ShakeMap & ShakeCast for Earthquake Planning & Response

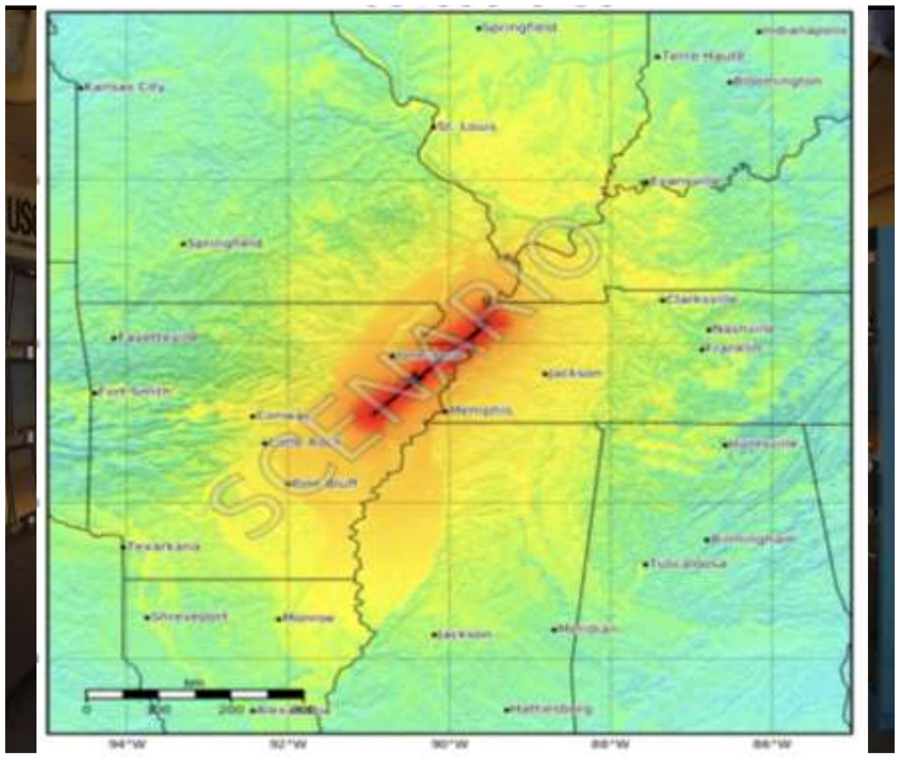
Michael White

Missouri DOT

Brandon Keller

Illinois DOT

Earthquake Summit 2023

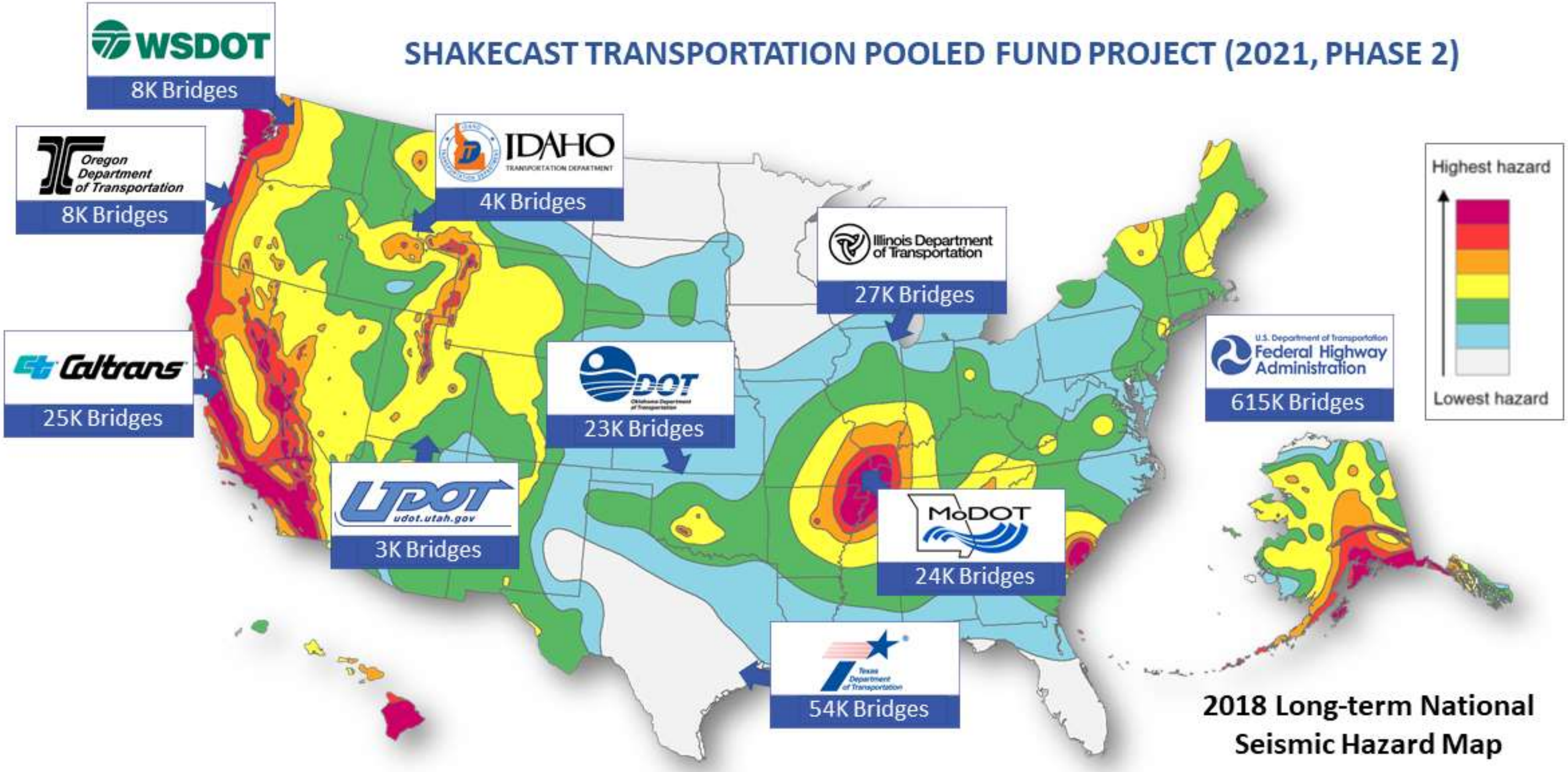


Outline

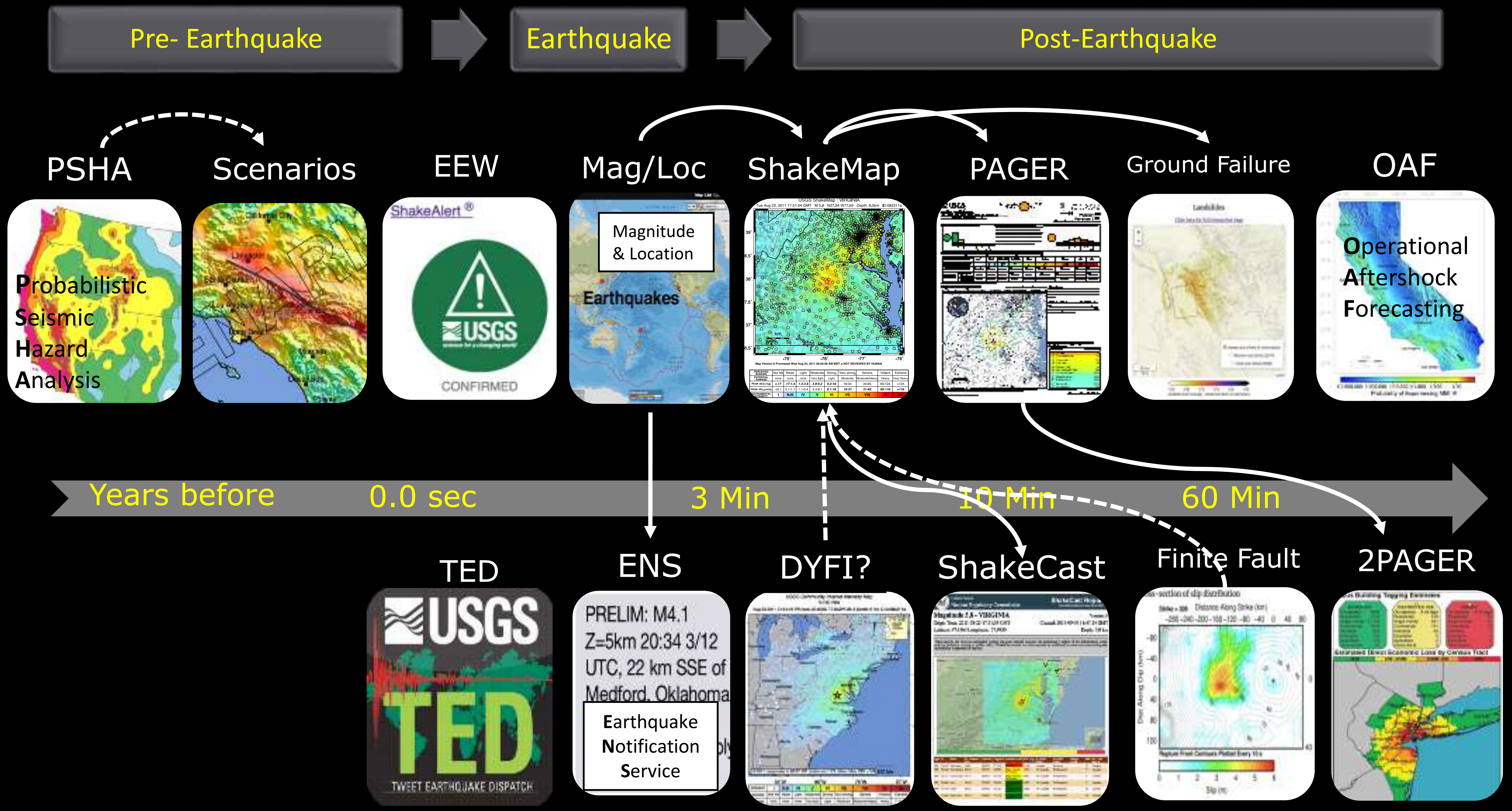
- Background on the USGS real-time **Earthquake Information System**
- **ShakeMap** Ingredients
- **ShakeCast** for Planning & Response
  - Background
  - Uses & Users
  - Specific Role of ShakeCast for Transportation
- **Priority Routes**
- **Shakecast Model Examples**
- **How Does Shakecast Impact Damage Assessments?**

USGS

Use Case: Transportation Pooled Fund (TPF)



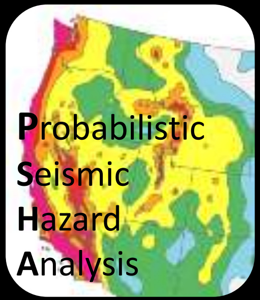
USGS Earthquake Information System



USGS Earthquake Information System

Pre- Earthquake → Earthquake → Post-Earthquake

PSHA

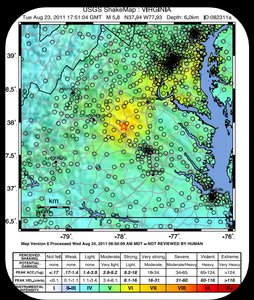


Scenarios

EEW

Mag/Loc

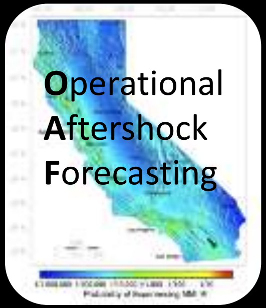
ShakeMap



PAGER

Ground Failure

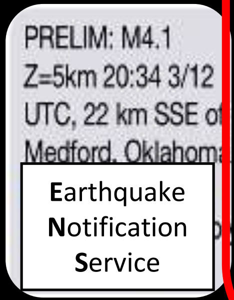
OAF



Years before — 0.0 sec — 3 Min — 10 Min — 60 Min

TED

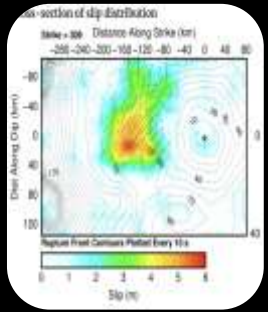
ENS



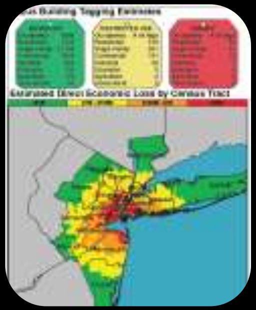
DYFI?

ShakeCast

Finite Fault

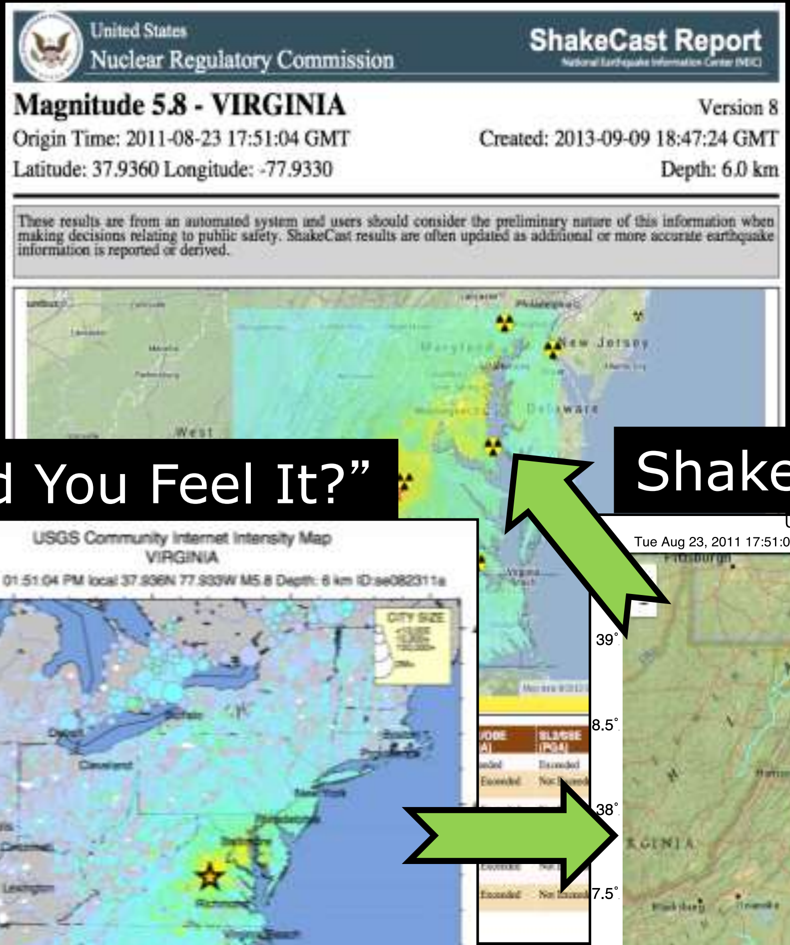


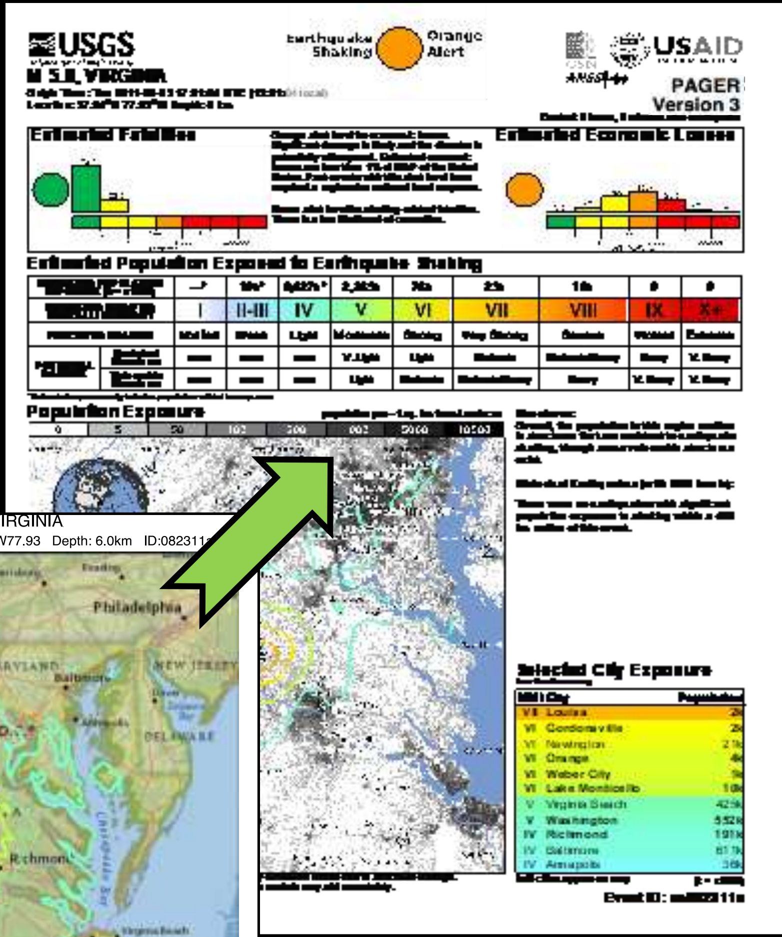
2PAGER



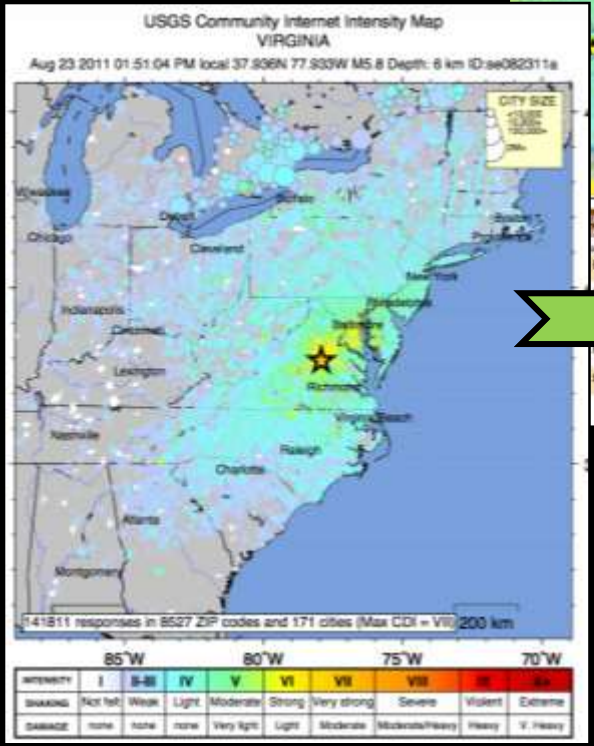
ShakeCast

PAGER (Prompt Assessment of Global Earthquakes for Response)

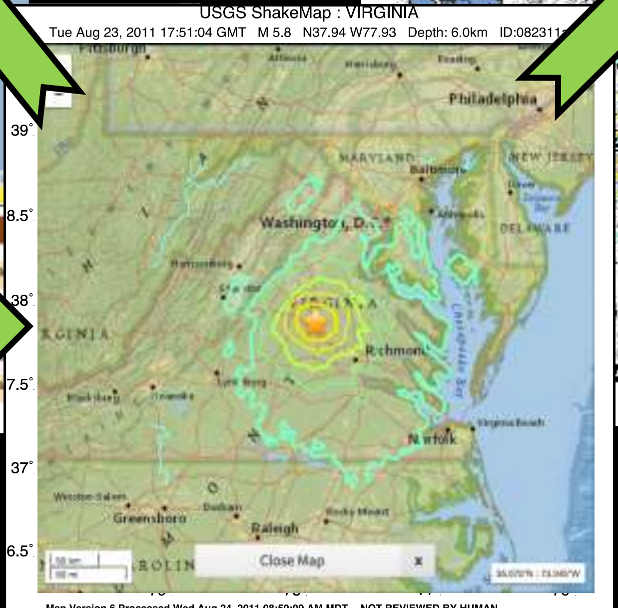




"Did You Feel It?"



