rolls, displaces or vaults
11	Undercarriage separates from floor, rolls and tumbles, badly bent
12	Complete destruction of unit; debris blows away

How Does the Enhanced Fujita Scale Work?

- **The Enhanced Fujita Scale is a set of wind estimates based on damage**
- *Damage indicators*- What was damaged?
- *Degree of Damage*- How much damage was done?
- *Quality of Construction*- Is the construction what you expect?

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DOD*	Damage description	EXP	LB	UB
1	Threshold of visible damage	61	51	76
2	Loss of shingles or other roof covering (<20%)	76	62	88
3	Damaged porches or carports	78	67	96
4	Broken windows	83	68	95
5	Uplift of roof deck and loss of significant roof covering material (>20%)	88	75	108
6	Complete uplift of roof; most walls remain standing	93	77	110
7	Unit slides off CMU block piers	94	78	109
8	Removal of entire roof structure leaving most walls standing	97	80	117
9	Complete destruction of roof and walls leaving undercarriage in place	113	93	131
10	Unit rolls, displaces or vaults	114	82	130
11	Undercarriage separates from floor, rolls and tumbles, badly bent	127	109	145
12	Complete destruction of unit; debris blows away	134	119	154

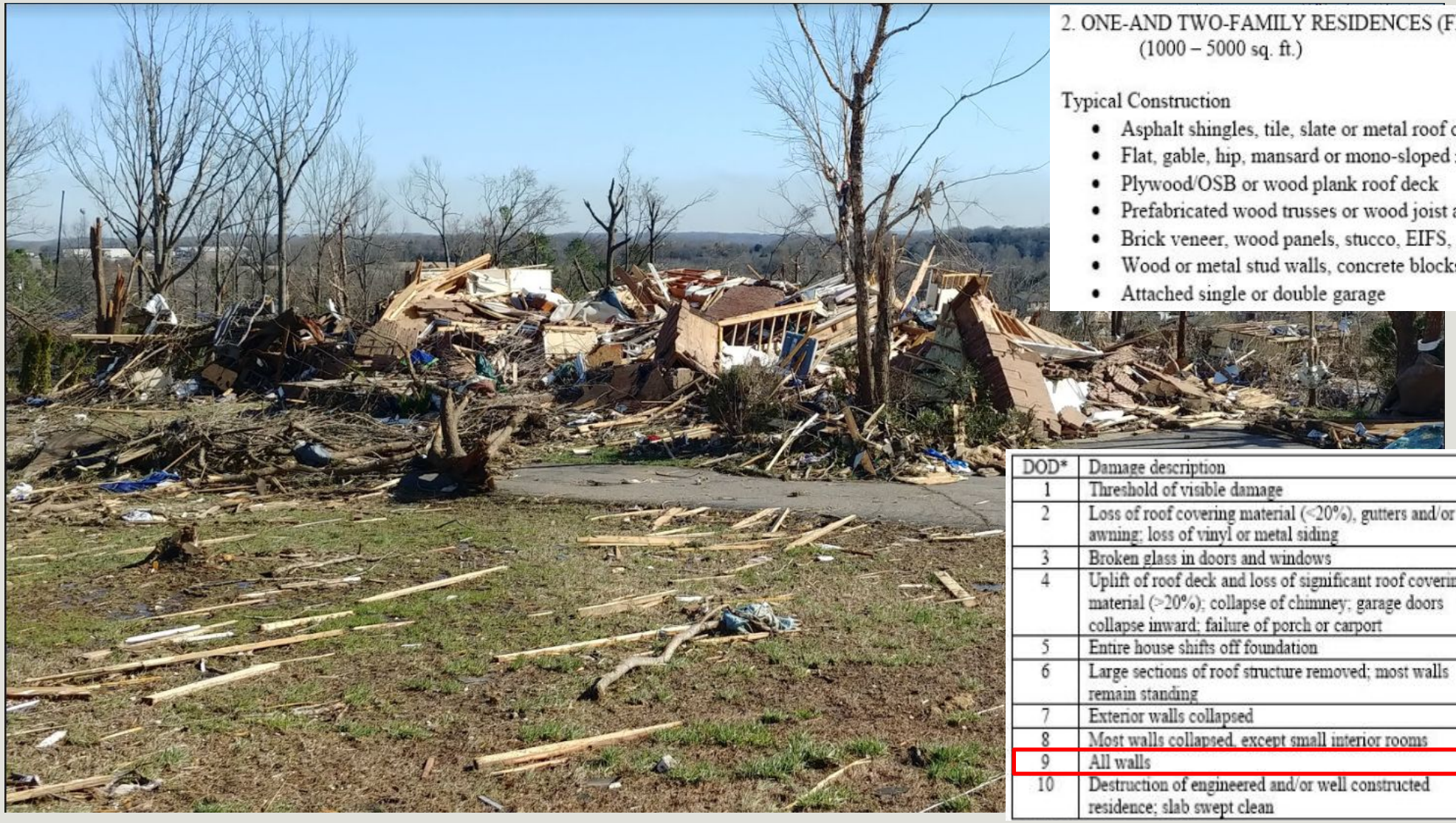
March 2-3, 2020 Survey- Residences

