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16. ABSTRACT

When an earthquake occurs, the U. S. Geological Survey (USGS) product, ShakeMap, portrays the extent of potentially damaging shaking. In turn, ShakeCast, a freely available, post-earthquake situational awareness application, automatically retrieves earthquake shaking data from ShakeMap, analyzes shaking intensity data against users' facilities (e.g., bridges, buildings, roads), sends notifications of potential impacts, and generates maps and other web-based products for emergency managers and responders.
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hakeCast is particularly suitable for earthquake planning and response purposes by State Departments of Transportation (DOTs), in part since it can utilize existing Federal Highway Administration (FHWA) National Bridge Inventory (NBI) databases to implement shaking-based inspection priority and impact assessments. The California Department of Transportation (Caltrans) has been working with the USGS since 2007 to develop a robust and operational ShakeCast platform. A long-term goal is to "connect the DOTs" to bring this technology to all states with seismic hazards, as the major earthquakes anticipated to occur in the future will cross state borders. The third iteration of the system, ShakeCast V3, released in 2014, includes a full statistical fragility analysis framework for general structural assessment of bridges as part of the near real-time system; significant improvements in the graphical user interface, including a console view for operations centers; and custom, user-defined hazard and loss modules. This version is intended to include advancements in estimating the likelihood of shaking-induced secondary hazards to bridges and along roadways due to landslides and liquefaction.

Following a major earthquake, transportation agencies are tasked with assessing the condition of all potentially impacted bridges and roadway corridors on the state highway system. Timely response is important to ensure public safety, guide emergency vehicle traffic, and re-establish critical lifeline routes. ShakeCast provides an effective tool that assures post-earthquake situational awareness in the minutes and hours following a damaging earthquake. It allows responders to make informed decisions and take quick actions to ensure safety, restore system

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TPF-5(357), “Connecting the DOTs Phase II: Implementing ShakeCast Across Multiple State Departments of Transportation for Rapid Post-Earthquake Response”

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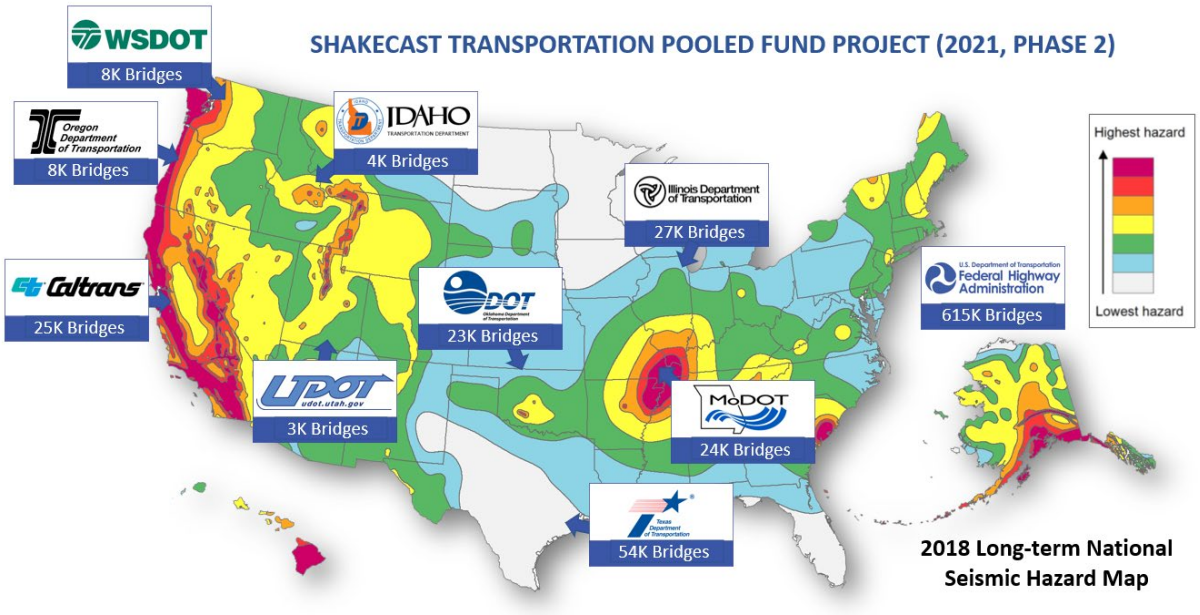

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Contents

1 PROJECT BACKGROUND

When an earthquake occurs, the U. S. Geological Survey (USGS) product, ShakeMap, portrays the extent of potentially damaging shaking. In turn, ShakeCast, a free and open-source application for post-earthquake situational awareness, automatically retrieves earthquake shaking data from ShakeMap, analyzes shaking intensity data against users' facilities (e.g., bridges, buildings, roads), sends notifications of potential impacts, and generates maps and other web-based products for emergency managers and responders.

ShakeCast is particularly suitable for earthquake planning and response purposes by State Departments of Transportation (DOTs), in part since it can utilize existing Federal Highway Administration (FHWA) National Bridge Inventory (NBI) databases to implement shaking-based inspection priority and impact assessments. The California Department of Transportation (Caltrans) has been working with the USGS since 2007 to develop a robust and operational ShakeCast platform. A long-term goal is to "connect the DOTs" to bring this technology to all states with seismic hazards, as the major earthquakes anticipated to occur in the future will cross state borders. The third iteration of the system, ShakeCast V3, released in 2014, includes a full statistical fragility analysis framework for general structural assessment of bridges as part of the near real-time system; significant improvements in the graphical user interface, including a console view for operations centers; and custom, user-defined hazard and loss modules. This version is intended to include advancements in estimating the likelihood of shaking-induced secondary hazards to bridges and along roadways due to landslides and liquefaction.

Following a major earthquake, transportation agencies are tasked with assessing the condition of all potentially impacted bridges and roadway corridors on the state highway system. Timely response is important to ensure public safety, guide emergency vehicle traffic, and re-establish critical lifeline routes. ShakeCast is an effective tool that assures post-earthquake situational awareness in the minutes and hours following a damaging earthquake. It allows responders to make informed decisions, take quick actions to ensure safety, restore system functionality, and minimize losses. ShakeCast, short for *Shake*Map Broad*cast*, was developed in the mid-2000s by the USGS as a tool to support dissemination and use of ShakeMap products. ShakeMap is a system for automatically generating maps of ground motion from instrumental recordings immediately following an earthquake.

ShakeCast is a fully-automated, open-source system for delivering specific ShakeMap products to users and for triggering established post-earthquake response protocols. ShakeCast allows infrastructure owner/operators to automatically determine the shaking value at their facilities, set thresholds for notification of damage states for each facility and then automatically notify (via pager, cell phone, or email) specified operators, inspectors, and others within their organizations responsible for those facilities in order to prioritize inspection and response. Caltrans assumed a leadership role in working closely with the USGS in the development and deployment of an initial pilot application that is now embraced within Caltrans and is being modeled by other organizations. The technology behind ShakeCast continues to evolve and mature, and this project seeks to continue Caltrans' partnership with the USGS to provide more, better, and tailored bridge and roadway status information to emergency responders.

Starting in July 2017, under the Transportation Pooled Fund (TPF) Project Study Number TPF-5(357), Connecting the DOTs: Implementing ShakeCast across Multiple State Departments of Transportation for Rapid Post-Earthquake Response (TPF ShakeCast), the USGS began work to develop, deploy, and support full ShakeCast operation for all participating members. The proposed work consists of several tasks and all work elements require extensive interaction with all participants.