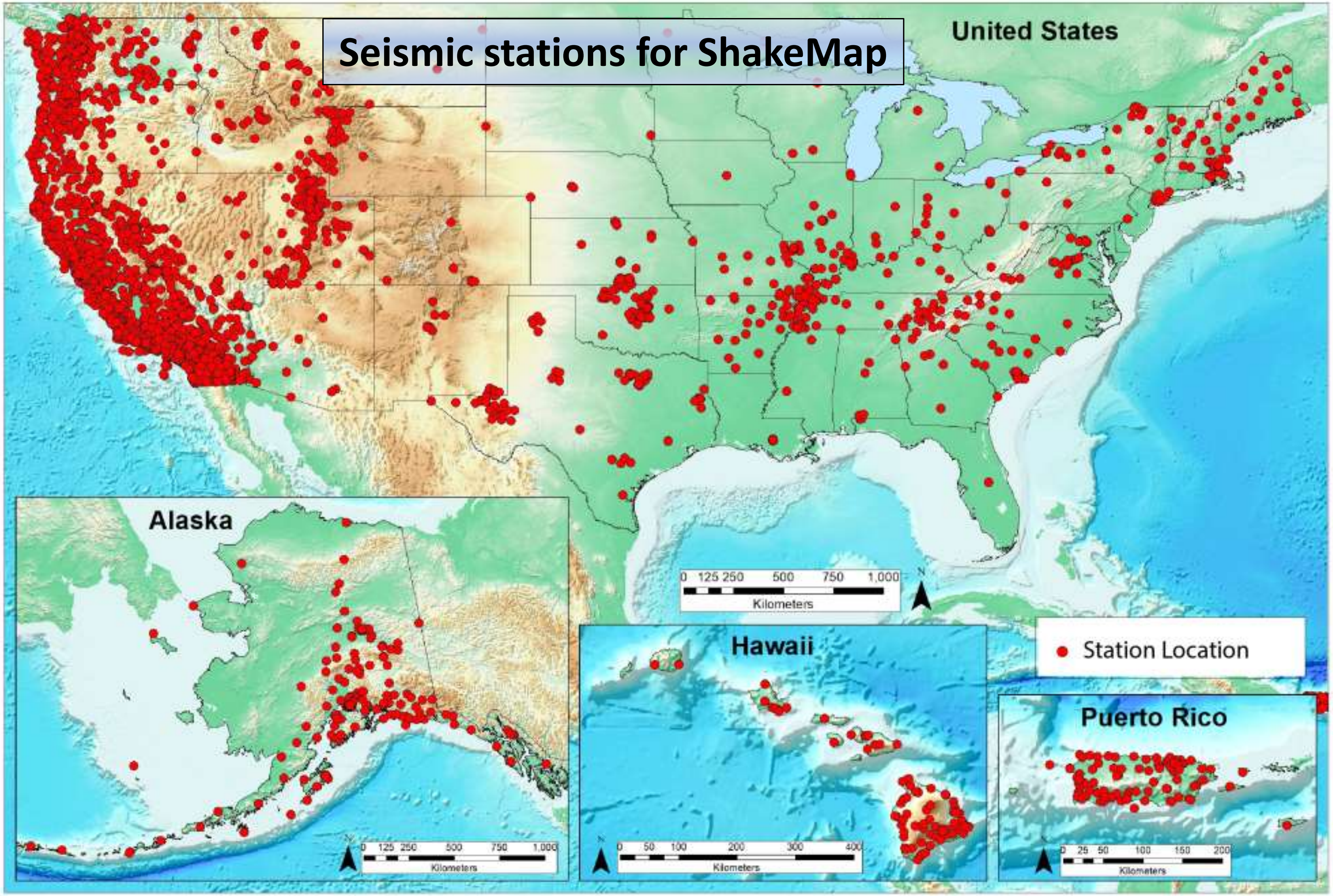
ShakeMap



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

USGS

Seismic stations for ShakeMap



Alaska: Geographic Coordinate System: GCS_North_American_1983
Projected Coordinate System: Alaska Albers Equal Area Conic

US, HI, PR: Geographic Coordinate System: GCS_WGS_1984
Datum: D_WGS_1984

Hillshade: Amante and Eakins (2009), ETOPO1

11th National Conference on Earthquake Engineering

June 25–29, 2018

Overview: What is ShakeCast?

- **Open-source USGS software**; user installs (or USGS hosts).
- ***Automatically* retrieves ShakeMap & compares shaking levels with unique facility fragilities**.
- **Generates & delivers report of inspection priorities** (hierarchical lists of facilities likely impacted).
- **Sends notifications & reports to specified personnel/responders**.
- Raises post-earthquake situational awareness in first min. to hrs. following an earthquake.

MoDOT State of Missouri Department of Transportation

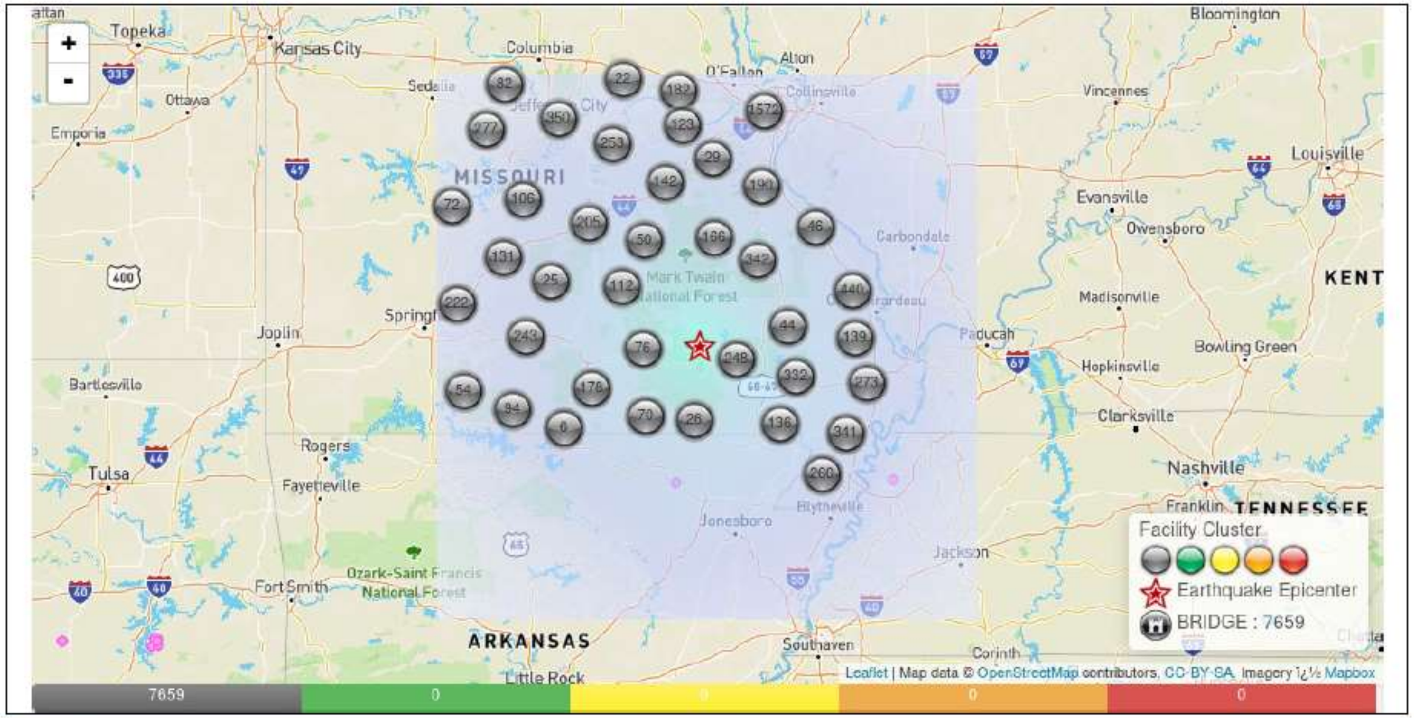
ShakeCast Report
National Earthquake Information Center (NEIC)

Magnitude 3.5 - 28 km WSW of Piedmont, Missouri, Version 1

Origin Time: 2022-11-05 13:44:12CDT Process Time: 2022-11-05 14:03:40CDT

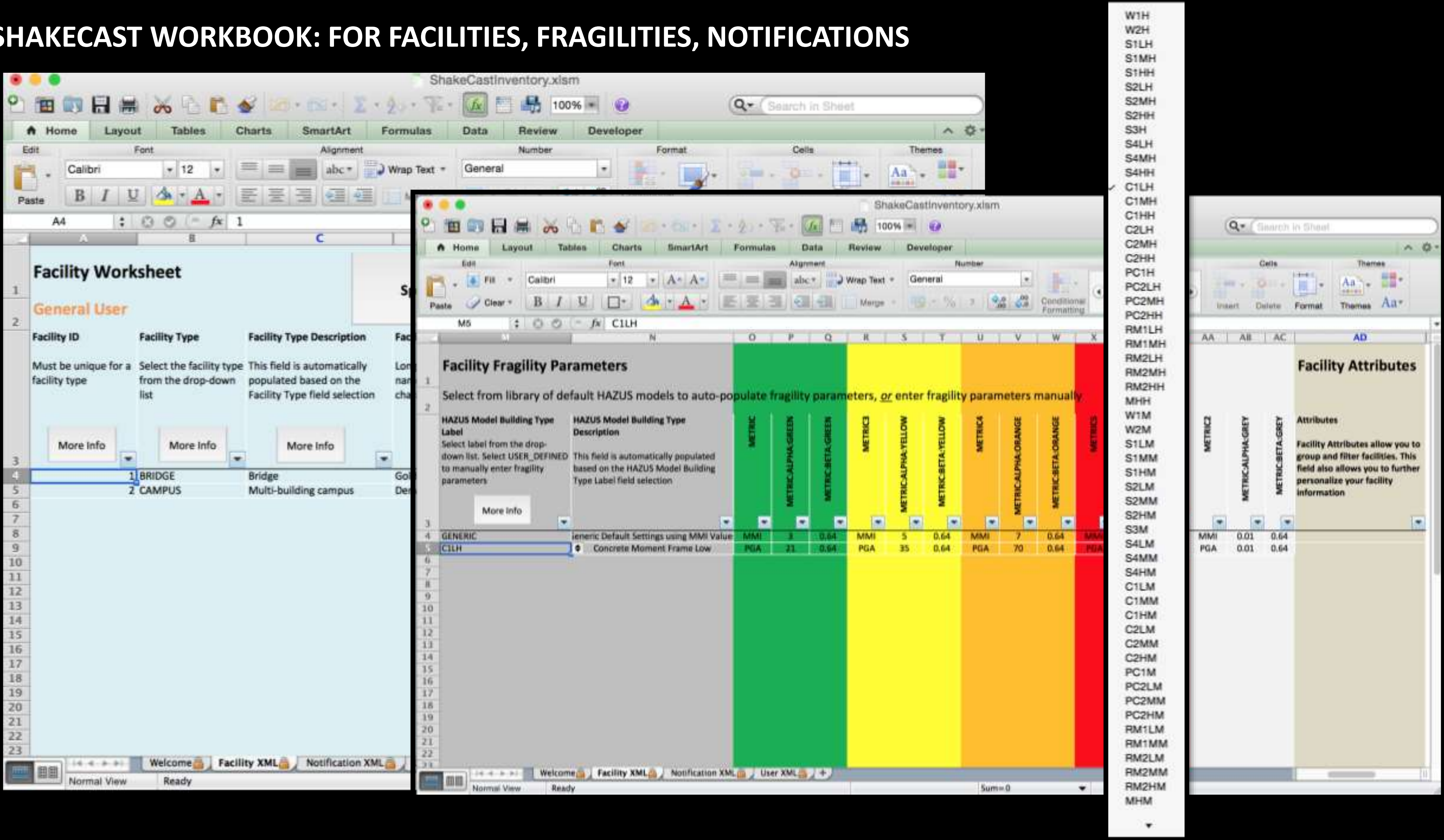
Latitude: 37.0778 Longitude: -90.9992 Depth: 5.8 km

These results are from an automated system and users should consider the preliminary nature of this information when making decisions relating to public safety. ShakeCast results are often updated as additional or more accurate earthquake information is reported or derived.



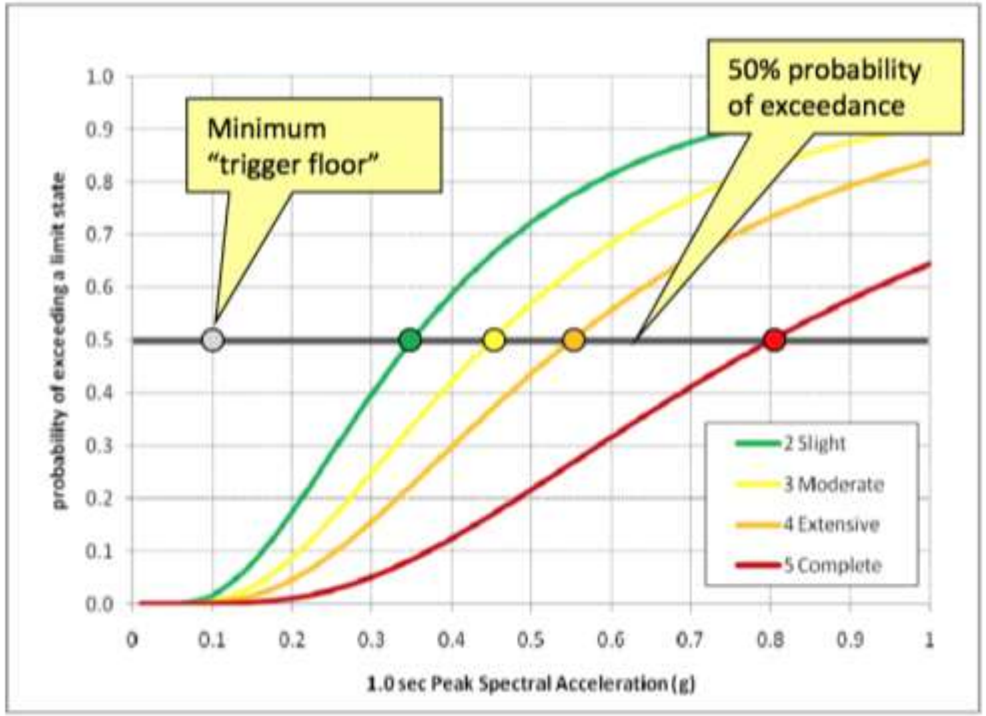
Type	ID	Name	Ep. Distance (km)	Inspection Priority	PGA (%g)	PGV (cm/s)	PSA 1s (%g)	MMI	Vs30 (m/s)
BRIDGE	A3997	3289 - NORWOOD HOLLOW	2.66	Below Threshold	8.454	0.7944	0.1031	IV	504.5
BRIDGE	P0479	7706 - CHITTON BR	3.15	Below Threshold	7.956	0.6914	0.08162	IV	647.2
BRIDGE	P0478	7705 - CRISTINS HOLLOW	5.01	Below Threshold	6.532	0.643	0.1006	IV	419
BRIDGE	A6399	29149 - CARTER CR	5.91	Below Threshold	6.558	0.6338	0.09317	IV	447.6
BRIDGE	A6398	29147 - CARTER CR	5.94	Below Threshold	6.558	0.6338	0.09317	IV	447.6

SHAKECAST WORKBOOK: FOR FACILITIES, FRAGILITIES, NOTIFICATIONS



Bridge Fragility

- Bridge fragility method is based upon work originally published by Basöz and Mander.
- Method was implemented in FEMA's HAZUS-MH software.
- Uses data from National Bridge Inventory (NBI) as inputs:
  - Year built
  - Year improved or retrofit
  - Angle of skew
  - Bridge type
  - Number of spans
  - Maximum span length
  - Total bridge length
  - Deck width

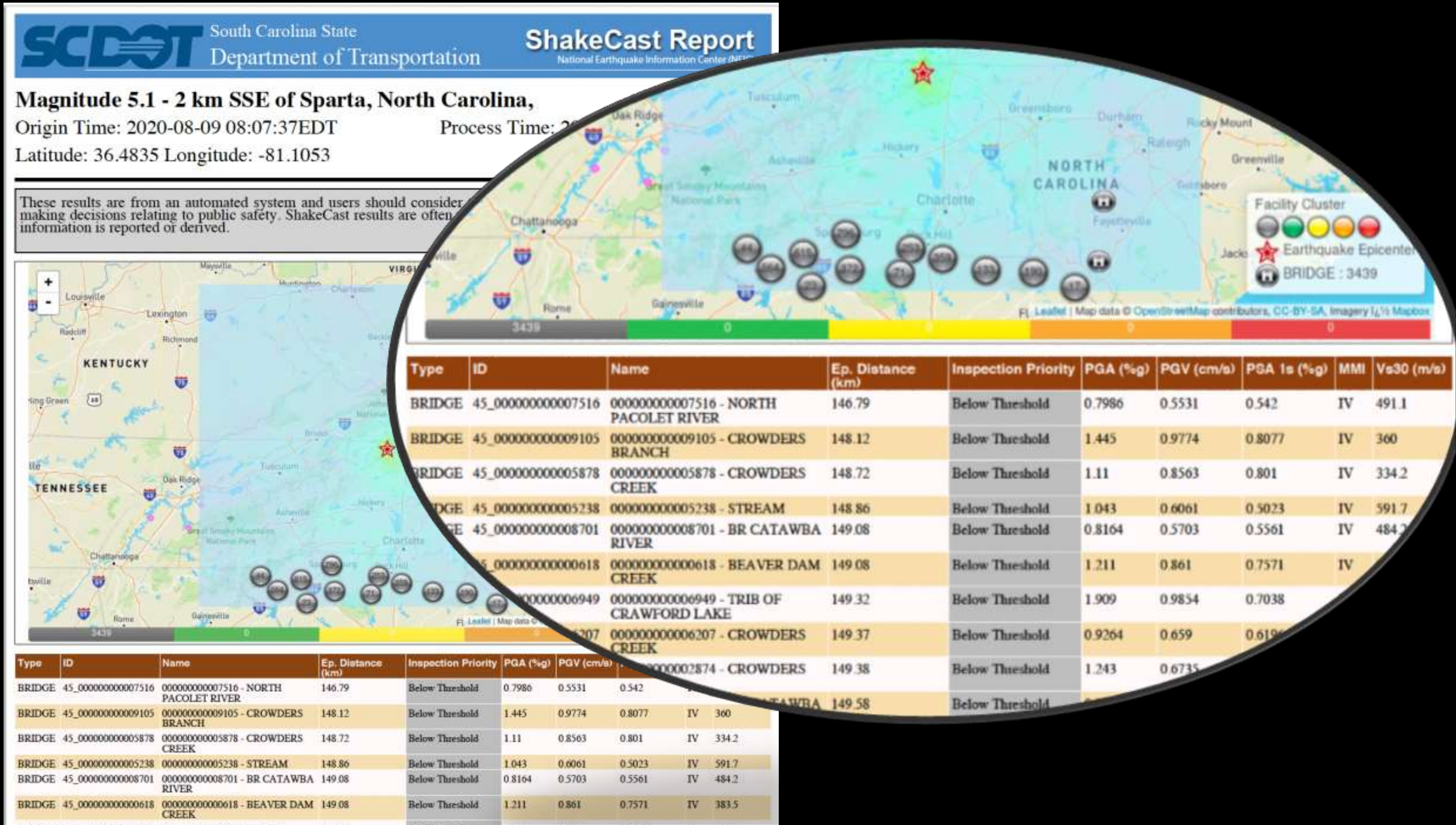


[Courtesy: Loren Turner, Caltrans]