2. ONE-AND TWO-FAMILY RESIDENCES (FR12)
(1000 – 5000 sq. ft.)

Typical Construction

- Asphalt shingles, tile, slate or metal roof covering
- Flat, gable, hip, mansard or mono-sloped roof or combinations thereof
- Plywood/OSB or wood plank roof deck
- Prefabricated wood trusses or wood joist and rafter construction
- Brick veneer, wood panels, stucco, EIFS, vinyl or metal siding
- Wood or metal stud walls, concrete blocks or insulating-concrete panels
- Attached single or double garage

March 2-3, 2020 Survey- Residences



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DOD*	Damage description	EXP	LB	UB
1	Threshold of visible damage	65	53	80
2	Loss of roof covering material (<20%), gutters and/or awning; loss of vinyl or metal siding	79	63	97
3	Broken glass in doors and windows	96	79	114
4	Uplift of roof deck and loss of significant roof covering material (>20%); collapse of chimney; garage doors collapse inward; failure of porch or carport	97	81	116
5	Entire house shifts off foundation	121	103	141
6	Large sections of roof structure removed; most walls remain standing	122	104	142
7	Exterior walls collapsed	132	113	153
8	Most walls collapsed, except small interior rooms	152	127	178
9	All walls	170	142	198
10	Destruction of engineered and/or well constructed residence; slab swept clean	200	165	220