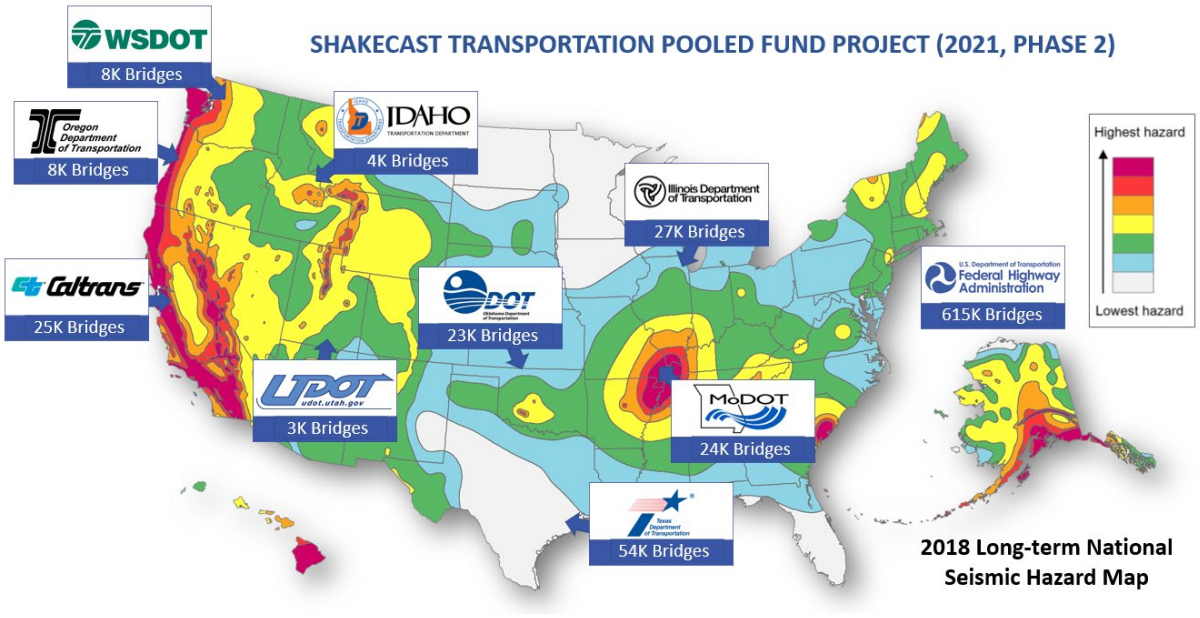


Figure 1.1 Distribution of shaking hazards and state transportation department partners in the TPF Phase II Project. Ten state Departments of Transportation (DOT) – CA, ID, IL, MO, OK, OR, SC (Partial), TX, UT, WA, and FHWA – have partnered with the USGS ShakeCast team.

1.1 Scope of Work

The work was carried out by the USGS over a three-year period beginning July 2017 and ending June 2020, with an extension to 2022. The tasks are listed below for the first phase (Phase I)

- Task 1- Establish operational ShakeCast systems for participating DOTs.
- Task 2 - Develop, modify, and customize ShakeCast features to the meet the needs of the state DOT participants.
- Task 3 - Develop a roadmap for long-term ShakeCast operations.
- Task 4 - Prepare a Final Report that documents the work carried out under this project.

From 2022 to 2024, some of the core tasks for Phase II of the TPF are similar to Phase I tasks as they pertain to operations and maintenance, but other tasks are modified as listed below:

- Task 1 – Operations and Maintenance of ShakeCast systems for participating DOTs.
    - Provide ShakeCast Cloud Hosting at USGS. Hosting includes: (i) Standing up secure cloud hardware and firewalls, with redundant operations in Denver and Sioux Falls; (ii) troubleshooting as needed (switching primary and secondary for maintenance, patching software; (iii) system and software monitoring and heartbeats; (iv) fixing bounced email messages; (v) ShakeCast software bug fixes and updates.
    - Update ShakeCast instances to Version 4 of ShakeCast (PyCast) for both in-house and USGS cloud hosted instances. V4 ShakeCast is virtually the same in terms of products and output but has been completed refactored, modernizing platform (Perl to Python), communications, databases and web platform and functionality.

- Task 2 – TPF User Support
    - Facilitate updates to DOT facilities, fragility, notifications, and configurations.
    - Provide Operational Support for earthquake scenarios and after actual events.
    - Provide support for product template and notification configurations and website content modifications.
    - Respond to DOT technical and support questions, and provide training on ShakeCast components (e.g., ShakeCast Workbook, ShakeCast website), as requested.

- Task 3 – Develop, modify, and customize individual and TPF ShakeCast features:
    - Implement leftover feature requests from Phase I (2017-2020), including:
        - Ground Failure
        - Advanced Fragilities (e.g., g2f)
    - Identify and implement new features and improvements (e.g., long-term hazard/risk analyses).
    - Develop, test and implement new features (e.g., extended inventory types).

- Task 4 – Reporting
    - Document Task milestones in Quarterly Reports; document events of significance and efforts to support individual DOTs.
    - Collectively update and develop a Roadmap for long-term ShakeCast operations and research following the conclusion of the TPF project.
    - Prepare a Final Report that documents the work carried out under this project.

2 OVERVIEW OF THE SHAKECAST TPF

ShakeCast (ShakeCast · Wiki · ghsc / Engineering Seismology and Impacts / Shakecast / ShakeCast · GitLab (usgs.gov)), short for *Shake*Map Broad*cast*, is a fully-automated, open-source system for delivering specific ShakeMap and related earthquake products to critical users and for triggering established post-earthquake response protocols. ShakeCast allows utilities, transportation agencies, and other large organizations to automatically determine the shaking value at their facilities, set thresholds for notification of damage conditions (typically green, yellow, and red) for each facility and then automatically notify (via pager, cell phone, or email) specified operators, inspectors, and others within their organizations responsible for those facilities to prioritize inspection and response.

DOTs are prime candidates for deploying ShakeCast for quick evaluation of seismic intensity at their bridges. Since the shaking pattern is complex and the vulnerability of bridges varies greatly, ShakeCast can greatly increase the accuracy of post-earthquake inspection prioritization over simplified approaches. Recent improvements in cloud-hosting and ShakeCast software improvements have made implementation and operation of ShakeCast less onerous. For a robust 24x7 operation of such a critical notification system, some significant technical in-house expertise is required by the user, and staff must be available and aware of technical problems that typically come with operating any such system. Several critical users, including the U.S. Nuclear Regulatory Commission (USNRC, for Nuclear Power Plants, or NPP's), the Federal Energy Regulatory Commission (FERC, for Hydroelectric Dams), the Veteran's Administration (VA, for hospitals), and the Alyeska Pipeline Service Company (Alyeska, for mainline integrity) all outsourced operations of their ShakeCast "instance" by funding USGS directly to operate ("host") their respective ShakeCast systems in the USGS internal cloud computing environment. USGS provides alerts to interested personnel of these organizations and provide interactions on the use of the system for real earthquakes, planning scenarios, and overall system configuration.

The TPF ShakeCast Remote (V3) system, a modified multi-tenant system consisting of twelve instances on which the USGS ShakeCast V3 is based, was created and has been in operation since 2018. The Caltrans ShakeCast V3 system is a post-earthquake application and accommodates a broader range of facility, vulnerability function, notification message and product to satisfy the requirements of Caltrans user groups (Figure 2.1).

The TPF ShakeCast system automatically retrieves earthquake shaking data from the USGS, compares ground motion intensity measures against the relevant data (e.g., fragility curves) for the facilities in the impacted area, sends notifications of potential impact to responsible parties, and generates facility impact assessment maps and other web-based products for emergency managers and responders. The earthquake shaking data used by ShakeCast is in the form of a ShakeMap (i.e., a map that displays earthquake shaking parameters spatially), which is obtained by the ShakeCast system that monitors USGS web products. If an earthquake occurs that is above magnitude 3.5 for the Territories of the United States, the software retrieves the ShakeMap and begins a series of actions based on protocols and databases previously specified by the user for the impacted area. For example, the Caltrans ShakeCast instance will perform probabilistic fragility analysis for State and local-owned bridges (BRIDGE_ST and BRIDGE_LC), and HAZUS-based building fragility analysis for selected buildings. After performing the specified actions, the

system sends automated notifications containing information needed by key Caltrans ShakeCast users.