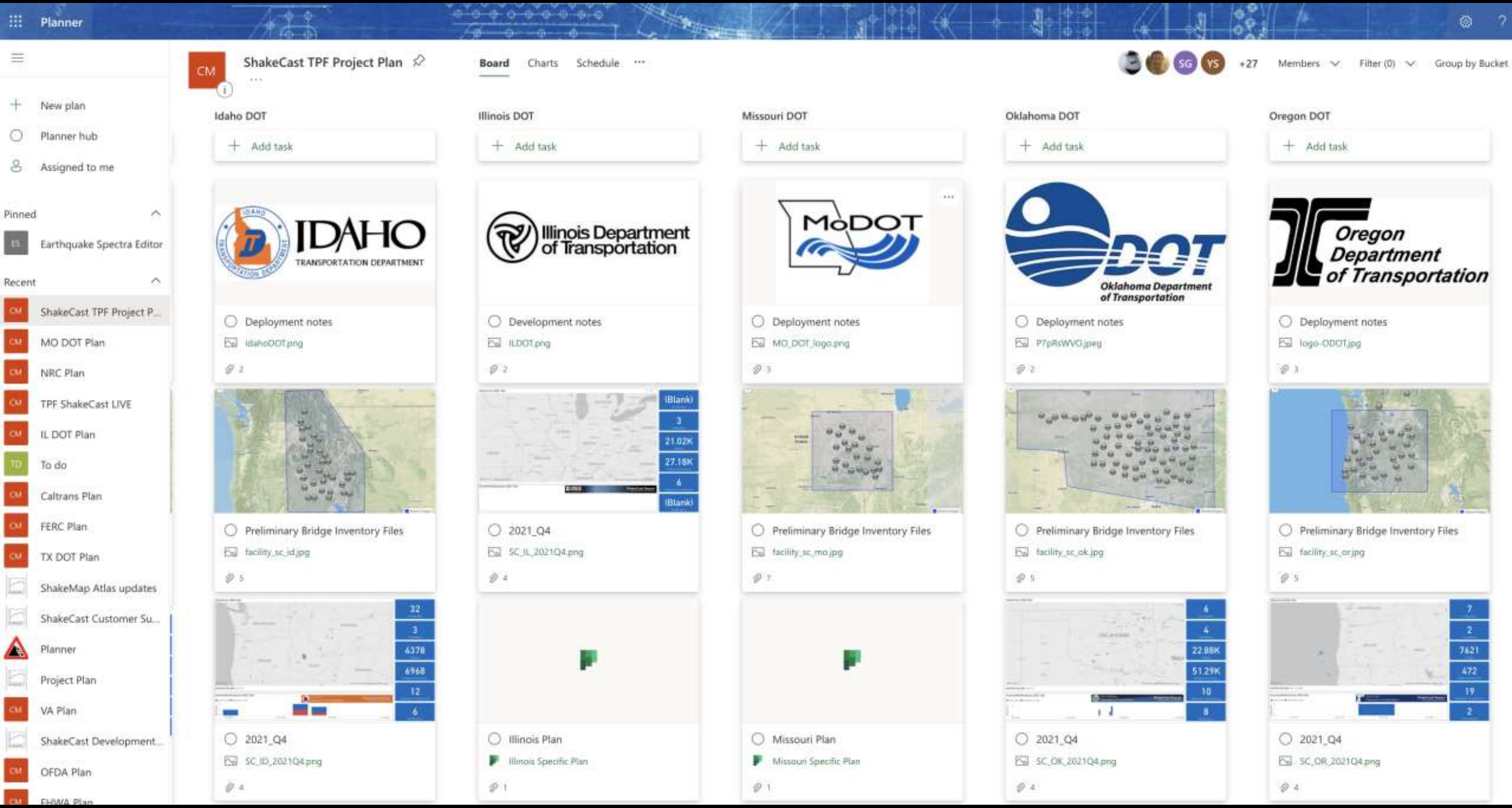
Federal Highway (FHWA) National Bridge Inventory (NBI)
→ Parsed directly into ShakeCast fragility look-up tables

	external_facility_id	facility_type	facility_name	description	lat	lon	METRIC:PSA10:GREEN	METRIC:PSA10:YELLOW	METRIC:PSA10:ORANGE	METRIC:PSA10:RED
2	001001C	BRIDGE	001001C - BEAVER RIVER	1-span; 3; 02; 10 deg skew; 7.3 m Max Span Length; NBI Class 302; HAZUS Class HWB24; Built 1945;	38.26633	-112.63272	10	39.94	51.36	79.89
3	001002F	BRIDGE	001002F - BEAVER RIVER	1-span; 5; 04; 0 deg skew; 7.6 m Max Span Length; NBI Class 504; HAZUS Class HWB3; Built 1985;	38.27233	-112.61356	10	115	138	195.5
4	001003C	BRIDGE	001003C - BEAVER RIVER	1-span; 3; 10; 0 deg skew; 18.3 m Max Span Length; NBI Class 310; HAZUS Class HWB24; Built 1923;	38.25233	-112.78919	10	40.25	51.75	80.5
5	001004E	BRIDGE	001004E - BEAVER RIVER	1-span; 1; 19; 5 deg skew; 6.1 m Max Span Length; NBI Class 119; HAZUS Class HWB4; Built 1998;	38.22219	-112.93053	10	114.78	137.74	195.13
6	001005F	BRIDGE	001005F - BEAVER RIVER	1-span; 5; 04; 0 deg skew; 10.7 m Max Span Length; NBI Class 504; HAZUS Class HWB3; Built 1985;	38.25097	-112.71367	10	115	138	195.5
7	001006V								137.04	211.79
8	001007F								97.58	138.24
9	001008V								137.04	211.79
10	001009E								128.99	175.89
11	001010C								51.75	80.5
12	001011E								97.58	138.24
13	001012V								48.16	74.91
14	001013V	BRIDGE	001013V - DRY WASH	4-span; 4; 19; 34 deg skew; 1.8 m Max Span Length; NBI Class 419; HAZUS Class HWB16; Built 2005;	38.30611	-113.01	10	104.6	127.85	174.34
15	001014V	BRIDGE	001014V - DRY WASH	4-span; 3; 19; 15 deg skew; 2 m Max Span Length; NBI Class 319; HAZUS Class HWB14; Built 2005;	38.31694	-113.00972	10	97.95	134.69	208.15
16	003001F	BRIDGE	003001F - MALAD RIVER	1-span; 5; 04; 0 deg skew; 14.9 m Max Span Length; NBI Class 504; HAZUS Class HWB3; Built 1930;	41.97614	-112.21631	10	115	138	195.5
17	003002F	BRIDGE	003002F - MALAD RIVER	1-span; 5; 04; 0 deg skew; 14.9 m Max Span Length; NBI Class 504; HAZUS Class HWB4; Built 1991;	41.94397	-112.19711	10	115	138	195.5
18	003003V	BRIDGE	003003V - MALAD RIVER	1-span; 3; 19; 0 deg skew; 7 m Max Span Length; NBI Class 319; HAZUS Class HWB24; Built 1980;	41.88611	-112.1885	10	40.25	51.75	80.5
19	003004D	BRIDGE	003004D - DEEP CREEK	3-span; 2; 04; 0 deg skew; 6.7 m Max Span Length; NBI Class 204; HAZUS Class HWB10; Built 1941;	41.96553	-112.72233	10	114.89	140.42	191.47
20	003006C	BRIDGE	003006C - WEST CANAL	1-span; 3; 02; 0 deg skew; 7 m Max Span Length; NBI Class 302; HAZUS Class HWB24; Built 1950;	41.72006	-112.23975	10	40.25	51.75	80.5
21	003008D	BRIDGE	003008D - HIGHLINE CANAL	1-span; 1; 01; 45 deg skew; 7 m Max Span Length; NBI Class 101; HAZUS Class HWB3; Built 1950;	41.72542	-112.20142	10	96.7	116.04	164.4
22	003009V	BRIDGE	003009V - WEST CANAL	2-span; 3; 19; 30 deg skew; 3 m Max Span Length; NBI Class 319; HAZUS Class HWB24; Built 1980;	41.72339	-112.20075	10	37.46	48.16	74.91
23	003010V	BRIDGE	003010V - FAUST VALLEY WA	2-span; 3; 19; 21 deg skew; 3.4 m Max Span Length; NBI Class 319; HAZUS Class HWB24; Built 1965;	41.71964	-112.42217	10	38.89	50	77.78
24	003011F	BRIDGE	003011F - WEST CANAL	1-span; 5; 04; 0 deg skew; 11.6 m Max Span Length; NBI Class 504; HAZUS Class HWB3; Built 1915;	41.75553	-112.16964	10	115	138	195.5
25	003012A	BRIDGE	003012A - CORINNE CANAL	1-span; 7; 02; 15 deg skew; 9.4 m Max Span Length; NBI Class 702; HAZUS Class HWB3; Built 1948;	41.75588	-112.12811	10	113.02	135.63	192.14
26	003013C	BRIDGE	003013C - CORINNE CANAL	1-span; 3; 02; 0 deg skew; 6.1 m Max Span Length; NBI Class 302; HAZUS Class HWB24; Built 1950;	41.77056	-112.12889	10	40.25	51.75	80.5
27	003014F	BRIDGE	003014F - MALAD RIVER	1-span; 5; 04; 0 deg skew; 15.2 m Max Span Length; NBI Class 504; HAZUS Class HWB3; Built 1960;	41.77044	-112.14261	10	115	138	195.5
28	003015D	BRIDGE	003015D - WEST CANAL	1-span; 1; 07; 0 deg skew; 9.1 m Max Span Length; NBI Class 107; HAZUS Class HWB3; Built 1988;	41.77947	-112.16369	10	115	138	195.5
29	003016D	BRIDGE	003016D - HAMMAND MAIN	1-span; 1; 07; 45 deg skew; 6.7 m Max Span Length; NBI Class 107; HAZUS Class HWB4; Built 1993;	41.73333	-112.09944	10	96.7	116.04	164.4
30	003017C	BRIDGE	003017C - WEST CANAL	1-span; 3; 02; 0 deg skew; 10.4 m Max Span Length; NBI Class 302; HAZUS Class HWB24; Built 1950;	41.79217	-112.16031	10	40.25	51.75	80.5
31	003018D	BRIDGE	003018D - WEST CANAL	1-span; 1; 07; 0 deg skew; 10.4 m Max Span Length; NBI Class 107; HAZUS Class HWB4; Built 1991;	41.81389	-112.15883	10	115	138	195.5
32	003019D								138	195.5
33	003020F								138	195.5
34	003021C								116.04	164.4
35	003022F								138	195.5
36	003023C								51.75	80.5
37	003024C								51.75	80.5
38	003025D								116.04	164.4
39	003026F								138	195.5
40	003028C								50.86	79.12
41	003030D								129.06	182.83
42	003031F								45.29	70.46
43	003033C	BRIDGE	003033C - CORINNE CANAL	1-span; 3; 02; 0 deg skew; 8.5 m Max Span Length; NBI Class 302; HAZUS Class HWB24; Built 1945;	41.65478	-112.14066	10	40.25	51.75	80.5
44	003034F	BRIDGE	003034F - MALAD RIVER	1-span; 5; 04; 0 deg skew; 9.1 m Max Span Length; NBI Class 504; HAZUS Class HWB3; Built 1978;	41.65539	-112.15997	10	115	138	195.5
45	003035V	BRIDGE	003035V - MALAD RIVER	1-span; 3; 19; 0 deg skew; 9.1 m Max Span Length; NBI Class 319; HAZUS Class HWB4; Built 2001;	41.65339	-112.16275	10	115	138	195.5
46	003037F	BRIDGE	003037F - MALAD RIVER	1-span; 5; 04; 0 deg skew; 14.6 m Max Span Length; NBI Class 504; HAZUS Class HWB3; Built 1969;	41.66872	-112.15556	10	115	138	195.5
47	003038E	BRIDGE	003038E - CORINNE CANAL	1-span; 1; 19; 0 deg skew; 6.1 m Max Span Length; NBI Class 119; HAZUS Class HWB3; Built 1967;	41.67778	-112.14158	10	115	138	195.5
48	003039C	BRIDGE	003039C - CORINNE CANAL	1-span; 3; 02; 0 deg skew; 7.9 m Max Span Length; NBI Class 302; HAZUS Class HWB24; Built 1945;	41.68322	-112.14175	10	40.25	51.75	80.5
49	003040C	BRIDGE	003040C - MALAD RIVER	1-span; 3; 02; 0 deg skew; 11.6 m Max Span Length; NBI Class 302; HAZUS Class HWB24; Built 1945;	41.68328	-112.15561	10	40.25	51.75	80.5
50	003041C	BRIDGE	003041C - BEAR RIVER	3-span; 4; 09; 0 deg skew; 22.9 m Max Span Length; NBI Class 409; HAZUS Class HWB15; Built 1945;	41.83264	-112.05875	10	87.69	87.69	128.61
51	003042F	BRIDGE	003042F - MALAD RIVER	1-span; 5; 04; 0 deg skew; 14.9 m Max Span Length; NBI Class 504; HAZUS Class HWB3; Built 1965;	41.69736	-112.16183	10	115	138	195.5
52	003043F	BRIDGE	003043F - CORINNE CANAL	1-span; 5; 04; 0 deg skew; 6.7 m Max Span Length; NBI Class 504; HAZUS Class HWB3; Built 1977;	41.70503	-112.14242	10	115	138	195.5
53	003044F	BRIDGE	003044F - MALAD RIVER	1-span; 5; 04; 0 deg skew; 15.2 m Max Span Length; NBI Class 504; HAZUS Class HWB3; Built 1965;	41.72658	-112.15078	10	115	138	195.5

description
1-span; 3; 02; 10 deg skew; 7.3 m Max Span Length; NBI Class 302; HAZUS Class HWB24; Built 1945;
1-span; 5; 04; 0 deg skew; 7.6 m Max Span Length; NBI Class 504; HAZUS Class HWB3; Built 1985;
1-span; 3; 10; 0 deg skew; 18.3 m Max Span Length; NBI Class 310; HAZUS Class HWB24; Built 1923;
1-span; 1; 19; 5 deg skew; 6.1 m Max Span Length; NBI Class 119; HAZUS Class HWB4; Built 1998;



Type	ID	Name	Ep. Distance (km)	Inspection Priority	PGA (%g)	PGV (cm/s)	PSA 1s (%g)	MMI	Vs30 (m/s)
BRIDGE	45_000000000007516	000000000007516 - NORTH PACOLET RIVER	146.79	Below Threshold	0.7986	0.5531	0.542	IV	491.1
BRIDGE	45_000000000009105	000000000009105 - CROWDERS BRANCH	148.12	Below Threshold	1.445	0.9774	0.8077	IV	360
BRIDGE	45_000000000005878	000000000005878 - CROWDERS CREEK	148.72	Below Threshold	1.11	0.8563	0.801	IV	334.2
BRIDGE	45_000000000005238	000000000005238 - STREAM	148.86	Below Threshold	1.043	0.6061	0.5023	IV	591.7
BRIDGE	45_000000000008701	000000000008701 - BR CATAWBA RIVER	149.08	Below Threshold	0.8164	0.5703	0.5561	IV	484.2
BRIDGE	45_000000000000618	000000000000618 - BEAVER DAM CREEK	149.08	Below Threshold	1.211	0.861	0.7571	IV	383.5
	000000006949	000000000006949 - TRIB OF CRAWFORD LAKE	149.32	Below Threshold	1.909	0.9854	0.7038		
	207	000000000006207 - CROWDERS CREEK	149.37	Below Threshold	0.9264	0.659	0.619		
		00000002874 - CROWDERS	149.38	Below Threshold	1.243	0.6735			
		TAWBA	149.58	Below Threshold					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Planner hub
Assigned to me
Pinned
Earthquake Spectra Editor
Recent
ShakeCast TPF Project P...
MO DOT Plan
NRC Plan
TPF ShakeCast LIVE
IL DOT Plan
To do
Caltrans Plan
FERC Plan
TX DOT Plan
ShakeMap Atlas updates
ShakeCast Customer Su...
Planner
Project Plan
VA Plan
ShakeCast Development...
OFDA Plan
FHWA Plan
Idaho DOT
Illinois DOT
Missouri DOT
Oklahoma DOT
Oregon DOT
Add task
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Missouri Plan
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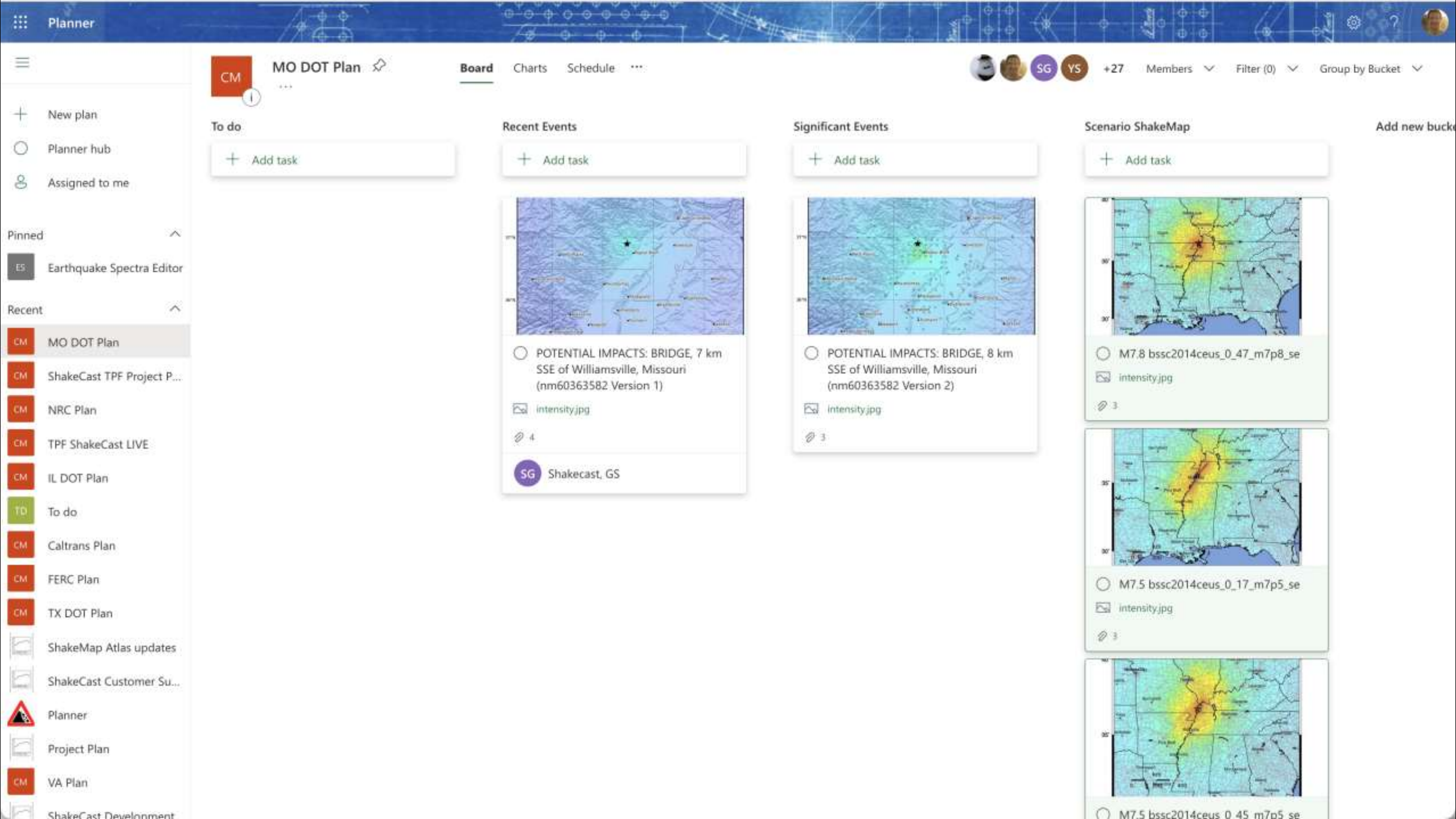
Planner
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Group by Bucket
New plan
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Assigned to me
Pinned
Earthquake Spectra Editor
Recent
MO DOT Plan
ShakeCast TPF Project P...
NRC Plan
TPF ShakeCast LIVE
IL DOT Plan
To do
Caltrans Plan
FERC Plan
TX DOT Plan
ShakeMap Atlas updates
ShakeCast Customer Su...
Planner
Project Plan
VA Plan
ShakeCast Development
To do
Add task
Recent Events
Add task
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intensity.jpg
4
Shakecast, GS
Significant Events
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Scenario ShakeMap
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3
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3
M7.5 bssc2014ceus_0_45_m7p5_se
Add new bucket

← Latest Earthquakes

Overview
Interactive Map
Regional Information

Impact
Felt Report - Tell Us!
Did You Feel It?
ShakeMap
PAGER

Technical
Origin
Moment Tensor
Waveforms

Download Event KML

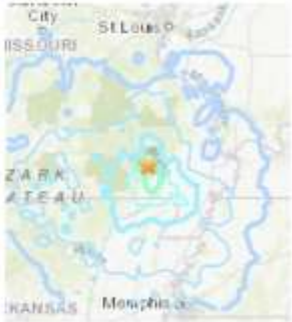
View Nearby Seismicity

Earthquakes
Hazards
Data & Products

M 4.0 - 7 km S of Williamsville, Missouri

2021-11-18 02:53:03 (UTC) | 36.908°N 90.543°W | 16.5 km depth

Interactive Map



Contributed by NM [1]

Regional Information

Contributed by NM [1]

Felt Report - Tell Us!