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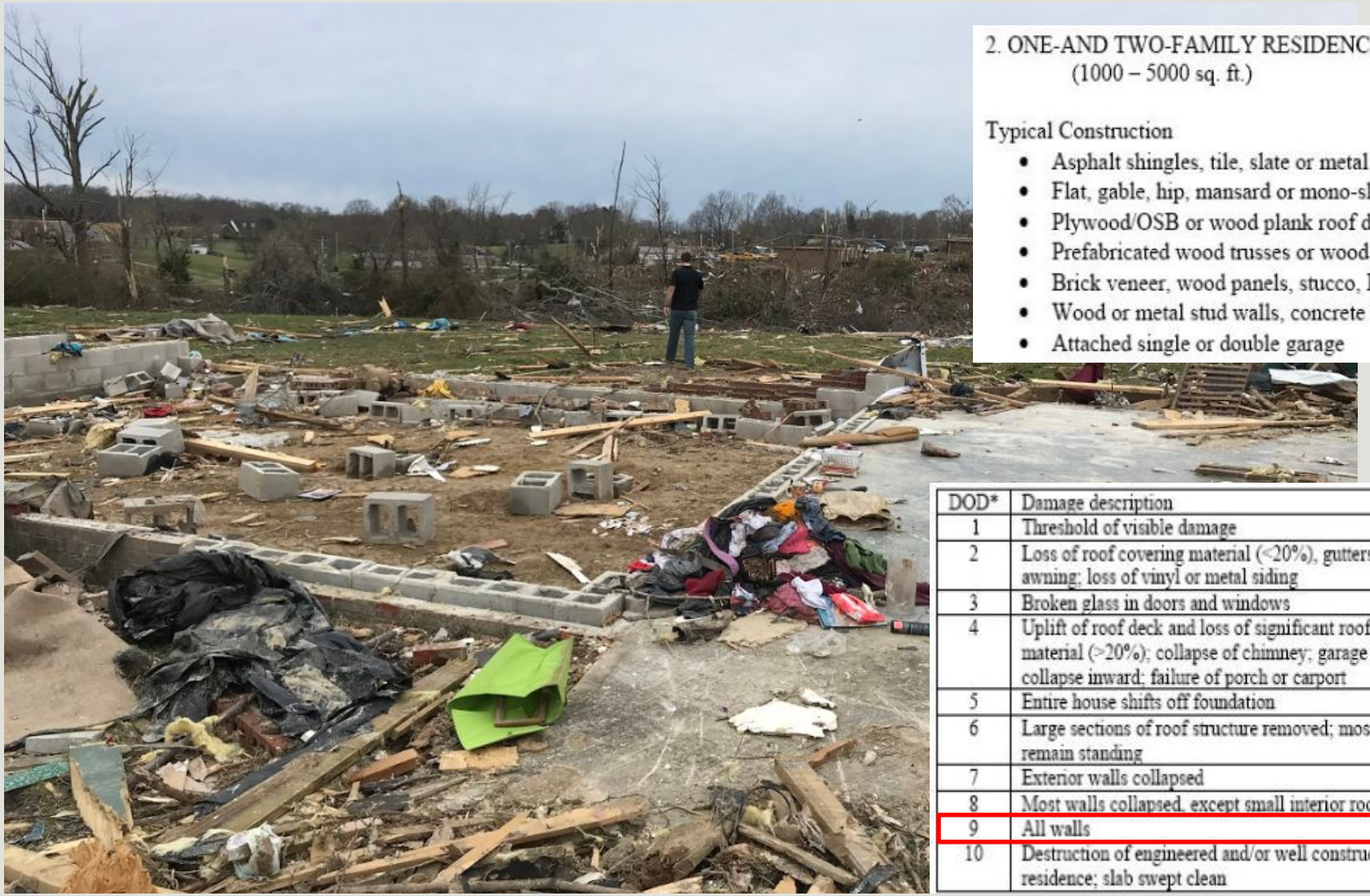

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March 2-3, 2020 Survey- Residences

3. MANUFACTURED HOMES – SINGLE WIDE (MHSW)

Typical Construction

- Steel undercarriage supported on concrete block piers
- Metal straps and ground anchors (Frame and/or over-the-top strap anchors
- Asphalt shingles or one-piece metal roof covering
- Wood roof joists
- Metal, vinyl, or wood siding
- Wood roof joists
- Wood stud walls and partitions
- Better construction in post 1974 models in coastal areas

DOD*	Damage description	EXP	LB	UB
1	Threshold of visible damage	61	51	76
2	Loss of shingles or partial uplift of one-piece metal roof covering	74	61	92
3	Unit slides off block piers but remains upright	87	72	103
4	Complete uplift of roof; most walls remain standing	89	73	112
5	Unit rolls on its side or upside down; remains essentially intact	98	84	114
6	Destruction of roof and walls leaving floor and undercarriage in place	105	87	123
7	Unit rolls or vaults; roof and walls separate from floor and undercarriage	109	96	128
8	Undercarriage separates from unit; rolls, tumbles and is badly bent	118	101	136
9	Complete destruction of unit; debris blown away	127	110	148

March 2-3, 2020 Survey- Trees

27. TREES: HARDWOOD

Typical Construction

- Hardwood: Oak, Maple, Birch, Ash

DOD*	Damage description	EXP	LB	UB
1	Small limbs broken (up to 1" diameter)	60	48	72
2	Large branches broken (1"-3" diameter)	74	61	88
3	Trees uprooted	91	76	118
4	Trunks snapped	110	93	134
5	Trees debarked with only stubs of largest branches remaining	143	123	167

March 2-3, 2020 Survey- Tree Construction?!