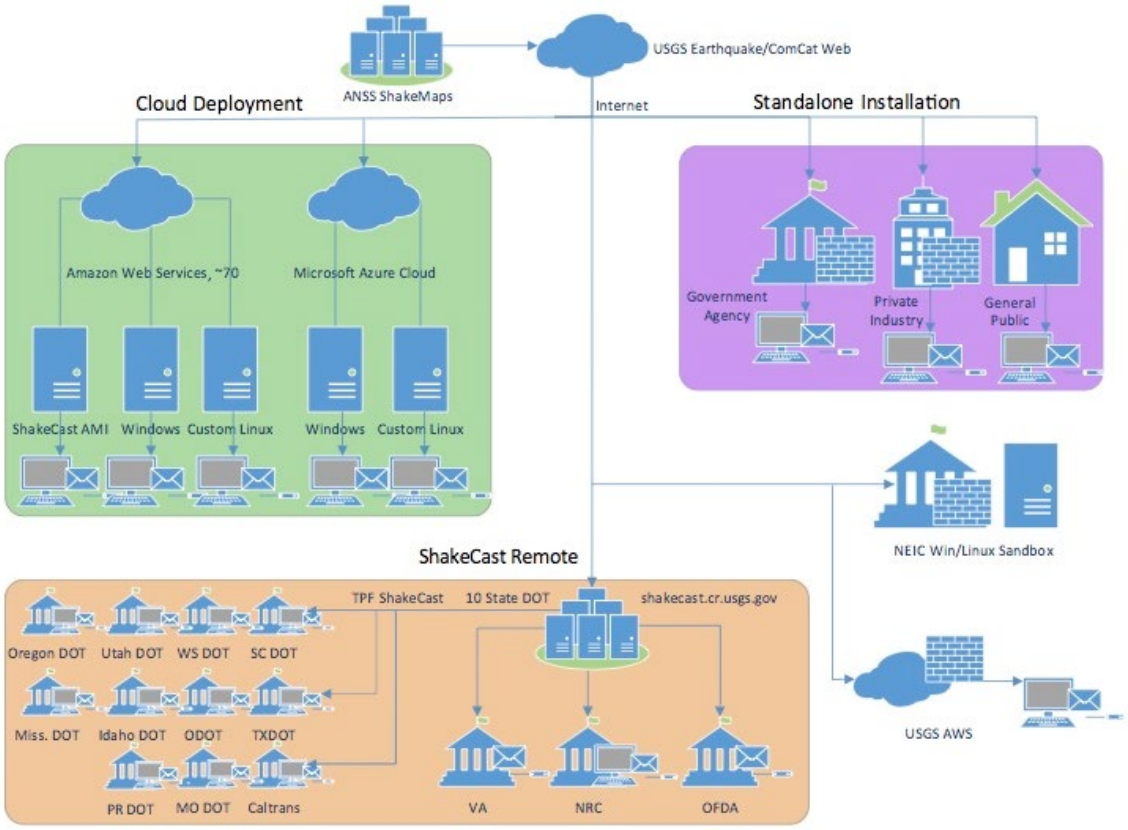


Figure 2.1 ShakeCast system and user topology showing deployment options and data pathway for earthquake/ShakeMap information.

Specific ShakeMap data related to facility assessment that have been made available to ShakeCast users include: (1) detailed processing parameters about the ShakeMap run; (2) ground shaking estimates at bedrock (before site corrections) and site amplifications at the grid level; and (3) uncertainty estimates for each computed shaking metric at the grid level.

The TPF ShakeCast further integrates the USGS Product Distribution Layer (PDL) as a redundant source to receive earthquake and ShakeMap products. Regarding ShakeMap scenarios for the purpose of earthquake exercises, the TPF ShakeCast system introduces a new workflow to streamline the process. Aside from direct access to the USGS ShakeMap archive, a suite of nearly 800 earthquake scenarios (BSSC2014) and 14,000 significant historical earthquakes (the ShakeMap Atlas; Marano et al., 2024) have been prepared for the TPF ShakeCast project.

3 OPERATIONAL TPF SHAKECAST INSTANCES

The first set of ten TPF ShakeCast instances were created after the project kickoff meeting in July 2017 and the completion for the cloud-based USGS ShakeCast Remote server at the Denver Federal Center with an exact functional backup at the USGS's Sioux Falls data center.

During Phase I of the project, 2018-2021, the default setup for a ShakeCast instance includes the initial bridge inventory based on the 2016 NBI database (later updated to 2020) for the designated State DOT and two notification groups (for actual and scenario earthquakes) that represent the geographic boundaries of the state. The ShakeCast NBI conversion tool was used to provide mapping between the NBI bridge class and the Hazus bridge model and fragility for the base bridge model further refined with additional NBI parameters based on the Hazus methodology. The USGS ShakeCast team also worked with each DOT to finalize their requirement specifications regarding structure inventory, user groups, products, and notification configuration. To balance the objective to provide the TPF ShakeCast as a "Cloud Software as a Service (SaaS)" and the security requirements (FedRAMP Low) of the ShakeCast server, a separate repository (Trello) was created for content management to minimize the needs for web access. Earthquake-specific ShakeCast reports and quarterly summaries are posted automatically by the TPF ShakeCast system.

Currently, the TPF ShakeCast system has been updated with the 2020 NBI database in 2022.

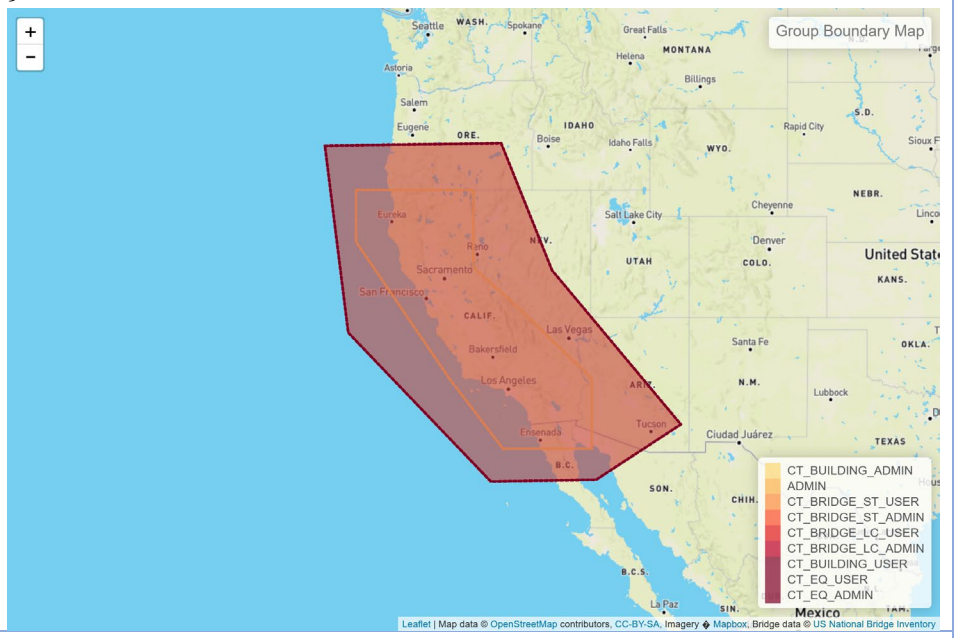
Table 1. State DOT ShakeCast Deployment Status in 2024

State DOT	In-House ShakeCast System? (2024)	ShakeCast-Related Research and Development?	Level of Customization
California	No	Yes	High
Washington	Yes?	No	Default
Utah	No	TBD	Moderate
Oregon	No	Yes	Moderate
Oklahoma	Yes (AWS)	Yes	High
S. Carolina	No	TBD	Default
Idaho	No	TBD	Moderate
Illinois	No	TBD	Moderate
Texas	No	Yes	High
Missouri	No	TBD	Moderate
FHWA	No	TBD	High

Figure 3.1 Earthquake monitoring regions for individual DOT regions. Each DOT region covers its State boundaries and bordering areas. The FHWA region covers all U.S. 50 States and territories.

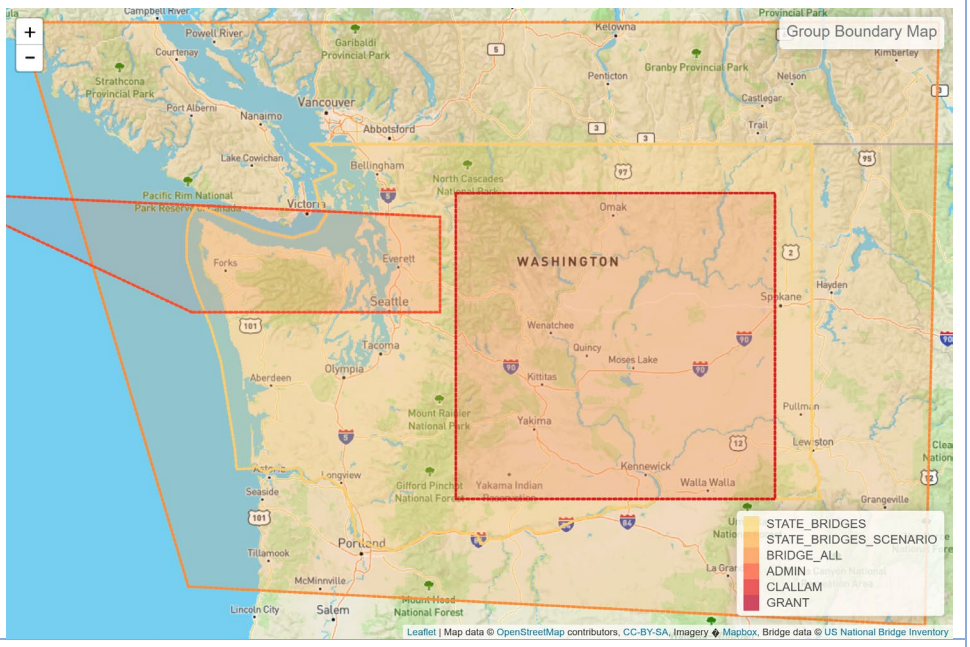
3.1 Caltrans ShakeCast Instance

The Caltrans ShakeCast instance at USGS was initially set up as the backup service for Caltrans' in-house ShakeCast V3 system with identical inventory of state and local bridges and Caltrans' own fragility assignments. Caltrans made the decision to retire their own system and the server migration to a remote USGS ShakeCast instance was completed in the summer of 2019.