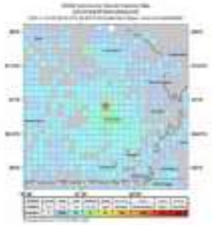
0 0 5 4 3 7

Responses

Contribute to citizen science. Please tell us about your experience.

Citizen Scientist Contributions

Did You Feel It? V



Community Internet Intensity Map

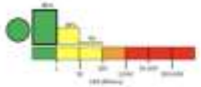
Contributed by US [2]

ShakeMap V

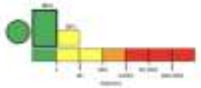
Estimated Intensity Map

Contributed by US [2]

PAGER GREEN



Estimated Economic Losses



Estimated Fatalities

Contributed by US [2]

Origin

Review Status
REVIEWED

Magnitude
4.0 mw

Depth
16.5 km

Time
2021-11-18 02:53:03 UTC

Contributed by NM [1]

Moment Tensor

Fault Plane Solution

Contributed by US [2]

View Nearby Seismicity

Time Range
± Three Weeks

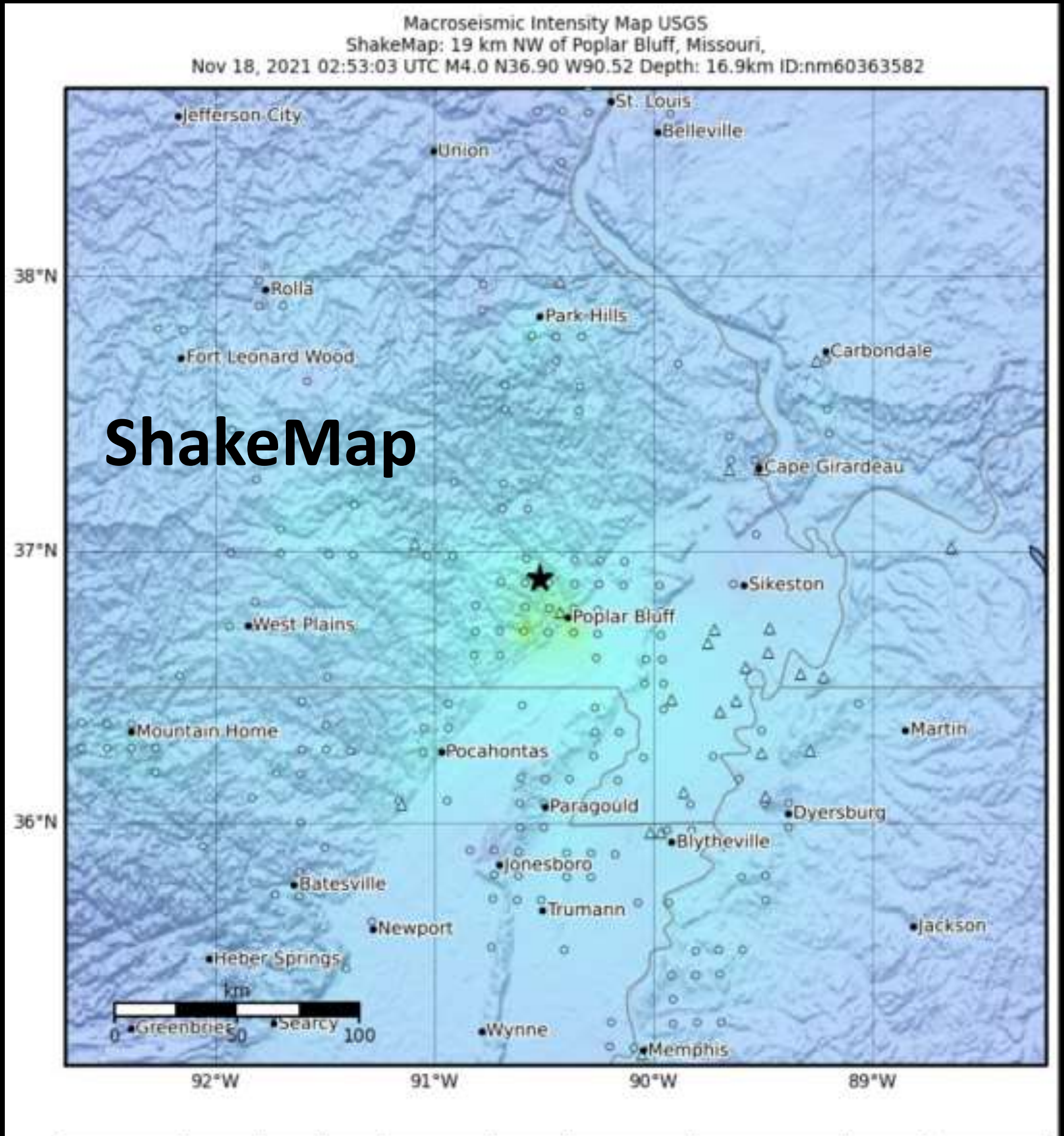
Search Radius
250.0 km

Magnitude Range
≥ 1.0

ANSS Comcat

For More Information

- Impact Summary
- Technical Summary



SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	None	None	None	Very light	Light	Moderate	Moderate/heavy	Heavy	Very heavy
PGA(%g)	<0.00663	0.0795	0.954	4.99	8.76	15.4	27	47.4	>83.2
PGV(cm/s)	<0.0028	0.0383	0.524	3.03	6.48	13.9	29.6	63.4	>136
INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

MoDOT State of Missouri Department of Transportation

ShakeCast Report

National Earthquake Information Center (NEIC)

Magnitude 4.0 - 19 km NW of Poplar Bluff, Missouri, Version 2

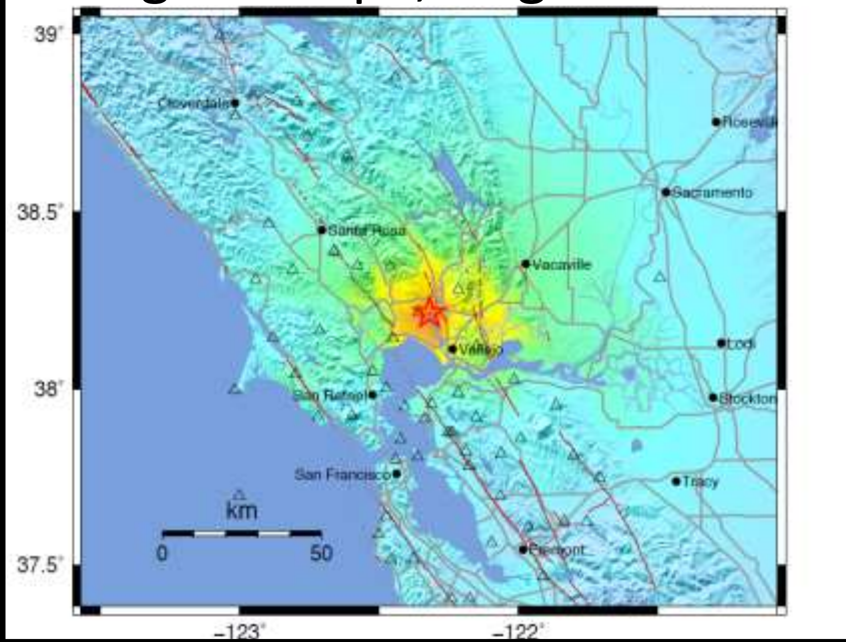
Origin Time: 2021-11-17 20:53:03CST Process Time: 2021-11-17 21:50:07CST

Latitude: 36.9007 Longitude: -90.5238 Depth: 16.9 km

These results are from an automated system and users should consider the preliminary nature of this information when making decisions relating to public safety. ShakeCast results are often updated as additional or more accurate earthquake information is reported or derived.

Type	ID	Name	Ep. Distance (km)	Inspection Priority	PGA (%g)	PGV (cm/s)	PSA 1s (%g)	MMI	Vs30 (m/s)
BRIDGE	P0931	7979 - ESSMAN SPR	1.64	Below Threshold	7.294	1.185	0.2925	IV	693.6
BRIDGE	P0873	7944 - SWIFT CR	1.69	Below Threshold	7.446	1.229	0.3035	IV	673.3
BRIDGE	W0191	9435 - CR	2.74	Below Threshold	7.235	1.167	0.2785	IV	848.7
BRIDGE	P0874	7945 - LIGETT CR	2.82	Below Threshold	7.039	1.118	0.2752	IV	736.9
BRIDGE	A3274	2771 - BLACK RVR	3.77	Below Threshold	7.847	1.515	0.5104	IV	333.9
BRIDGE	900032	34798 - MILLER CR	3.78	Below Threshold	6.768	1.057	0.2559	IV	805.4
BRIDGE	A7303	31371 - BLACK RVR	3.85	Below Threshold	7.847	1.515	0.5104	IV	333.9
BRIDGE	A3273	2770 - UP RR	4.02	Below Threshold	7.847	1.515	0.5104	IV	333.9
BRIDGE	A7302	31372 - UP RR	4.02	Below Threshold	7.847	1.515	0.5104	IV	333.9
BRIDGE	100016	34519 - CANE CR	5.5	Below Threshold	6.788	1.22	0.3797	IV	466.1
BRIDGE	K0020	5632 - SMALL CR	5.58	Below Threshold	6.979	1.177	0.2908	IV	616
BRIDGE	80023	32537 - CANE CR	5.59	Below Threshold	6.872	1.168	0.3032	IV	617
BRIDGE	X0659	9753 - HOCKINBERRY CR	6.08	Below Threshold	6.857	1.141	0.276	IV	708.6
BRIDGE	A6444	28994 - CANE CR	6.35	Below Threshold	7.772	1.57	0.5332	IV	337.5
BRIDGE	A6443	28996 - CANE CR	6.39	Below Threshold	7.772	1.57	0.5332	IV	337.5
BRIDGE	A6644	29346 - KEARBY CR	6.44	Below Threshold	7.949	1.644	0.5238	V	373.8

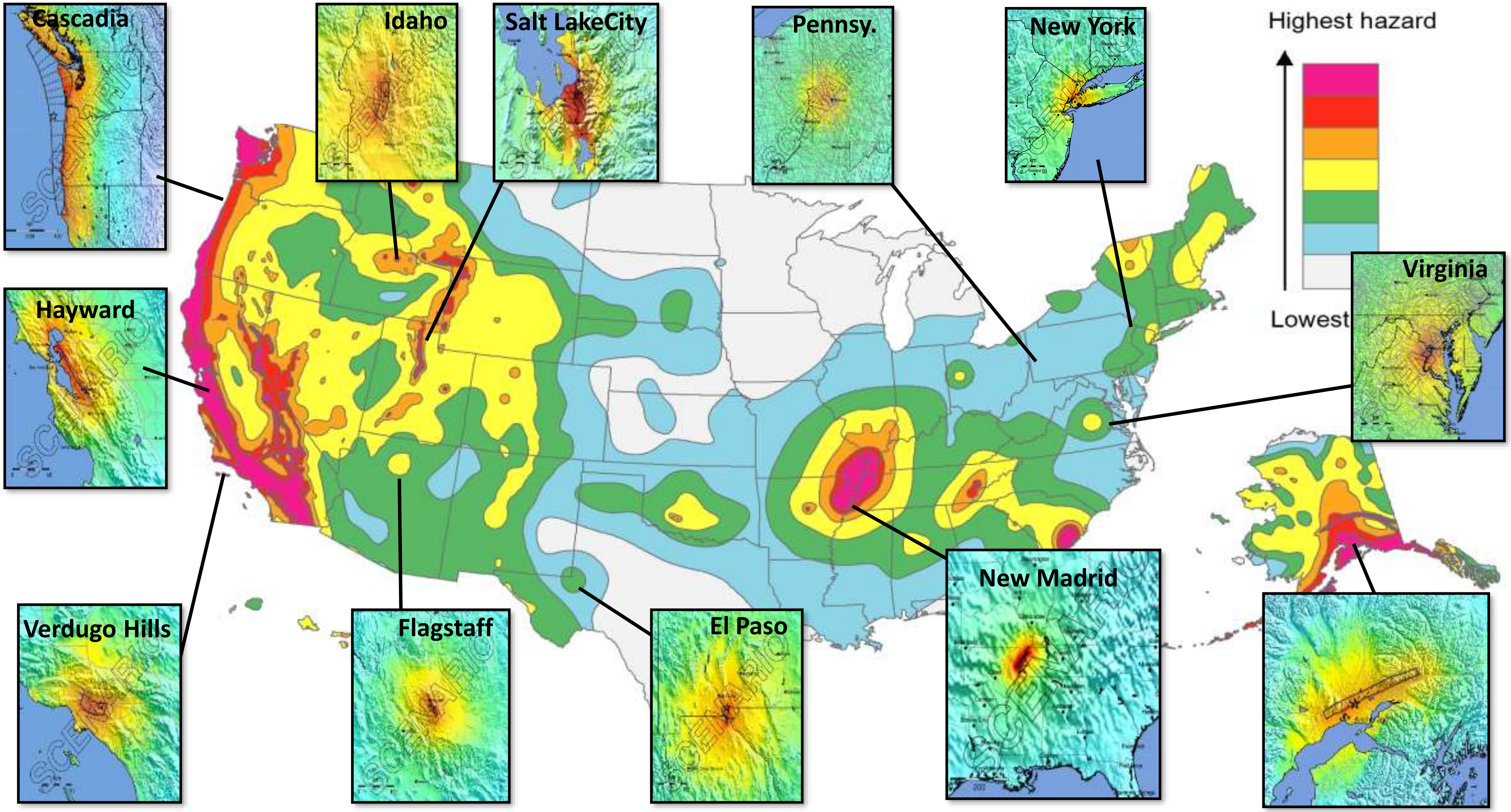
Mag 6.0 Napa, August 2014



ShakeCast identified the 9 bridges that sustained minor damage. They were in the top 40% of a list of 87 total. Over 2,700 state bridges were in the ShakeMap region.

Courtesy L. Turner, Caltrans

USGS National Seismic Hazard Map & Example Scenarios (>800 available online)



Overview
Interactive Map
Regional Information

Impact
ShakeMap

Technical
Origin

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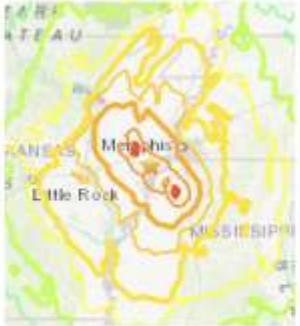
M 7.5 Scenario Earthquake - Marianna_RLME

2017-05-12 18:52:32 (UTC) | 34.913°N 90.530°W | 19.2 km depth

This event is a scenario (it did not occur) and should only be used for planning purposes.
More information about scenarios

Interactive Map

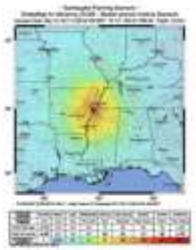


Contributed by US [1]

Regional Information

Contributed by US [1]

ShakeMap IX



Estimated Intensity Map

Contributed by US [1]

Origin

Review Status
AUTOMATIC

Magnitude
7.5

Depth
19.2 km

Time
2017-05-12 18:52:32 UTC

Contributed by US [1]

For More Information

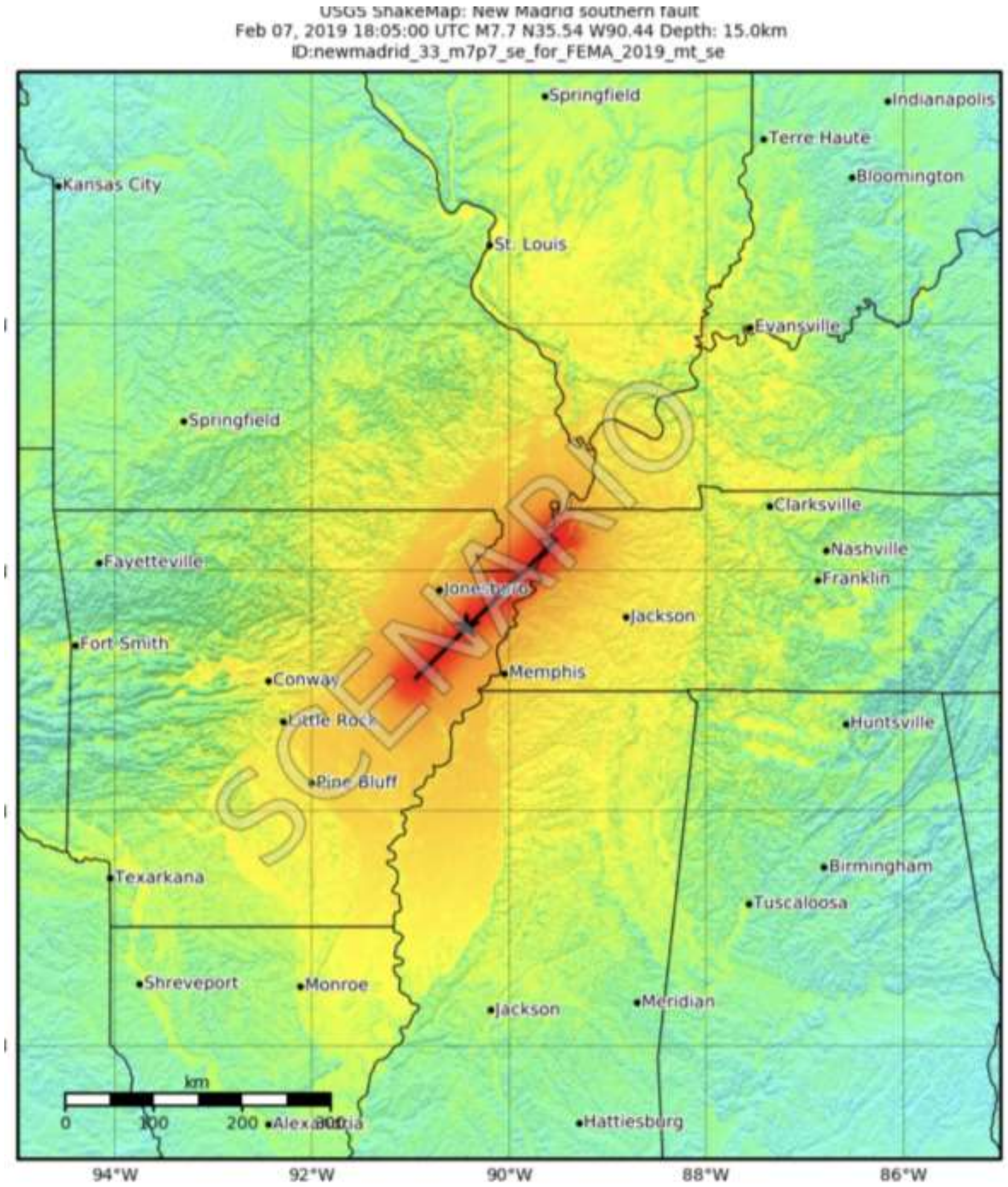
- Impact Summary
- Technical Summary

Contributors

1. USGS National Earthquake Information Center, PDE

Additional Information

- ANSS Comprehensive Earthquake Catalog (ComCat) Documentation
- Technical terms used on event pages