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March 2-3, 2020 Survey- Schools

15. ELEMENTARY SCHOOL (ES)

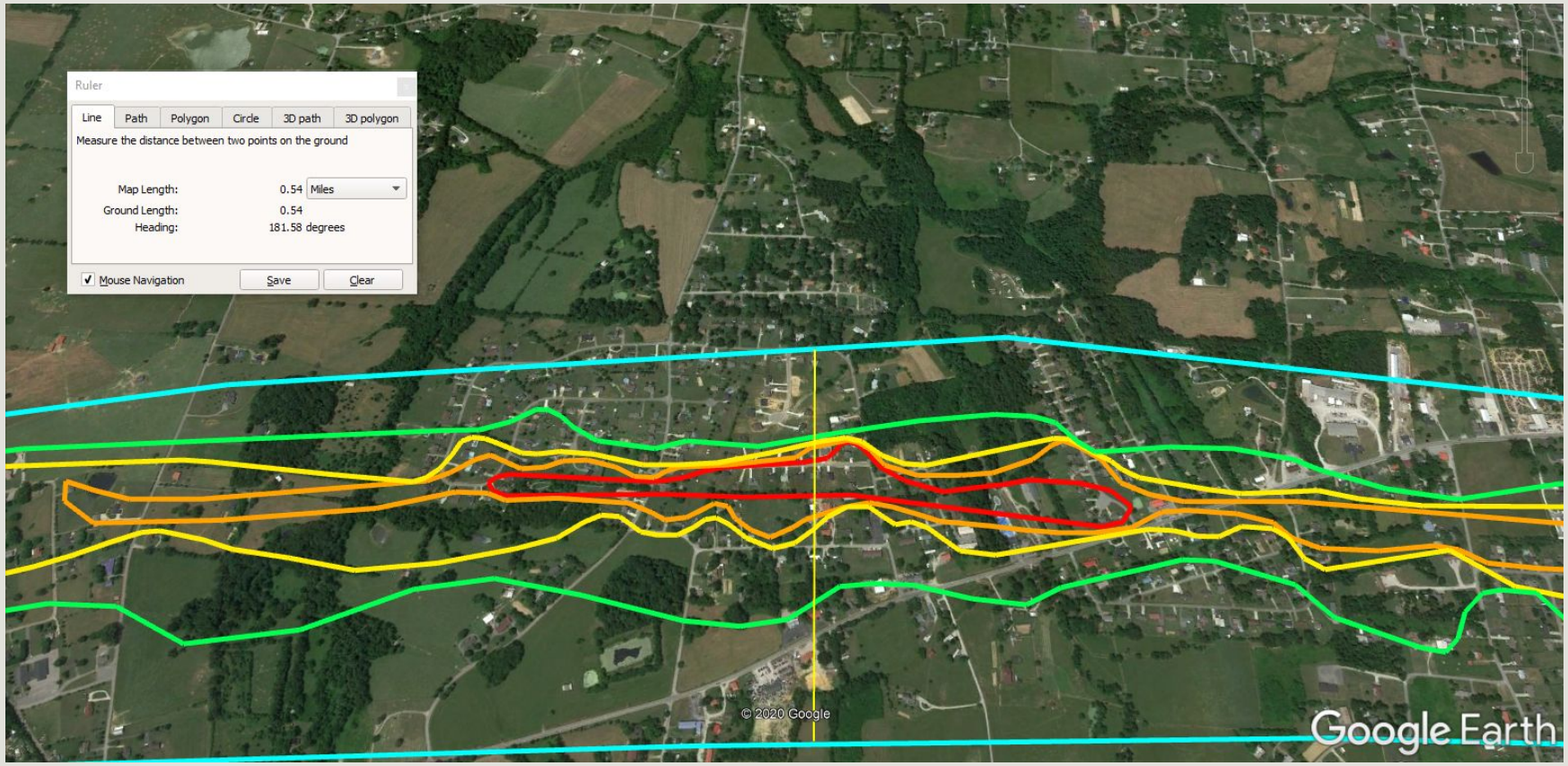
General Description

- These buildings are typically single story with flat roofs
- Building may contain a small gym or cafeteria with moderately long spans between supports
- Buildings have long interior hallways with bearing or non-bearing walls
- BUR, single-ply membrane, or metal standing seam roof panels
- Metal or plywood roof decking supporting a light-weight poured gypsum deck
- Roof structure consists of open web steel joists bearing on exterior walls and steel interior girders
- Exterior non-bearing walls constructed with CMUs, glass curtain walls or metal studs with brick veneer, stucco, or EIFS cladding
- CMU bearing walls with brick veneer, stucco, or EIFS cladding
- Walls can have a large percentage of window glass