Deployment Item	Note
Header Logo	
Facility	BRIDGE_LC (13,264), BRIDGE_ST (13,202), BUILDING (380)
Data Assurance	Yes
Fragility	Hazus, 2nd Generation Facility (g2F), AEBM (Building)
Notification Group	9 
User	Admin (3), Group (9), Individual (32)
Custom Product	CSV, KML, HTML
Magnitude Threshold	4.0 (GSM-only)
Notification Template	Custom
Scenario Exercise	Yes
Supplemental Data	Yes

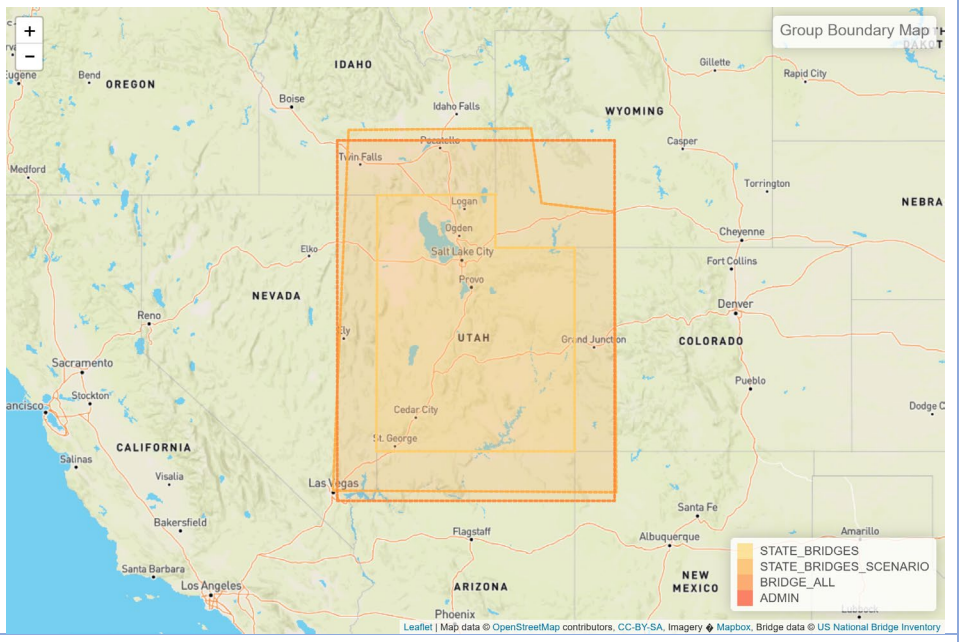
3.2 Washington DOT ShakeCast Instance

WSDOT's ShakeCast effort dated back to version 2 of the ShakeCast software. The TPF ShakeCast instance at USGS is however not tied to their in-house installation and is considered as the default setup.

Deployment Item	Note
Header Logo	Washington State Department of Transportation — ShakeCast Report — National Earthquake Information Center (NEIC)
Facility	BRIDGE (7,782)
Data Assurance	Default
Fragility	Hazus
Notification Group	4 
User	Admin (1), Group (4), Individual (6)
Custom Product	Default
Magnitude Threshold	3.5
Notification Template	Default
Scenario Exercise	Yes
Supplemental Data	Yes (Local/County Data)

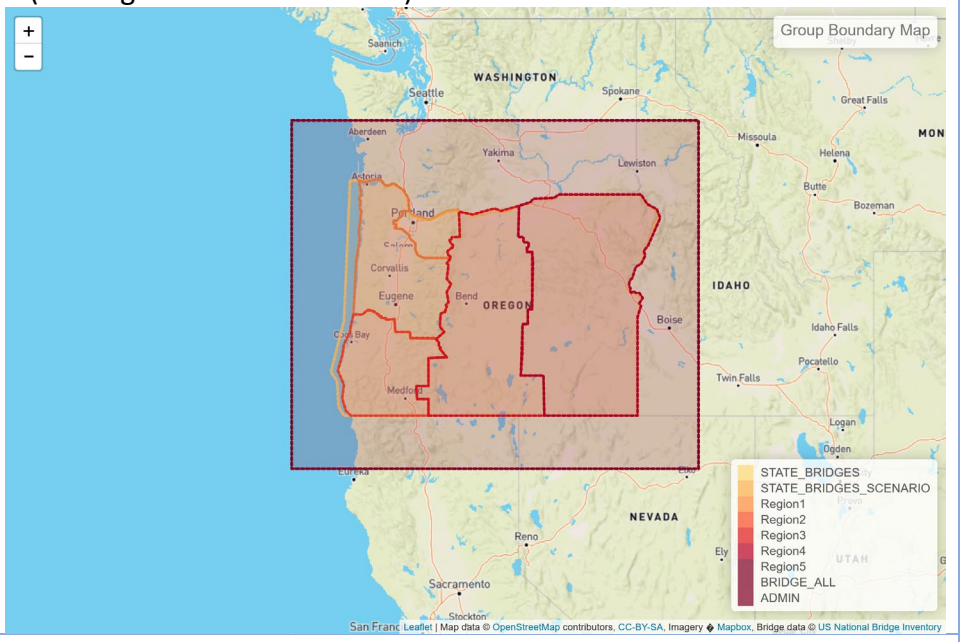
3.3 Utah DOT ShakeCast Instance

UDOT's ShakeCast effort dated back to version 2 of the ShakeCast software via the University of Utah and the OES. The TPF ShakeCast instance at USGS is a redeployment and had been checked for data assurance.

Deployment Item	Note
Header Logo	State of Utah Department of Transportation — Keeping Utah Moving — ShakeCast Report — National Earthquake Information Center (NEIC)
Facility	BRIDGE (3,017)
Data Assurance	Yes
Fragility	Hazus (CA model)
Notification Group	4 
User	Admin (1), Group (4), Individual (8)
Custom Product	Default
Magnitude Threshold	4
Notification Template	Default
Scenario Exercise	Yes
Supplemental Data	No

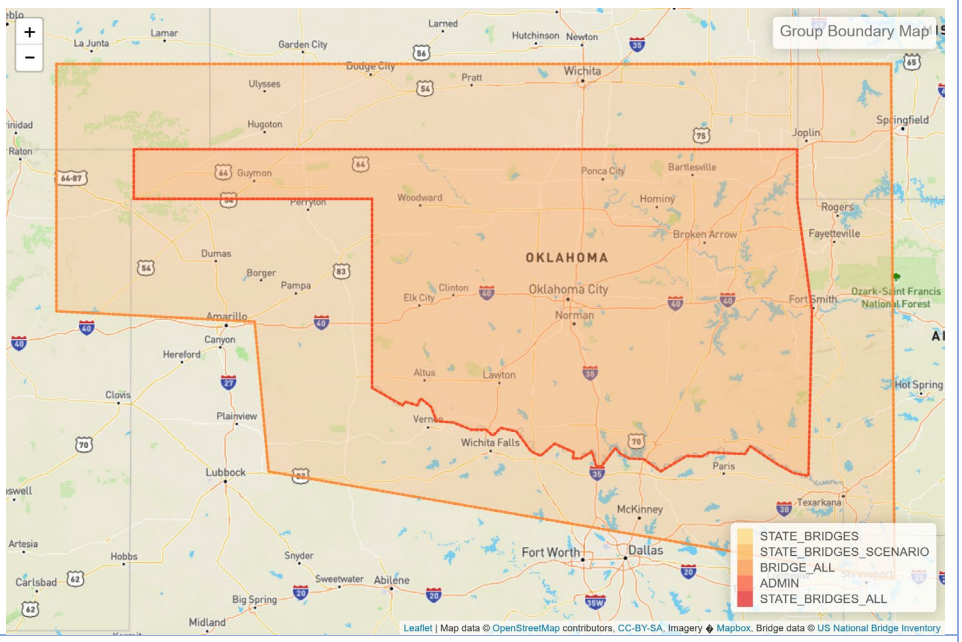
3.4 Oregon DOT ShakeCast Instance

ODOT's ShakeCast effort dated back to version 2 of the ShakeCast software (Windows OS). The TPF ShakeCast instance at USGS is a redeployment and had been checked for data assurance.