MoDOT State of Missouri Department of Transportation

ShakeCast Report

National Earthquake Information Center (NEIC)

Magnitude 7.7 - New Madrid southern fault

Version 1

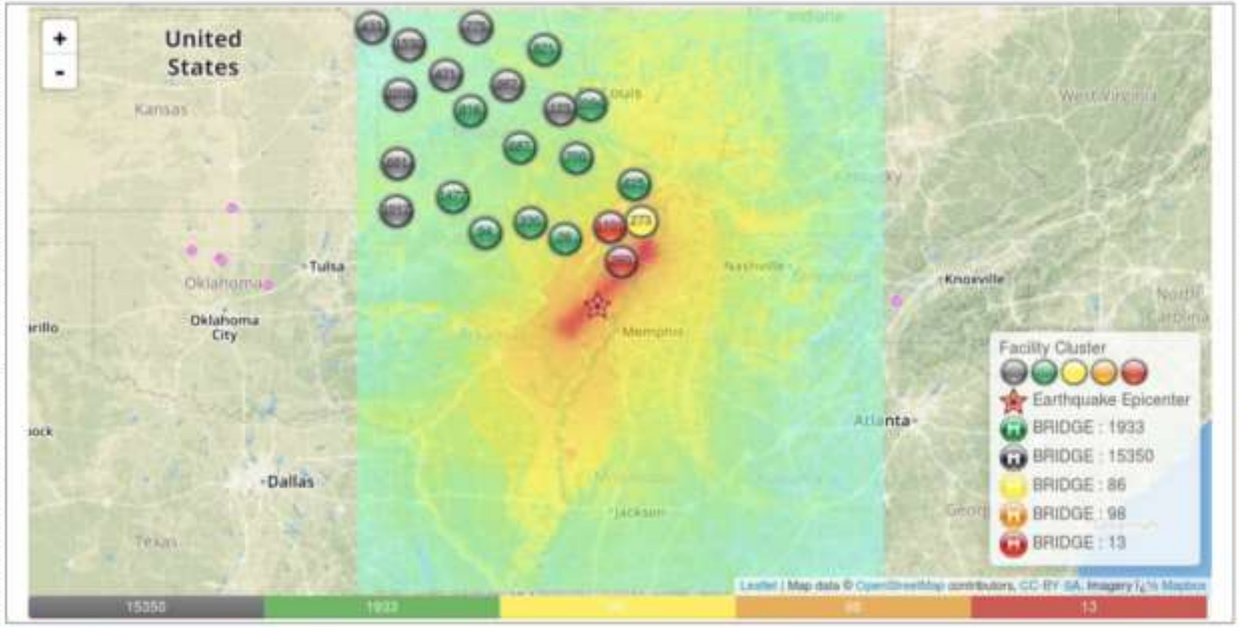
Origin Time: 2019-02-07 11:05:00 GMT

Created: 2019-01-30 15:35:49 GMT

Latitude: 35.5426 Longitude: -90.4365

Depth: 15.0 km

These results are from an automated system and users should consider the preliminary nature of this information when making decisions relating to public safety. ShakeCast results are often updated as additional or more accurate earthquake information is reported or derived.



Type	ID	Name	Ep. Distance (km)	Inspection Priority	PGA (%g)	PGV (cm/s)	PSA 1s (%g)	MMI	Vs30 (m/s)
BRIDGE	X0034	9506 - COUNTY DTCH	73.7	High	72.32	90.88	76.58	IX	214
BRIDGE	X0509	9695 - DRAIN DTCH NO 8	75.14	High	75.43	85.81	72.62	IX	224.3
BRIDGE	P0132	7513 - PEMISCOT BYU	75.99	High	74.62	100.7	84.33	IX	217
BRIDGE	G0457	4649 - PEMISCOT BYU	77.51	High	79.24	92.77	78.19	IX	227.5
BRIDGE	L0474	6294 - MAIN DTCH	77.79	High	78.04	97.72	82.06	IX	224
BRIDGE	3010009	21331 - DRAIN DTCH	78.23	High	79.24	92.77	78.19	IX	227.5
BRIDGE	L0477	6296 - OLD FRANKLIN DRAIN	82.14	High	79.39	104.8	87.6	IX	225.3
BRIDGE	G0458	4650 - MAIN DTCH NO 6	82.2	High	73.73	92.93	78.22	IX	217
BRIDGE	H0187	4890 - DRAIN DTCH NO 3	84.52	High	70.38	94.58	79.4	IX	211.2
BRIDGE	L0472	6293 - DRAIN DTCH NO 3	85.58	High	75.07	96.06	80.69	IX	219.4
BRIDGE	A1937	1629 - DRAIN DTCH NO 3	85.65	High	75.07	96.06	80.69	IX	219.4
BRIDGE	F0175	4450 - MAIN DTCH	94.81	High	70.69	83.21	70.51	IX	215.6
BRIDGE	J0291	5332 - DRAIN DTCH NO 6	99.7	High	80.42	86.94	73.52	IX	239.6

USGS
science for a changing world

Earthquake Shaking Red Alert

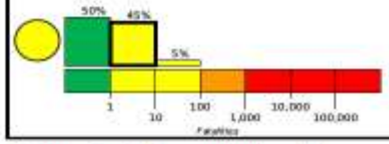
GSN ANSS USAID FROM THE AMERICAN PEOPLE

M 6.0, Scenario New Madrid M6.0 Aftershock

PAGER
Version 1

Origin Time: 2019-02-08 03:05:00 UTC (Thu 21:05:00 local)
Location: 36.2600° N 89.5200° W Depth: 12.0 km

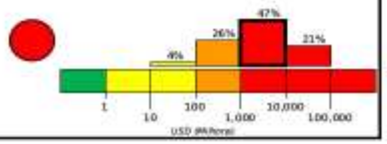
Estimated Fatalities



Red alert for economic losses. Extensive damage is probable and the disaster is likely widespread. Estimated economic losses are less than 1% of GDP of the United States. Past events with this alert level have required a national or international level response.

Yellow alert for shaking-related fatalities. Some casualties are possible.

Estimated Economic Losses



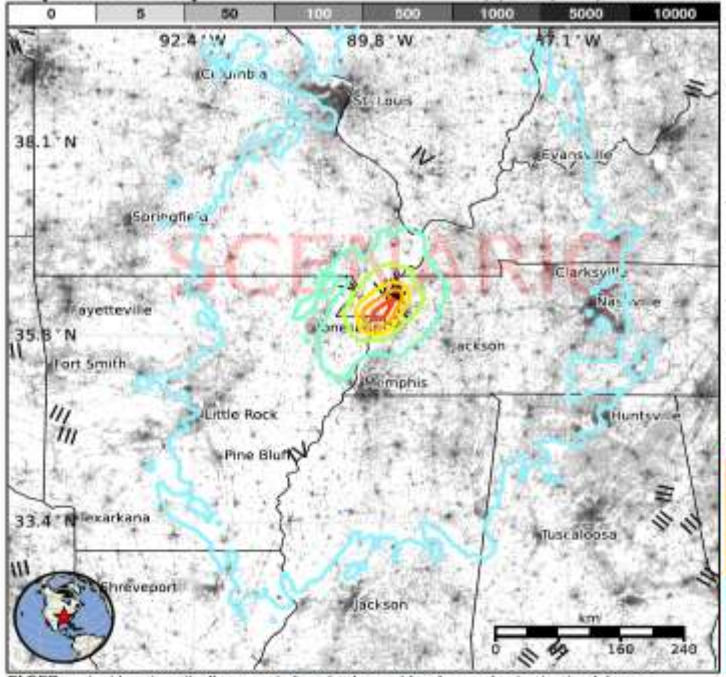
Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k=x1000)		–*	19,142k*	12,424k	242k	77k	9k	28k	9k	0
ESTIMATED MODIFIED MERCALLI INTENSITY		I	II-III	IV	V	VI	VII	VIII	IX	X+
PERCEIVED SHAKING		Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	Resistant Structures	None	None	None	V. Light	Light	Moderate	Mod./Heavy	Heavy	V. Heavy
	Vulnerable Structures	None	None	None	Light	Moderate	Mod./Heavy	Heavy	V. Heavy	V. Heavy

*Estimated exposure only includes population within the map area.

Population Exposure

population per 1 sq. km from Landscan



PAGER content is automatically generated, and only considers losses due to structural damage. Limitations of input data, shaking estimates, and loss models may add uncertainty.
http://earthquake.usgs.gov/data/pager/

Structures

Overall, the population in this region resides in structures that are resistant to earthquake shaking, though vulnerable structures exist. The predominant vulnerable building types are unreinforced brick masonry and reinforced masonry construction.

Historical Earthquakes

Date (UTC)	Dist. (km)	Mag.	Max MMI(#)	Shaking Deaths
1976-03-25	112	4.5	IV(32k)	–
1976-03-25	100	5.0	VI(59k)	–
1987-06-10	319	5.1	VI(1k)	0

Selected City Exposure

from GeoNames.org

MMI	City	Population
IX	Caruthersville	6k
VIII	Steele	2k
VIII	Ridgely	2k
VIII	Blytheville	16k
VIII	Gosnell	4k
VII	Hayti	3k
IV	**Nashville**	531k
III	**Little Rock**	194k
III	Indianapolis	830k
III	**Jackson**	174k
III	Montgomery	206k

bold cities appear on map. (k = x1000)

Event ID: usnewmadrid_m6p0_se_for_Fury_2019_se

MoDOT State of Missouri Department of Transportation

ShakeCast Report

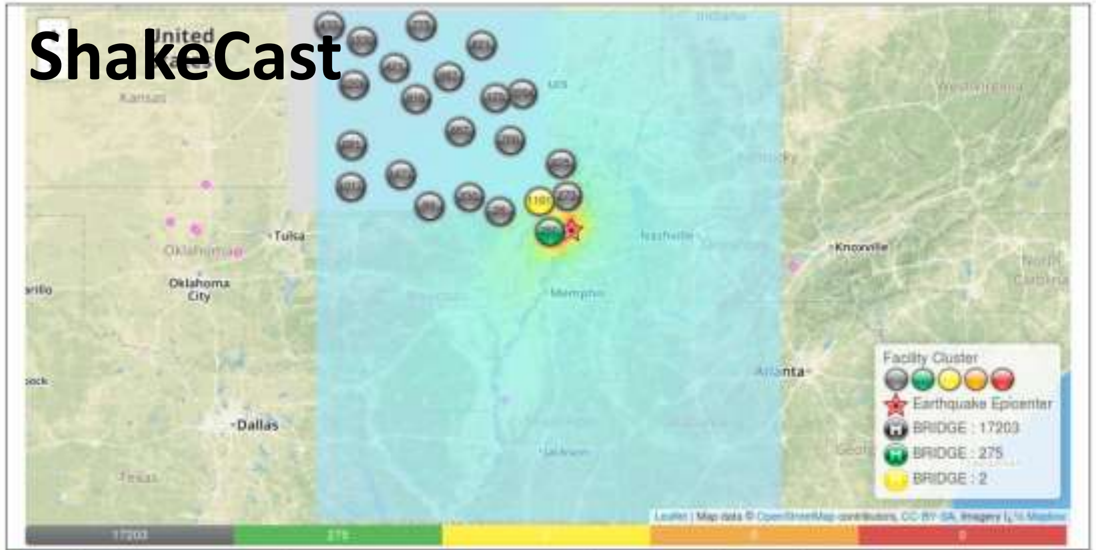
National Earthquake Information Center (NEIC)

Magnitude 6.0 - New Madrid M6.0 Aftershock

Version 1

Origin Time: 2019-02-07 20:05:00 GMT
Created: 2019-01-29 15:54:07 GMT
Latitude: 36.2600 Longitude: -89.5200
Depth: 12.0 km

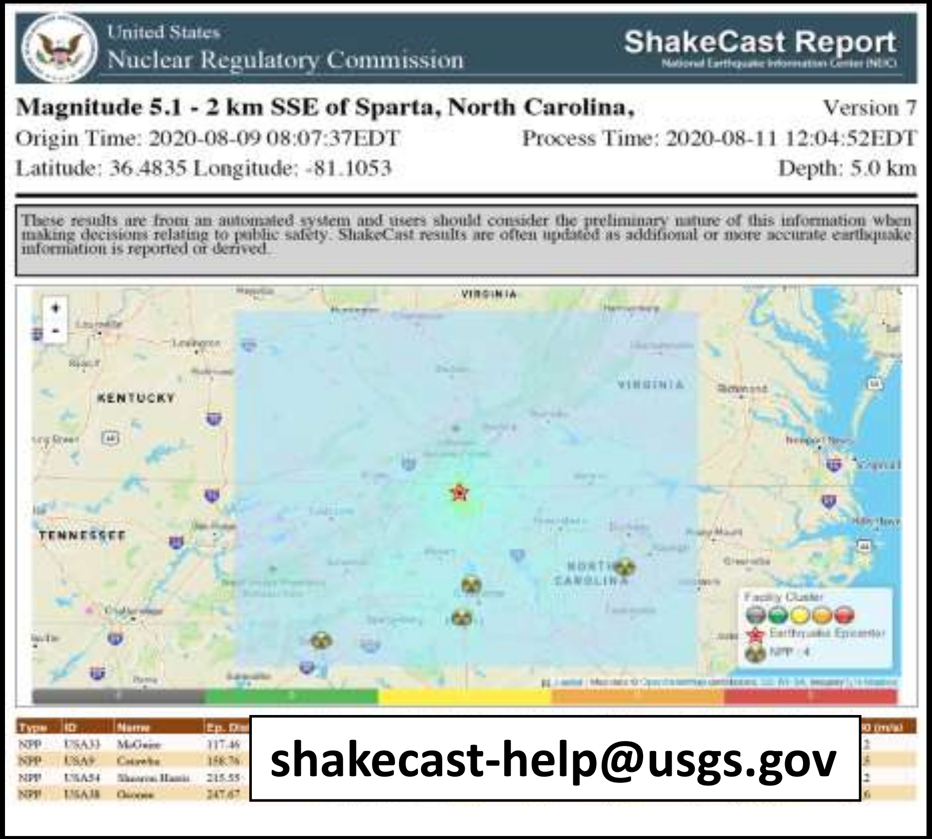
These results are from an automated system and users should consider the preliminary nature of this information when making decisions relating to public safety. ShakeCast results are often updated as additional or more accurate earthquake information is reported or derived.



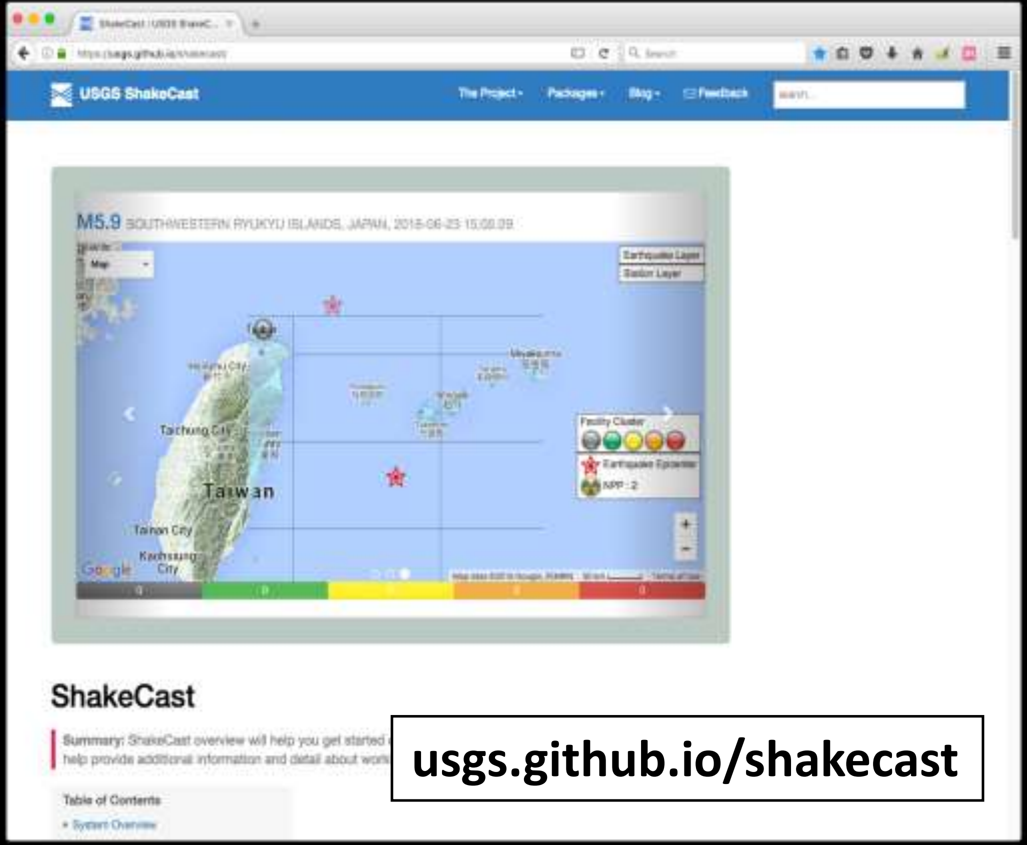
Type	ID	Name	Ep. Distance (km)	Inspection Priority	PGA (%g)	PGV (cm/s)	PSA 1s (%g)	MMI	Vs30 (m/s)
BRIDGE	L0472	6293 - DRAIN DTCH NO 3	29.52	Moderate	53.76	31.92	28.97	IX	219.4
BRIDGE	L0477	6296 - OLD FRANKLIN DRAIN	32.73	Moderate	62.11	39.38	35.74	IX	225.3
BRIDGE	S0883	8886 - MAIN DTCH NO 8	15.31	Low	42.37	19.11	17.49	VII	232
BRIDGE	1870003	32243 - DRAIN DTCH	16.84	Low	59.5	33.17	30.06	VIII	228.9
BRIDGE	A1820	1511 - IS 55	16.89	Low	41.04	19.77	18.15	VII	217.8
BRIDGE	A2481	32429 - COUNTY RD 362	16.91	Low	68.29	39.72	35.97	IX	237.3
BRIDGE	750027	14786 - DRAIN DTCH	17.09	Low	39.37	18.21	16.75	VII	220.3
BRIDGE	A6786	29424 - LATERAL DTCH NO 5	17.15	Low	63.16	38.42	34.9	IX	221.4
BRIDGE	A6787	29443 - LATERAL DTCH NO 5	17.21	Low	63.16	38.42	34.9	IX	221.4
BRIDGE	A1844	1535 - LATERAL DTCH NO 27	17.66	Low	39.73	18.59	17.08	VII	224.3
BRIDGE	A2415	2085 - IS 155	17.66	Low	64.64	38.71	35.11	IX	227.6
BRIDGE	A1743	1435 - LATERAL DTCH NO 27	17.71	Low	39.73	18.59	17.08	VII	224.3
BRIDGE	A1843	1534 - LATERAL DTCH NO 27	17.74	Low	39.73	18.59	17.08	VII	224.3
BRIDGE	A1700	1396 - MISSISSIPPI RVR COUNTY	17.89	Low	64.03	35.52	32.15	IX	238