DOD*	Damage description	EXP	LB	UB
1	Threshold of visible damage	65	47	80
2	Loss of roof covering (<20%)	79	66	99
3	Broken windows	87	71	106
4	Exterior door failures	99	85	118
5	Uplift of some roof decking; significant loss of roofing material (>20%); loss of rooftop HVAC	101	82	121
6	Damage to or loss of wall cladding	108	92	127
7	Uplift or collapse of roof structure	125	108	148
8	Collapse of non-bearing walls	139	117	162
9	Collapse of load-bearing walls	153	130	180
10	Total destruction of a large section of building or entire building	176	152	203

Determining Width and Strength of Tornado

- The strength assigned to a tornado path is the maximum strength through the entire track.
- The width of the tornado is the maximum width along the entire track.



March 3, 2020 Tornado Statistics

- Nashville Tornado
  - EF-3
  - Peak Winds: 165 mph
  - Path Length: 60.13 miles
  - Max Path Width: 1600 yards (0.91 miles)

- Cookeville Tornado
  - EF-4
  - Peak Winds: 175 mph
  - Path Length: 8.39 miles
  - Max Path Width: 900 yards (0.51 miles)

Impressions from Doing Surveys

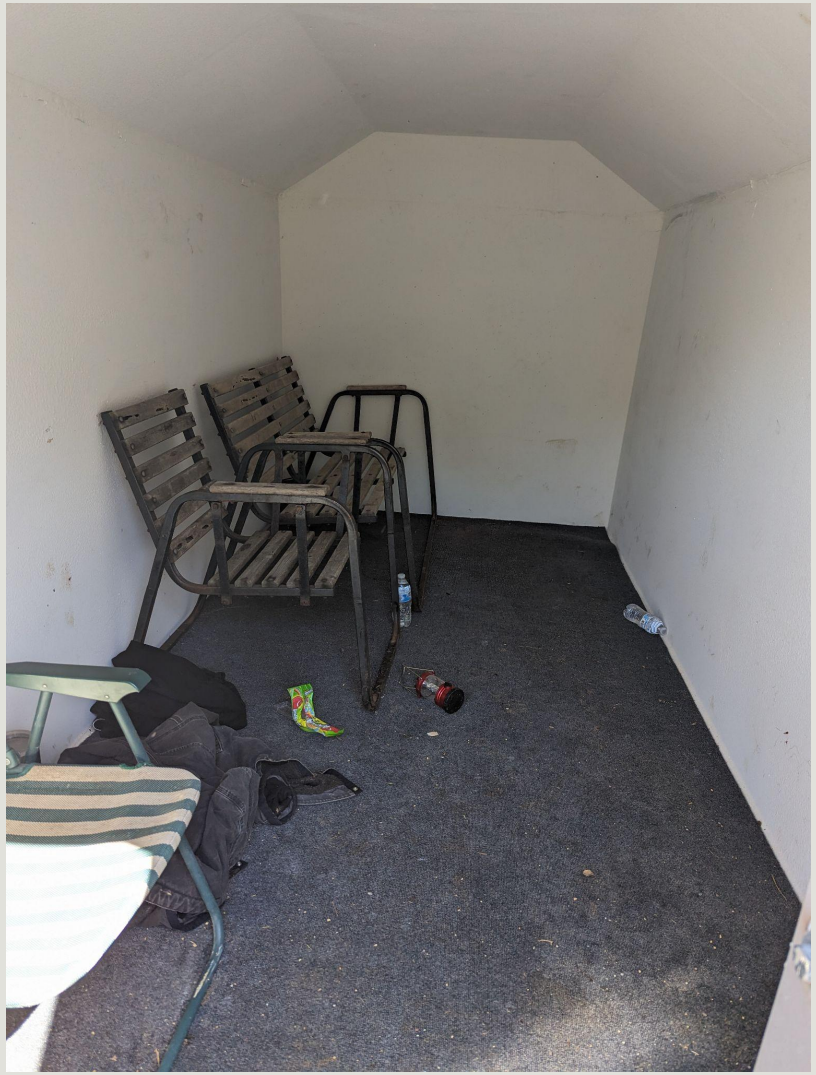
Vehicles are not a good place to be!

Impressions from Doing Surveys

Have a way to get warnings while you are asleep.

Impressions from Doing Surveys

A storm shelter is worth the investment.



Questions?

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