Deployment Item	Note
Header Logo	State of Oregon Department of Transportation — ShakeCast Report — National Earthquake Information Center (NEIC)
Facility	BRIDGE (7,621)
Data Assurance	Yes
Fragility	Hazus (CA model)
Notification Group	8 (five regions within the State) 
User	Admin (1), Group (10), Individual (24)
Custom Product	Default
Magnitude Threshold	4 (EQ/GSM Hybrid)
Notification Template	Default
Scenario Exercise	Yes
Supplemental Data	No

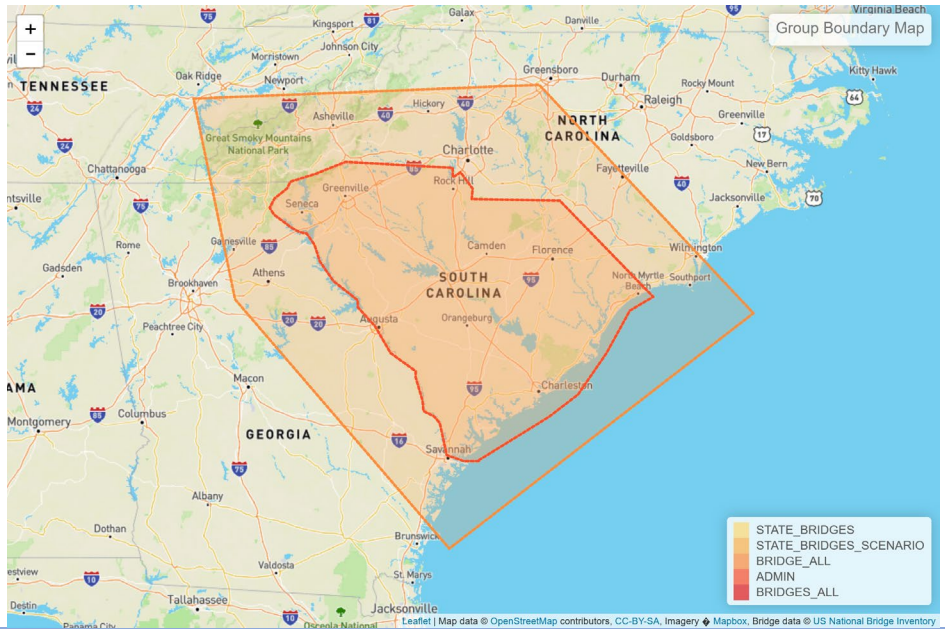
3.5 Oklahoma DOT ShakeCast Instance

The Oklahoma DOT ShakeCast instance at USGS was initially set up as a new deployment and was converted to be a backup service for the AWS installation managed by ODOT via the University of Oklahoma. The TPF ShakeCast system was populated with an identical copy of bridge inventory and fragility assignments from the university.

Deployment Item	Note
Header Logo	State of Oklahoma Department of Transportation — ShakeCast Report — National Earthquake Information Center (NEIC)
Facility	BRIDGE (22,882)
Data Assurance	Yes
Fragility	Hazus
Notification Group	2 
User	Admin (1), Group (6), Individual (3)
Custom Product	Default
Magnitude Threshold	4.0 (EQ/GSM Hybrid)
Notification Template	Default
Scenario Exercise	Yes
Supplemental Data	No

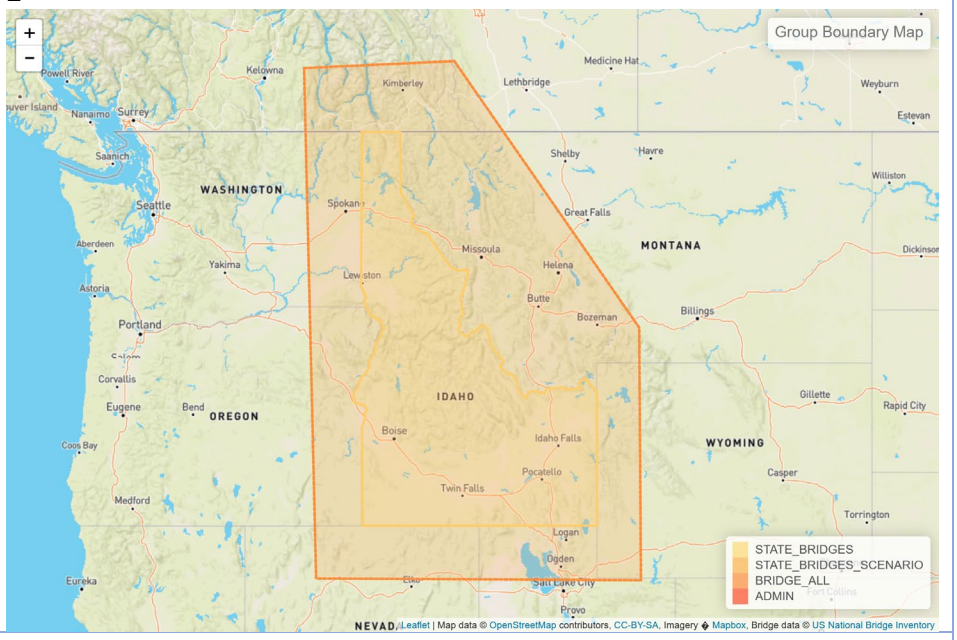
3.6 South Carolina DOT ShakeCast Instance

The South Carolina DOT ShakeCast instance was a new deployment with default setup.

Deployment Item	Note
Header Logo	South Carolina State Department of Transportation — ShakeCast Report — National Earthquake Information Center (NEIC)
Facility	BRIDGE (9,283)
Data Assurance	No
Fragility	Hazus
Notification Group	2 
User	Admin (1), Group (5), Individual (2)
Custom Product	Default
Magnitude Threshold	3.5 (EQ/GSM Hybrid)
Notification Template	Default
Scenario Exercise	Yes
Supplemental Data	No

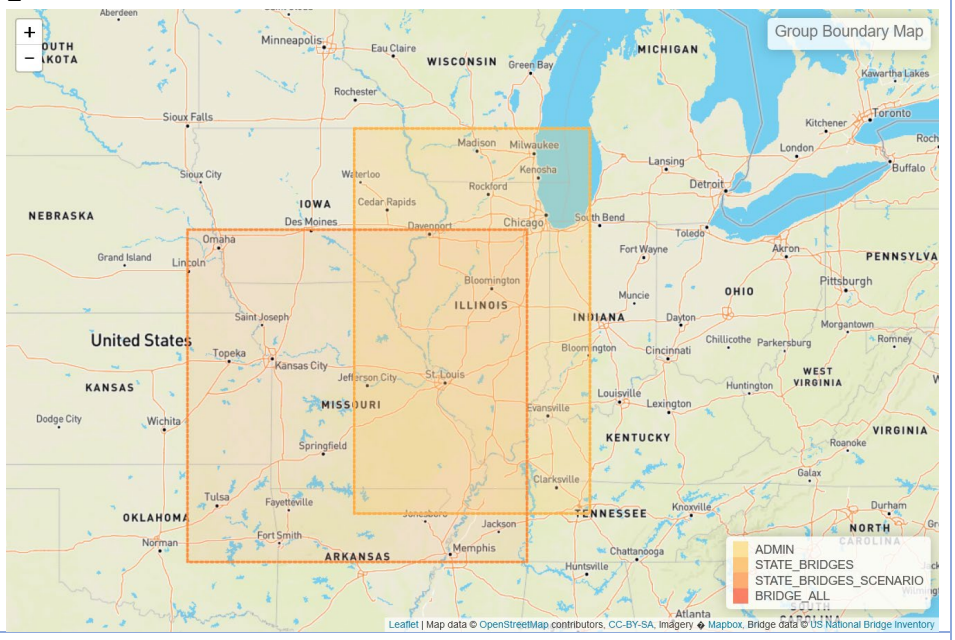
3.7 Idaho DOT ShakeCast Instance

The Idaho DOT ShakeCast instance was a new deployment with default setup and quality check on the input bridge data.