* MMI level may extend beyond map boundary; some facilities may not appear on the map due to space restriction

Questions?



shakecast-help@usgs.gov



usgs.github.io/shakecast

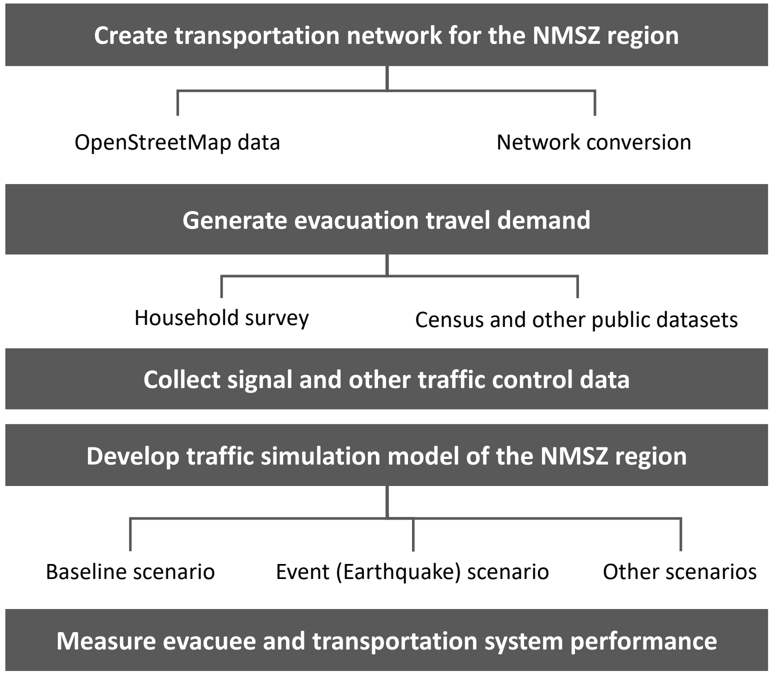
Earthquake Evacuation Modeling of New Madrid Region

Praveen Edara, Daeyeol Chang, Rick Bennett

Study sponsored by MoDOT
Chris Engelbrecht, Mike White, Jen Harper, Missouri DOT

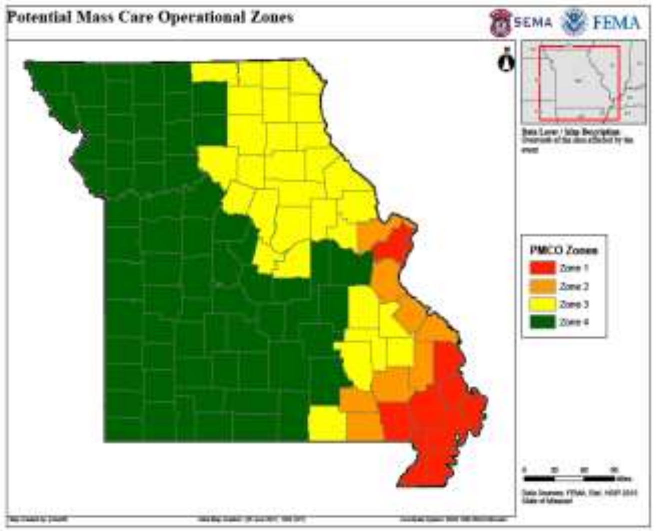
Project Objectives

- Assess evacuation performance using simulation models
- Identify locations of potential bottlenecks in the road network
- Estimate delays on major evacuation routes



Study Area

- Zone 1 of potential mass care operational zones developed by SEMA/FEMA
- Includes eight counties (Cape Girardeau, Scott, Mississippi, Stoddard, Butler, New Madrid, Dunklin and Pemiscot)

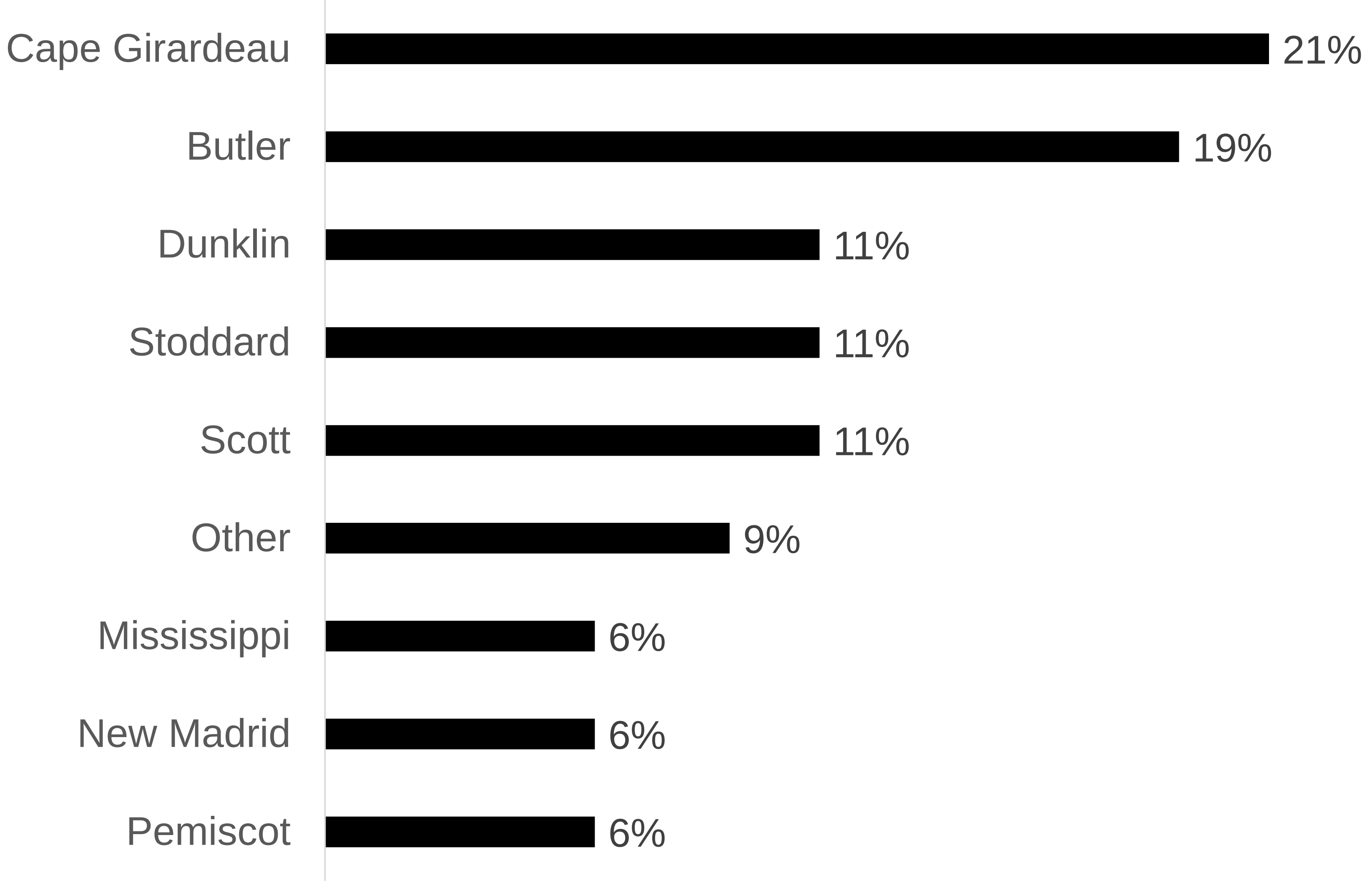


(Source: NMSZ Evacuation-MASS Care Initiative Overview, 2021)

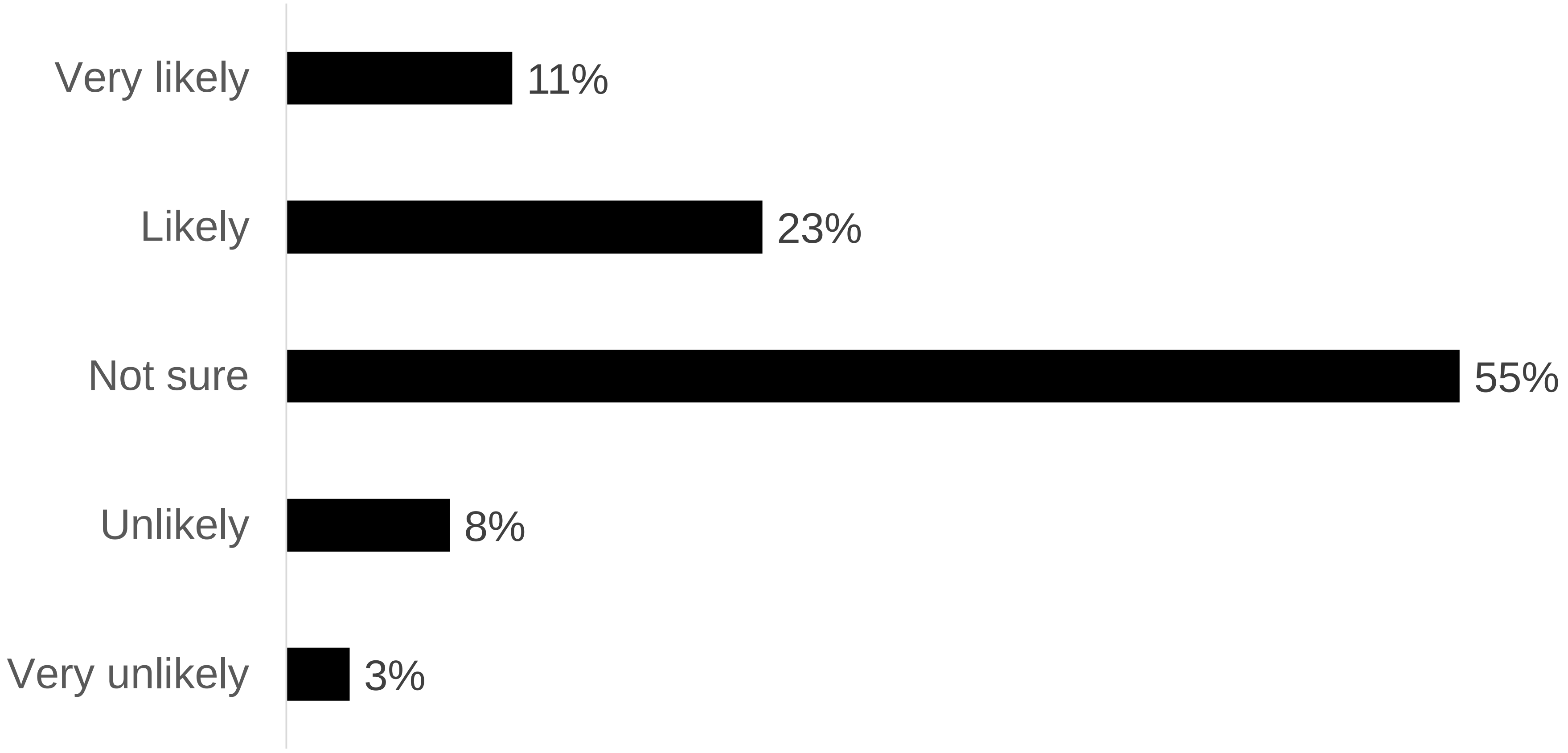
Survey Administration

- Online survey was open from January 28 to February 21
- 891 responses received

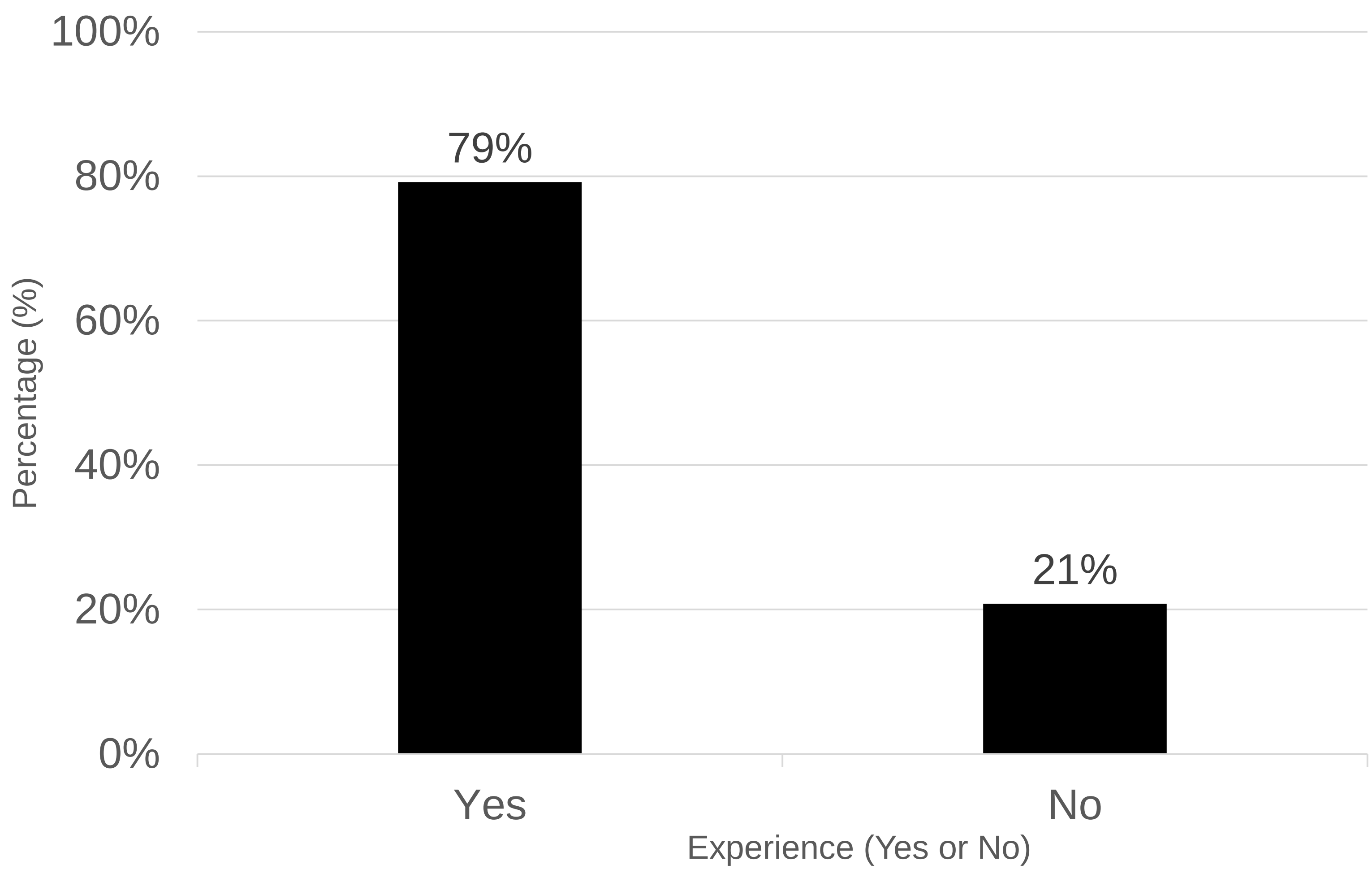
Q1. Select the county you live in (N= 891)



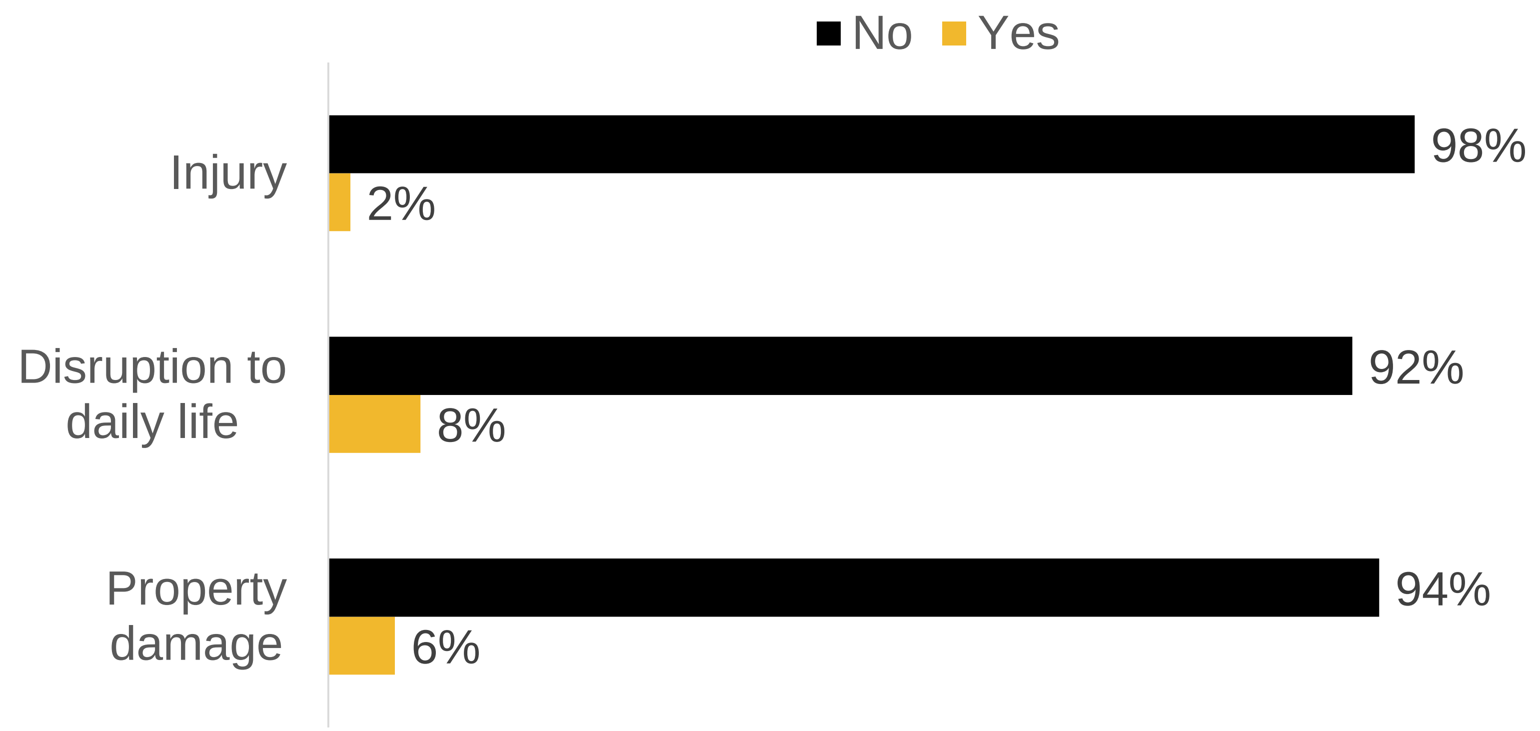
Q2. How likely is that you and your family will be impacted by an earthquake in the next five years? (N= 880)