Deployment Item	Note
Header Logo	State of Idaho Department of Transportation — ShakeCast Report — National Earthquake Information Center (NEIC)
Facility	BRIDGE (4,378)
Data Assurance	Yes
Fragility	Hazus
Notification Group	2 
User	Admin (1), Group (4), Individual (2)
Custom Product	Default
Magnitude Threshold	3.5
Notification Template	Default
Scenario Exercise	Yes
Supplemental Data	No

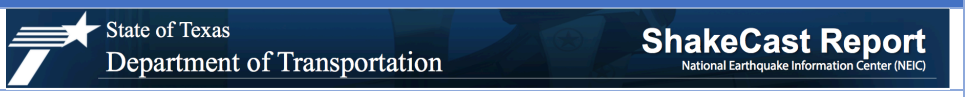
3.8 Illinois DOT ShakeCast Instance

The Illinois DOT ShakeCast instance was a new deployment with default setup with two regions: one covering the state, and the other assuring coverage in the case of New Madrid region events.

Deployment Item	Note
Header Logo	USGS science for a changing world — ShakeCast Report — National Earthquake Information Center (NEIC)
Facility	BRIDGE (26,562)
Data Assurance	Yes
Fragility	Hazus
Notification Group	2 
User	Admin (1), Group (4), Individual (4)
Custom Product	Default
Magnitude Threshold	3.5
Notification Template	Default
Scenario Exercise	No
Supplemental Data	No

3.9 Texas DOT ShakeCast Instance

The Texas DOT ShakeCast instance was a new deployment with default setup and quality check on the input bridge data. The bridge fragility model was initially created using the Hazus methodology but was later revised using the UT (PGA) model in 2020. The current production implementation has switched to using the default Hazus fragility model for NBI 2023.

Deployment Item	Note
Header Logo	
Facility	BRIDGE (56,313)
Data Assurance	Yes
Fragility	Hazus, UT (PGA)
Notification Group	2 
User	Admin (1), Group (4), Individual (12)
Custom Product	Default
Magnitude Threshold	3.5
Notification Template	Default
Scenario Exercise	Yes
Supplemental Data	No

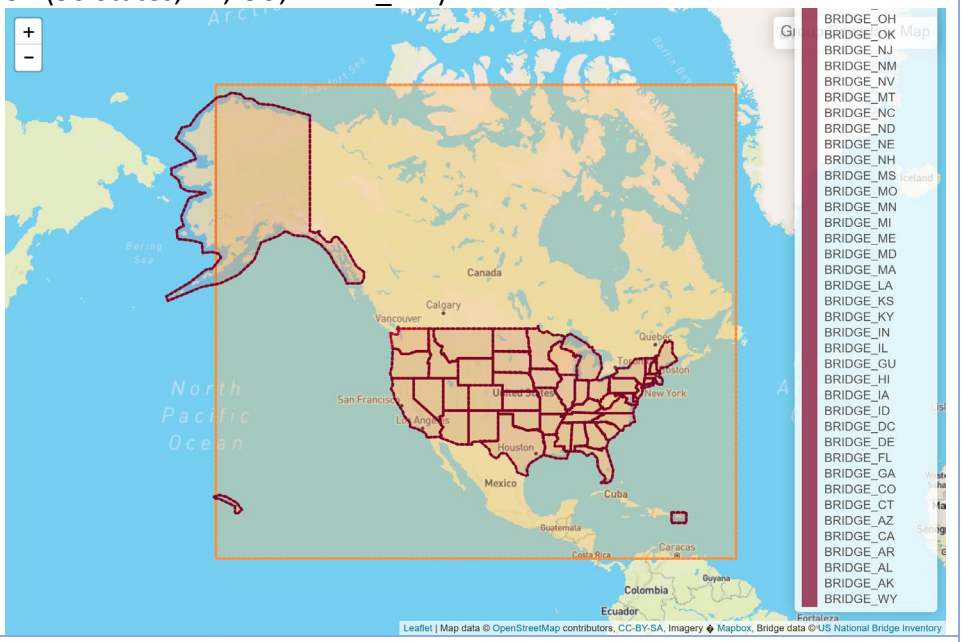
3.10 Missouri DOT ShakeCast Instance

The Missouri DOT ShakeCast instance was a new deployment with default setup and quality check on the input bridge data. The default Federal Bridge ID from NBI was replaced with their own State Bridge ID.

Deployment Item	Note
Header Logo	
Facility	BRIDGE (20,177)
Data Assurance	Yes
Fragility	Hazus
Notification Group	2 
User	Admin (1), Group (4), Individual (8)
Custom Product	Default
Magnitude Threshold	3.5
Notification Template	Default
Scenario Exercise	Yes
Supplemental Data	Yes

3.11 FHWA Nationwide ShakeCast Instance

The FHWA ShakeCast instance was a new deployment in 2019 with default setup. It is fully functional.

Deployment Item	Note
Header Logo	U.S. Department of Transportation Federal Highway Administration — ShakeCast Report, National Earthquake Information Center (NEIC)
Facility	BRIDGE (597,269)
Data Assurance	No
Fragility	Hazus
Notification Group	57 (50 States, PR, GU, FHWA_ALL) 
User	Admin (1), Group (57), Individual (2)
Custom Product	Custom
Magnitude Threshold	4.5
Notification Template	Custom
Scenario Exercise	Yes
Supplemental Data	Yes

4 OPERATIONAL EXAMPLES AND CASE HISTORIES

The initial Trello-based Web Portal for the TPF Project Management had been migrated to the USGS-hosted SharePoint site during the Phase II period. Specifically, several enhancements have been made to the TPF Project Management Portal to take advantage of the functionality of the Microsoft 365 platform.

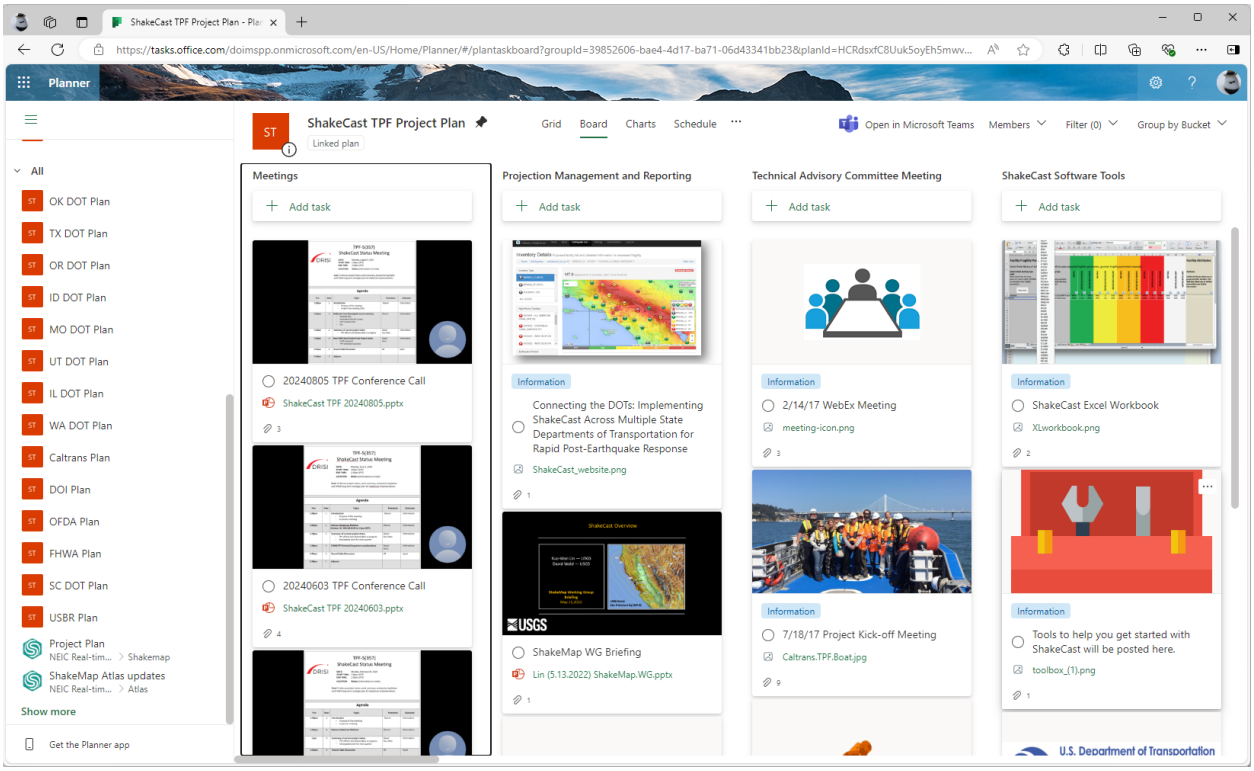


Figure 4.1 Screen capture of the ShakeCast TPF SharePoint management Portal. The USGS hosted site is the repository for all documents and resources of the TPF project and earthquake archive of each DOT's ShakeCast notifications and reports.

4.1 TPF SharePoint Project Site

The main TPF SharePoint is a member-only repository for hosting general project documents and earthquake reports without file size limitation. The new USGS ShakeCast GitLab repository is open to the public and contains software source code, installation packages, wiki/instructions, and utilities that are not confidential. Registered TPF group members can see other DOT's ShakeCast reports in case of a major, multistate emergency. Likewise, users can see all state DOT reports provided to FHWA (both default and Infobridge setup).

Each DOT has its own MS Planner Board and consists of four default bucket list for collaborations: Recent Events (with a retention period of ~180 days), Significant Events (archived ShakeCast reports), Scenario Exercises (DOT-specific runs on ShakeMap scenarios), and Quarterly Reports (detailed server report).

A copy of every processed Earthquake/ShakeMap is being posted to the Recent Events Bucket automatically for each DOT. Contrary to the static Trello site, the TPF SharePoint site utilizes Microsoft's Office Apps, including Power Automate, Outlook, Teams, and SharePoint/Planner, to streamline the workflow for automated posting and archiving of individual DOT Plans with ShakeCast reports. This framework can be replicated within DOT's own network infrastructure if the user has access to the above resources.

Additional resources are manually posted to each DOT Planner to assist individual operational needs and include the bridge inventory workbook, significant historic events, scenario exercises, and quarterly summary reports.

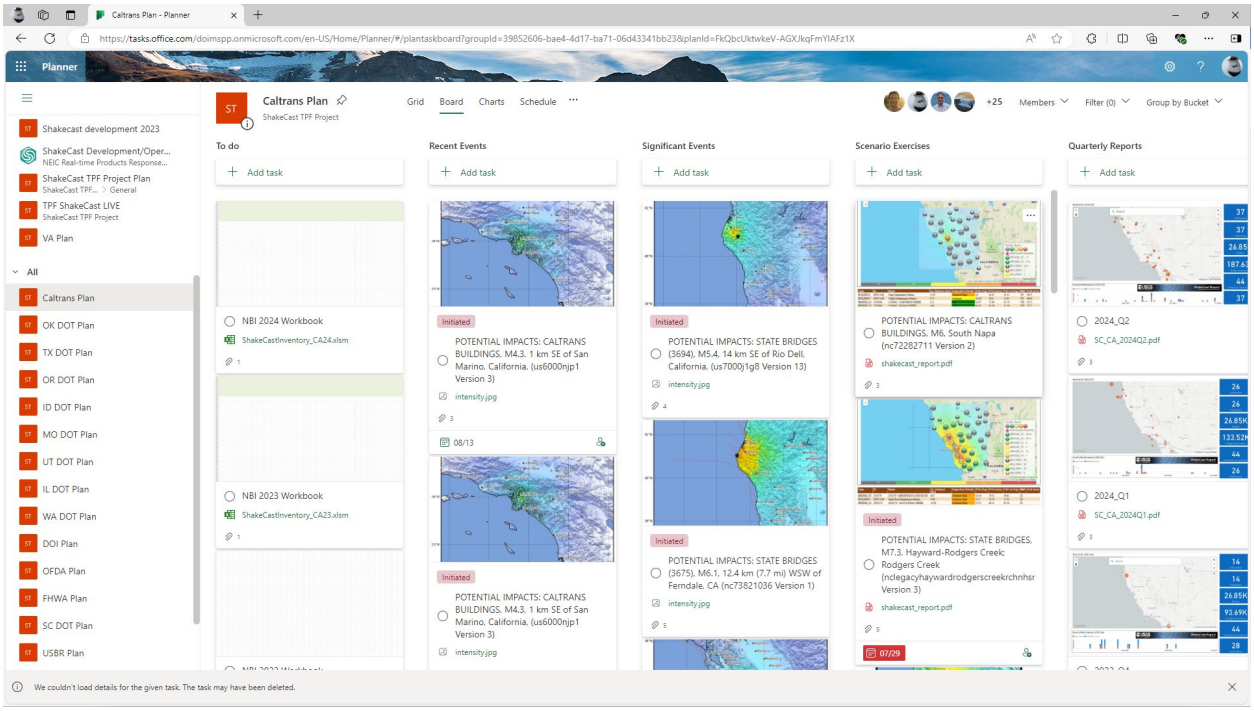


Figure 4.2 Caltrans' TPF Planner board. Each DOT member has its own SharePoint Plan to manage the ShakeCast inventory, deployment specifications, and notifications and reports from the ShakeCast server instance.

4.2 FHWA (Production and Infobridge)

In collaboration with FHWA, USGS hosts two ShakeCast instance variants. The production (default) instance uses the standard NBI-converted inventory and fragility for all US bridges (~600k). It is effectively a viable backup for all TPF State DOTs and extends coverage to regions of non-TPF States. The Infobridge implementation is experimental. The instances include a custom NBI conversion script to process NBI data (in XML format) directly from the Infobridge portal and generates output XML as part of the ShakeCast notifications to be uploaded back to the portal (not yet validated).

4.3 Case Histories: Notable Earthquakes and Scenario Exercises

Appendix B provides summary plots of the number, magnitude, and locations of earthquakes that were processed by each DOT ShakeCast instance during the life of the TPF Phase II and examples of recent significant earthquakes and earthquake scenarios delivered to each state Department of Transportation.

5 FUNCTIONAL IMPROVEMENTS

The main objective of Phase II for the TPF project is to extend the USGS ShakeCast service in support of the TPF operations for all DOT participants. During this period, 2021-2024, significant changes to the backend hosting infrastructure has prompted us to create new server frameworks to ensure continuity of the USGS ShakeCast service. Specifically, USGS in partnership with the DOTs redesigned and redeployed the following backend services:

- TPF Project Management Portal: migration from the Trello Project Management Web to Microsoft 365 SharePoint/Planner site with automated workflow.
- Software and Documentation/Resources Repository: migration from the public facing GitHub/ftp repository to the public/private USGS GitLab/wiki repository.
- Server Hosting Environment: general OS upgrade of the USGS server (mini-cloud) plus continuing integration/deployment (CI/CD) with the USGS GitLab pipelines.

Feature and functional improvements of individual systems/services are listed in the following sections.

5.1 Production ShakeCast V3 System

Specific TPF functional improvements:

- Leverage the USGS Product Distribution Layer (PDL) client to provide data redundancy on receiving the USGS earthquake products and triggering mechanism (GSM-only/EQ-Feed Hybrid).
- Create system snapshots of the ShakeCast TPF production server for each DOT. The Docker-based image contains all DOT-specific customizations, inventory data, processing results of earthquakes during Phase II, and can be re-deployed to users' own IT infrastructure. Appendix C describes the member-only USGS TPF SharePoint folder (Docker_images) and procedures to launch DOT ShakeCast server instances.
- Expand default NBI parameters for Hazus-based bridge fragility to include information pertinent to user operation.
- Expand NBI parameters for Hazus-based replacement cost (loss) calculation. This function has been put on-hold due to out-of-sync data between NBI update and the initial loss parameters (2019 copy).
- Accommodate supplemental product type (e.g. KML), new ShakeMap metric (i.e., PSA06), and data exchange between ShakeCast and FHWA's InfoBridge Portal.

5.2 Backup ShakeCast V4 System

Efforts toward the ShakeCast software development has been focused on the Python-based ShakeCast V4 system while maintaining the legacy V4 system. Since this is a major redesign of the application, there is no viable option for upgrade from a V3 to V4 system. We emphasis compatibility between both systems for input inventory and create add-on services that could be used by either system using common (e.g., csv) input/output format. During the Phase

II period, the baseline ShakeCast V4 application has been expanded to support Windows OS and various Python 2 and 3 (currently 3.11) versions. The public USGS ShakeCast GitLab repository is at the following URL:

https://code.usgs.gov/ghsc/esi/shakecast/shakecast

Specific TPF operational/functional improvements:

- Create test and backup environment for individual DOT server instances and product/notification templates.
- Create Docker images for individual DOT server instances.
- Expand server hosting options for V4 system to Docker environment, CI/CD deployment via the USGS ShakeCast GitLab pipeline to USGS servers. We are exploring options to use a similar mechanism for USGS AWS cloud deployment for ShakeCast V4.
- ShakeCast Docker service add-ons based on the same V4 base image include Ground Failure Probability sampling tool and multi-period list-mode ShakeMap service.