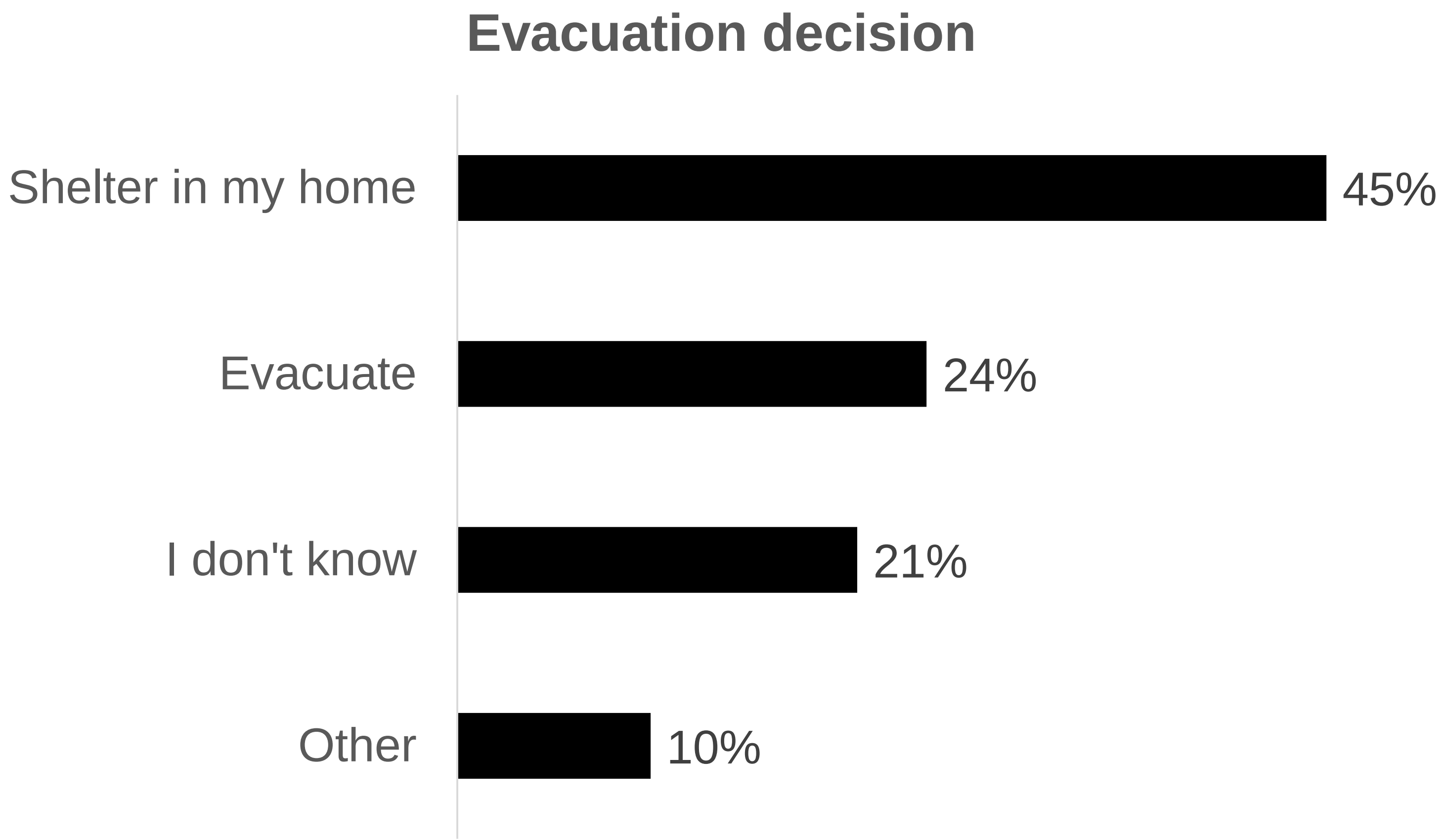
Q3. Have you ever experienced an earthquake? (N= 879)



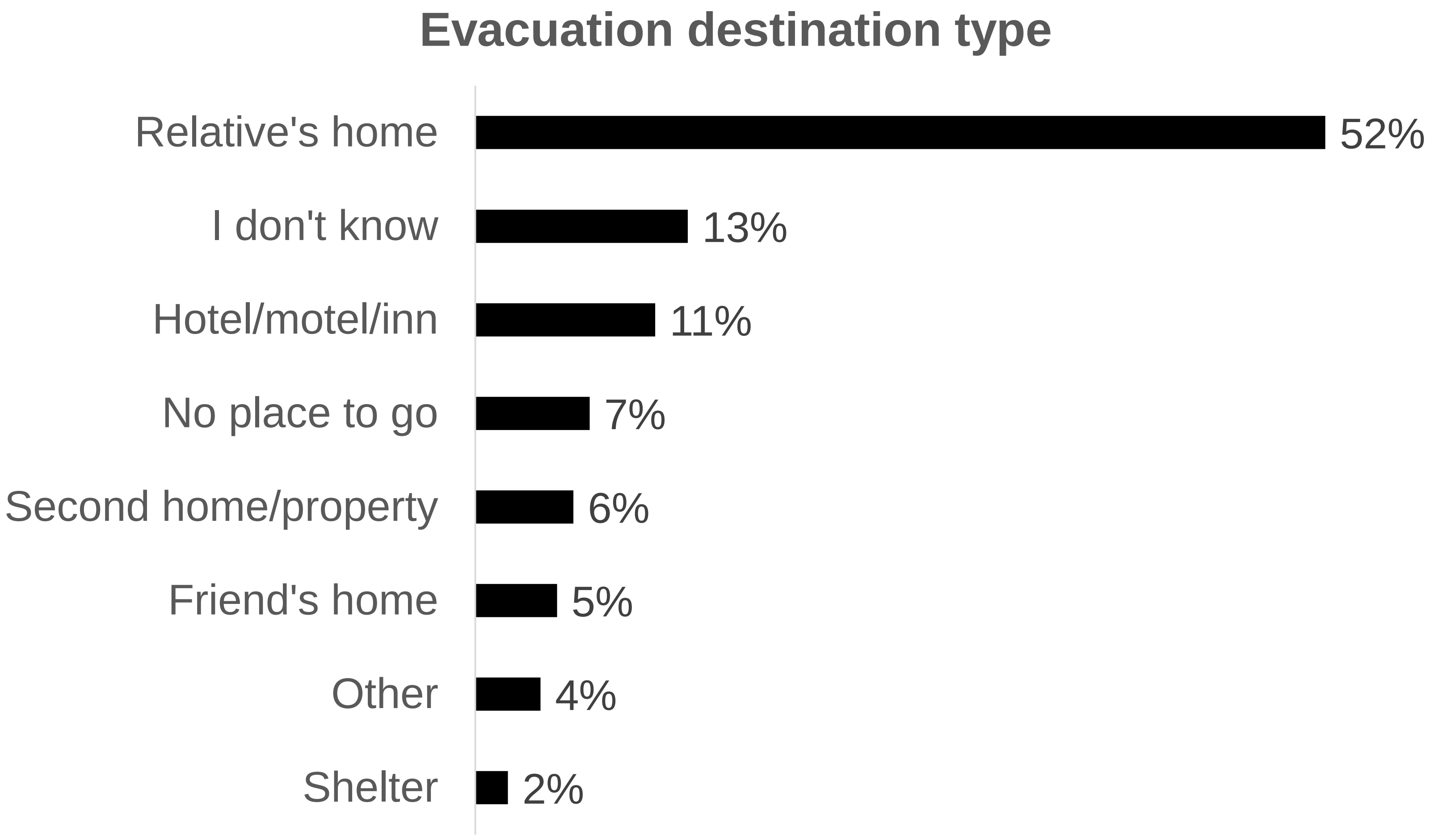
Q4. If you have experienced an earthquake before, did you have any of the following happen to you? (N= 790)



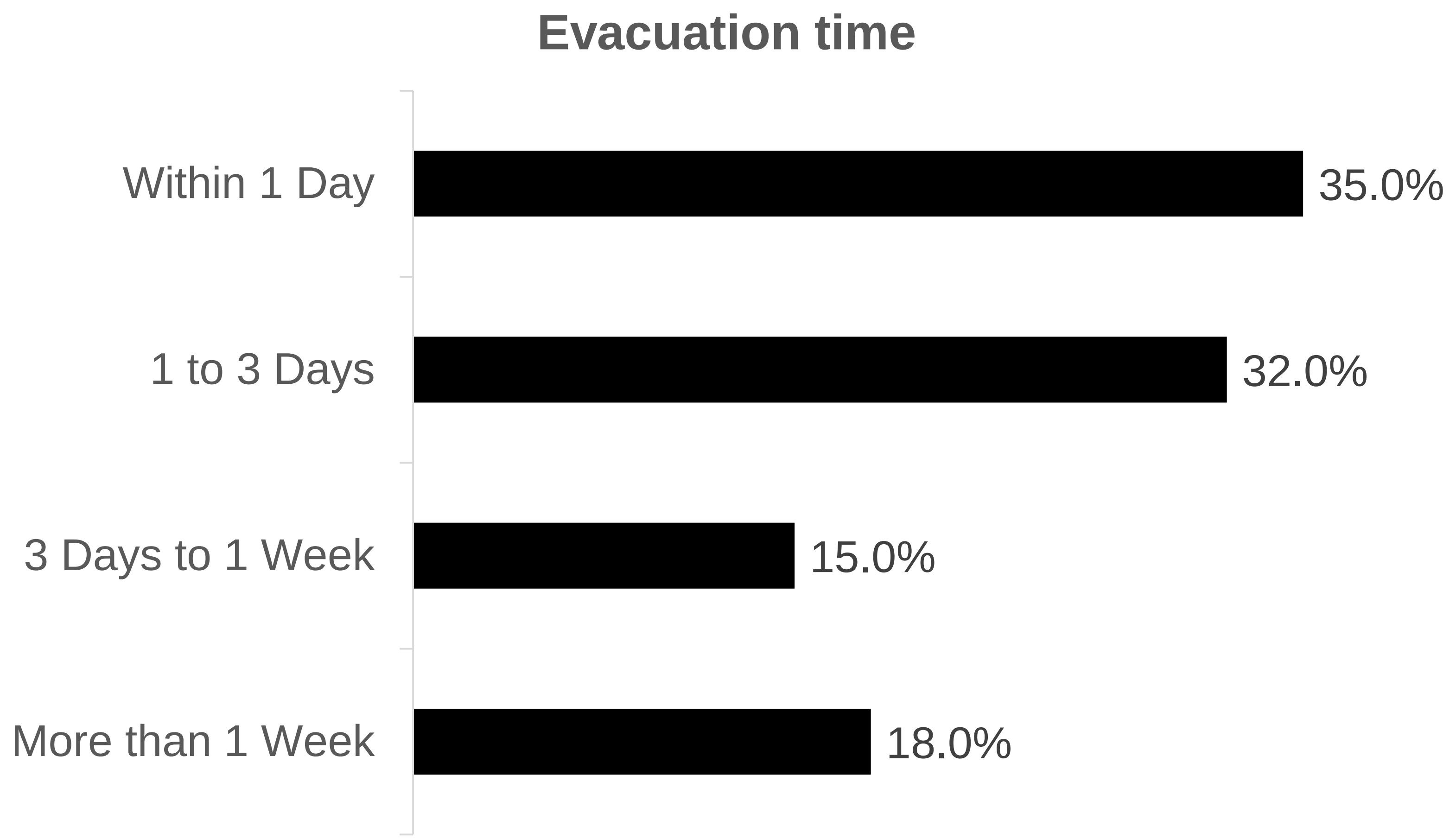
Q5. If an earthquake was going to impact your neighborhood, what would you be most likely to do? (N= 880)



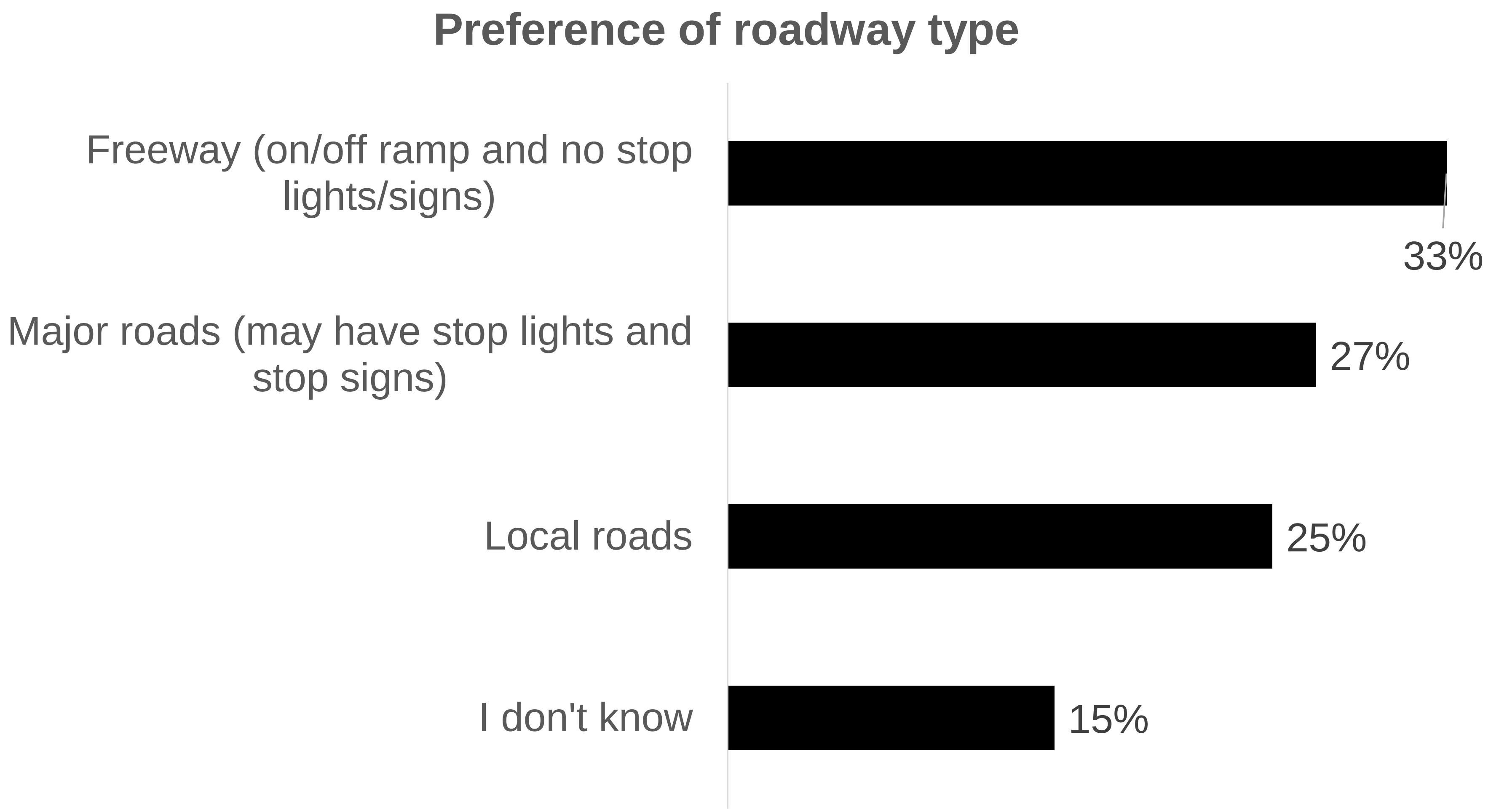
Q6. What kind of place would you go to? (N= 655)



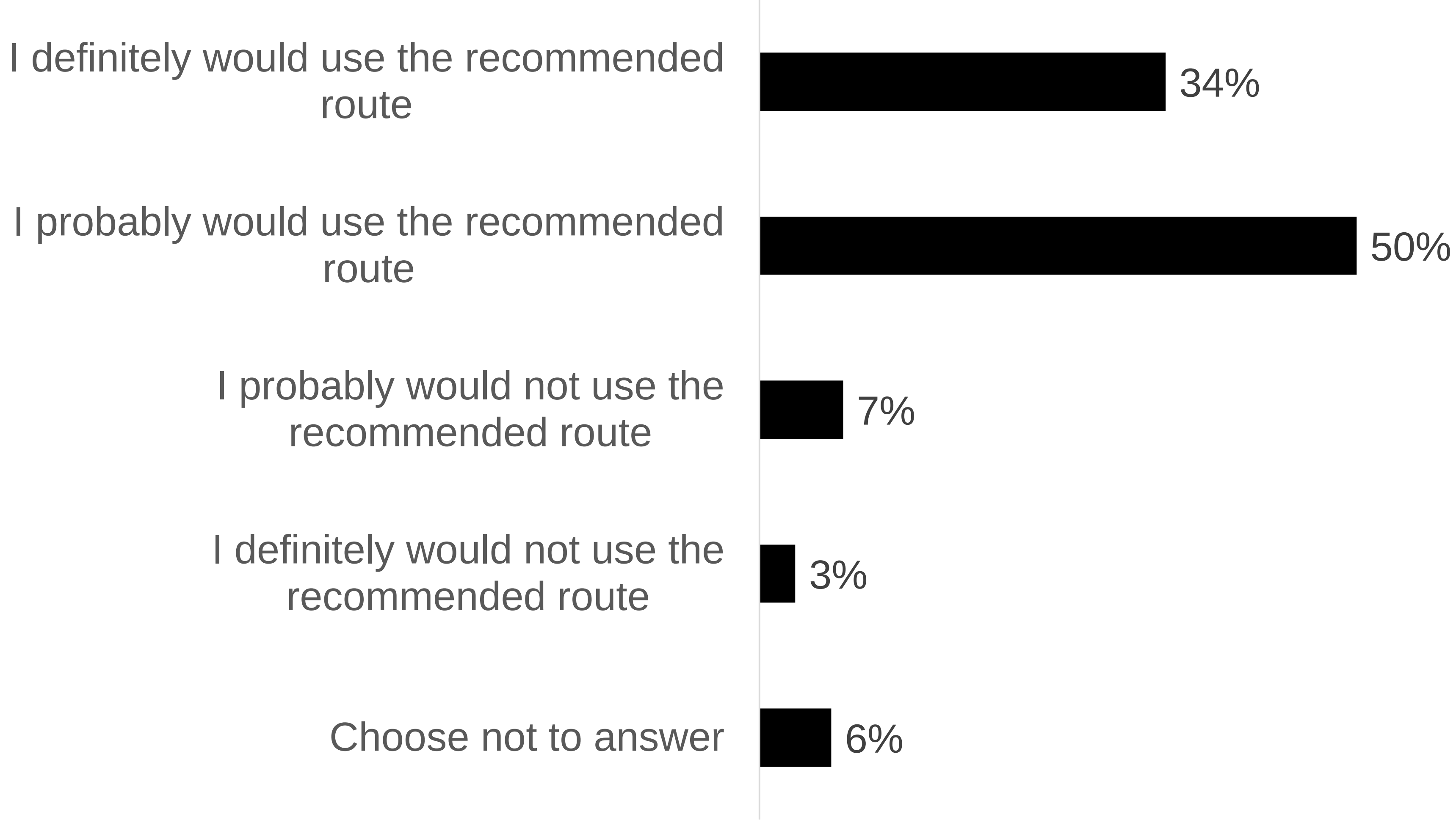
Q7. When do you think you would be most likely to leave to your destination after an earthquake? (N= 636)



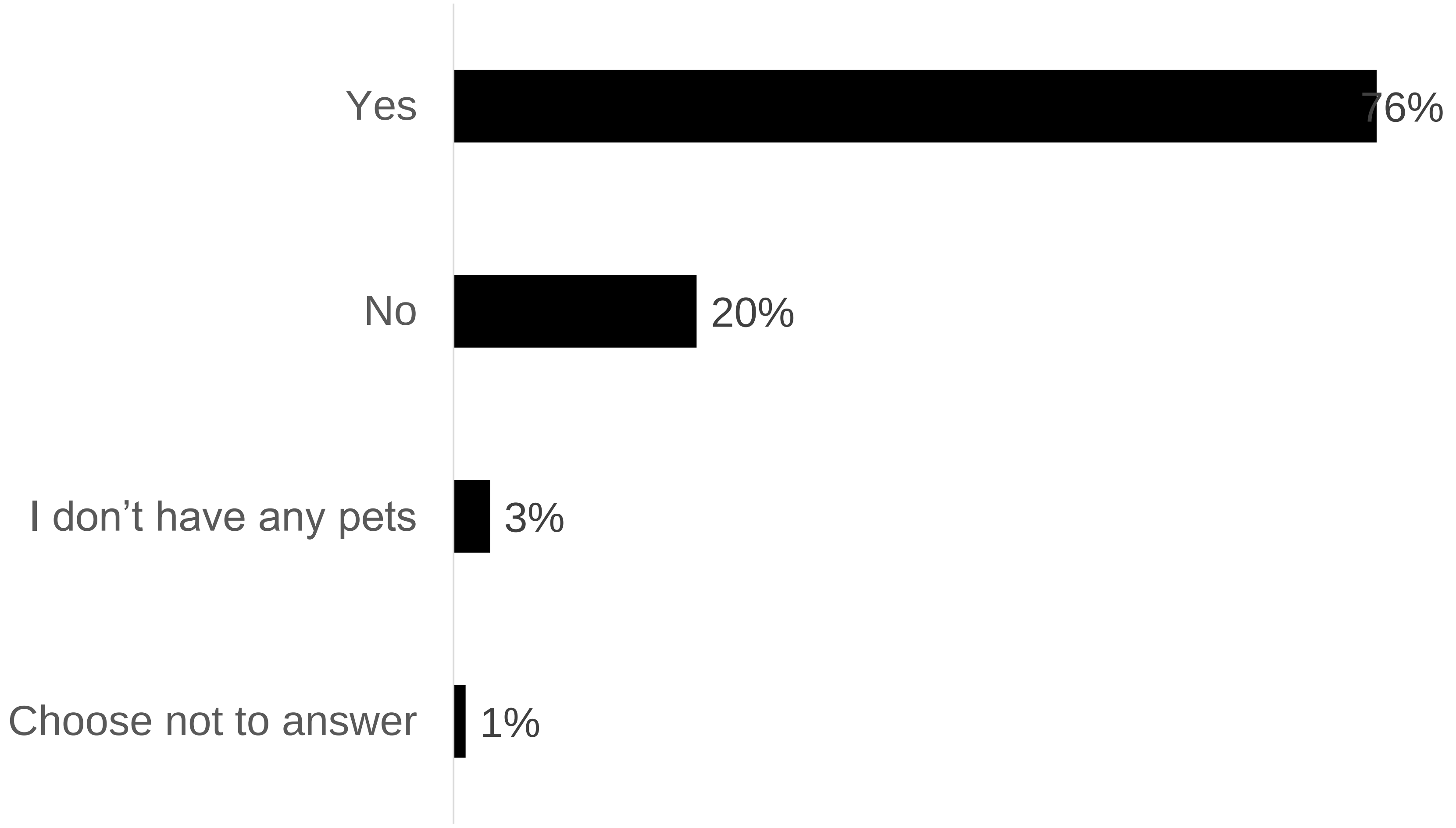
Q8. Which type of road would you mostly travel on? (N= 647)



Q9. If officials recommend using a particular evacuation route, would you use that route? (N= 649)



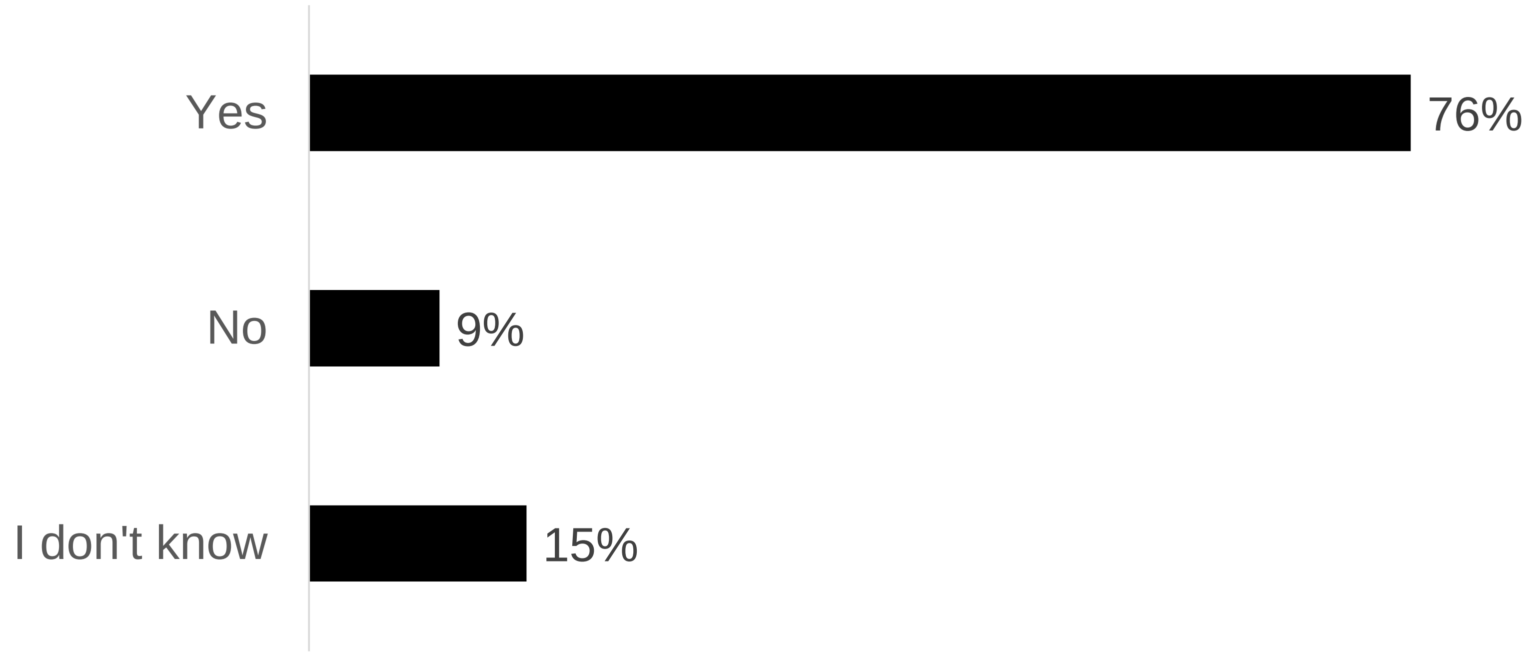
Q13. If you have any pets, will you take them with you if you evacuate? (N= 650)



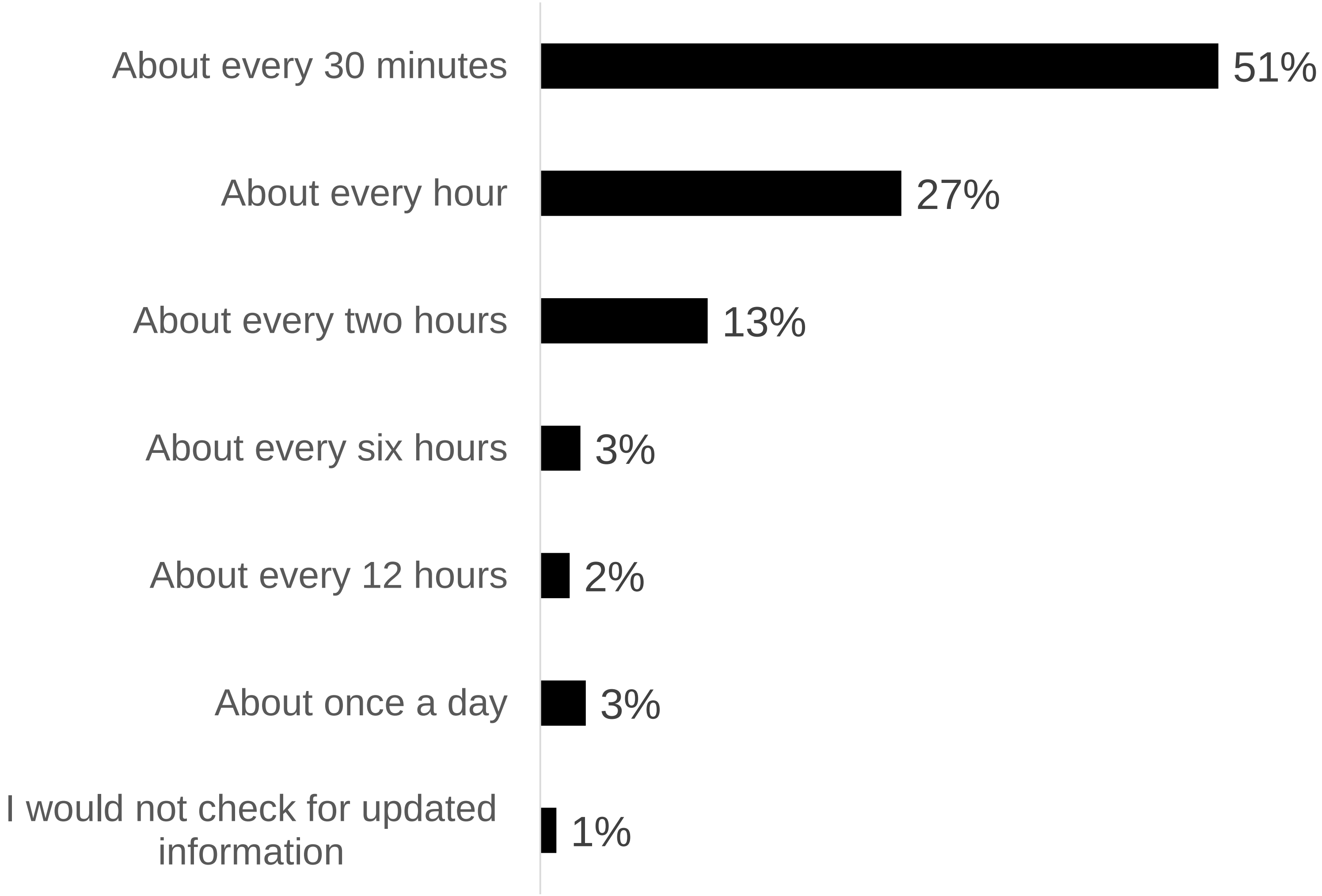
Earthquake Scenario

For the rest of the survey, we want you to <u>imagine that a catastrophic earthquake of magnitude 8.0 has occurred in the New Madrid region.</u> This region has experienced severe infrastructure damage with households losing access to basic utilities (power, internet, water, gas). A <u>mandatory evacuation order has been given for your neighborhood.</u> Please keep this scenario in mind as you answer the remaining questions.

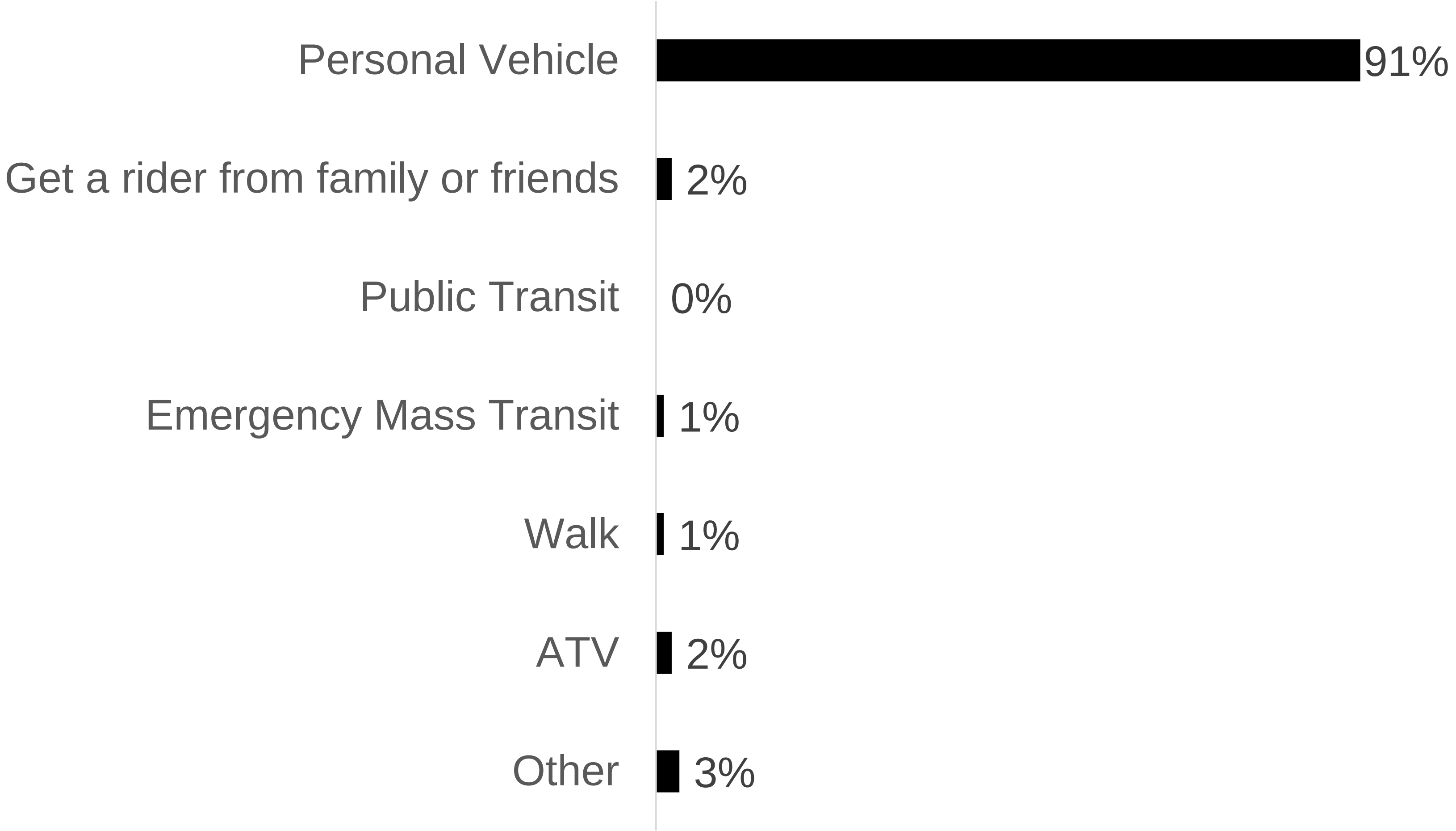
Q14. Given the scenario described above, would you evacuate? (N= 592)



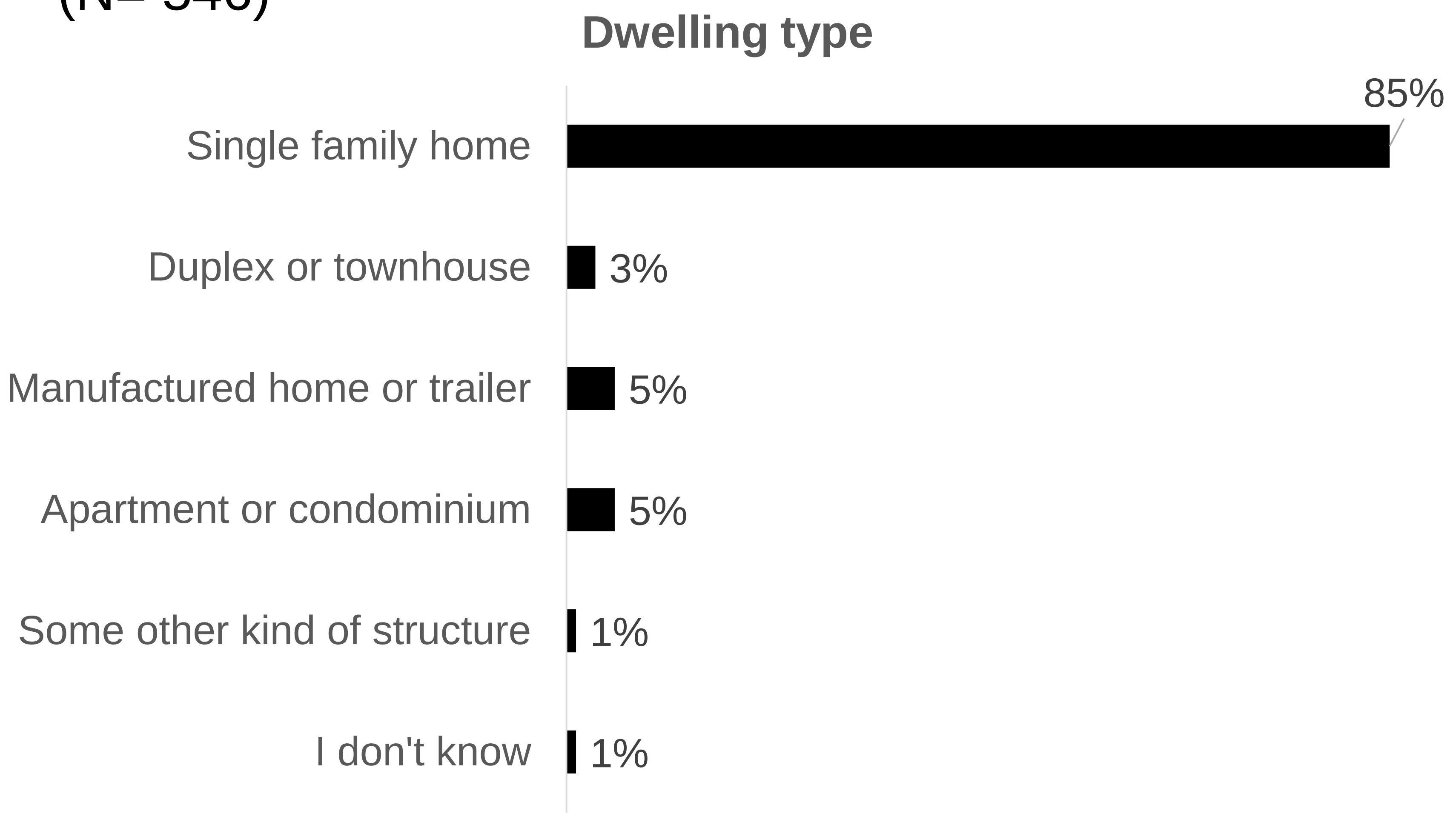
Q15. How frequently would you check for updated information on the earthquake and/or the evacuation? (N= 592)



Q16. Which of the following options would you be most likely to use to evacuate? (N= 586)



Q17. Which of the following best describes your home? (N= 546)



Q19. Where would you go? (N= 603)

Q20. What route would you take to get there? (N= 539)

Next Steps

- Analyze survey responses
- Build travel demand models using survey data and other public datasets (Census, ACS, BTS, etc)
- Generate demand between origin-destination pairs and assign it in simulation
- Generate evacuation performance measures

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