5.3 NBI Inventory Workbook and Conversion Scripts

5.3.1 NBI to ShakeCast Inventory Conversion Scripts

The original NBI to ShakeCast (as Hazus HWB) inventory conversion script was based on Caltrans' FileMaker database and was expanded to cover both Hazus CA and US models for all NBI bridge inventory. The command-line program has been updated several times during the TPF project period (2017 to present) based on user requests and feedback, even including a bug-report from Nevada DOT (non-TPF member). The current revision is a Python-based program. It supports both the NBI dataset from FHWA's direct download (zip/csv) and InfoBridge Portal (xml). The default output can be uploaded directly into the ShakeCast database or be imported into the standard ShakeCast Workbook for user review.

For the TPF project, we have downloaded and archived NBI dataset since 2012. While only selected years have been imported in the ShakeCast Workbook. DOT users can request a specific NBI dataset year to be imported. The default setup now includes a user-specified parameter framework and has captures a list of user-specified NBI fields to be included as bridge attributes in the ShakeCast database and to support Hazus-based loss (replacement) cost calculation.

5.3.2 ShakeCast (NBI) Inventory Workbook

The default ShakeCast Inventory Workbook is a Microsoft Excel spreadsheet to assist ShakeCast users manage input inventory regarding facilities, notification groups, and users. This workbook is general purpose which depends on the NBI conversion script to import raw NBI dataset and to define bridge fragility.

For Phase II, the DOT-specific ShakeCast Workbook was updated each year since 2022. Furthermore, we have created an NBI-specific Workbook (developmental) that integrates bridge inventory, bridge model/fragility mapping, earthquake response and review tasks. The motivation for the NBI Workbook is to provide another alternative to address the restricted ShakeCast Web Interface (https://shakecast.cr.usgs.gov) to meet the USGS security requirements. In general, we have configured the USGS ShakeCast Web services (API) to permit access of static content (e.g. KML-related resources) but not dynamic contents. The other TPF resources (MS SharePoint/Planner/Power BI) were also created to complement some ShakeCast Web functions.

Appendix E describes details of the ShakeCast NBI Workbook.

5.4 ShakeCast Docker Service for USGS Earthquake Products

ShakeCast Docker services available to the application are summarized in this section, but are not part of the current TPF production environment. Invocation of the service occurs via internal network requests, shared data folder/files, and/or direct (Docker) command executions. Ideally, these services can run independently without the ShakeCast application and have been used for scenario exercises. Further testing is required before any DOT user wishing to incorporate them into their production server can be completed.

- The USGS Product Distribution Layer (PDL) Docker service for ShakeCast. The PDL clint service is a Java program and this Docker service provides redundancy in receiving USGS earthquake products without Java program dependency of the hosting environment.
- ShakeCast image Docker service. This service returns the screenshot image of the requesting web address.
- The USGS Ground Failure (GF; Figure 5.1) Product probability sampling/ranking Docker service for ShakeCast. Using the ShakeCast exposure output in csv as input, the service extracts both landslide and liquefaction probability information from the provided GF products and returns the augmented csv file with added GF data fields. The standard ShakeCast PDF generation routine can take place afterwards for a custom report.
- The USGS site-specific/full spectrum ShakeMap Docker service for ShakeCast. Using the ShakeCast exposure output in csv as input, the service re-generates the ShakeMap shaking estimates based on the provided list of sites. The service returns a standalone csv file with shaking/uncertainty estimates for all specified periods. Currently there is no additional ShakeCast routine to process this data output.

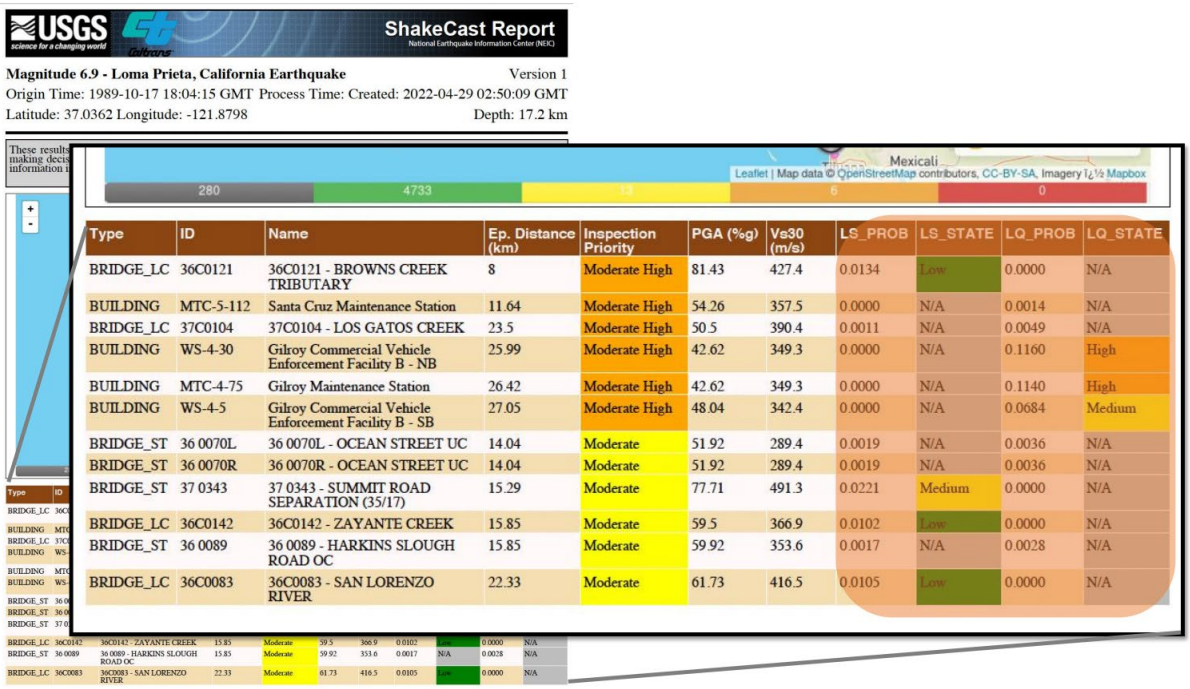


Figure 5.1 ShakeCast Ground Failure Report example for the M6.9 1989 Loma Prieta earthquake. The potential impact table includes additional fields (probability and mapped impact index) for both landslide and liquefaction. The input csv data file was generated by the ShakeCast GF Docker service using the ShakeCast csv product and the USGS GF products for the earthquake.

6 ROAD-MAP FOR LONG-TERM SHAKECAST OPERATIONS

6.1 Centralized ShakeCast Operations at USGS and On-site Instances

As of the end of the TPF Phase II contract with the USGS, DOT partners were operating with the following configurations:

- Centralized, redundant operations and notifications by USGS cloud-hosted ShakeCast instances: CA, IL, MO, ID, OK, OR, SC, TX, UT, WA, and FHWA.
- DOT onsite operations: OK.
- Note: NV hosts its own instance, developed by a contractor, and NV was not part of the TPF.
- Other States DOTs that have shown interest in ShakeCast include IN.
- FHWA instance is effectively yet slightly degraded backup for all instances.

Options for long-term ShakeCast operations among the DOT partners and FHWA were proposed and discussed; they fall into three categories, or options. In each case, there are variations in the roles, responsibilities, and level of support by each DOT. Besides the new contract for Caltrans to begin in the last quarter of 2024, USGS plans to continue hosting existing DOT instances with support from the FHWA. The plan could migrate to a nationwide FHWA ShakeCast instance would act as the primary ShakeCast instance or a backup for all states, if fully implemented and supported via FHWA.

As mentioned in Section 5.4, each DOT has the option of running their own ShakeCast instance facilitated by the ShakeCast Docker services described therein.

Upon re-deploying TPF ShakeCast servers, we plan to upgrade the ShakeCast application from V3 to V4. Depending on the deployment option, the hosting environment could remain the same data centers (DFC and SF) or the USGS AWS cloud.

6.2 State DOT / FHWA Participation

With a renewed TPF, hopefully, in FY'26, managed by FHWA, we anticipate participating DOTs will have the following benefits and roles and responsibilities:

- Benefits
    - AutomaticShakeCast notifications via hosted by USGS,
    - Access to USGS personnel for guidance on post-event content, scenario development, fragilities,
    - Training for developing user/use, software, fragility expertise,
    - Can provide input for new features,
    - Mutual-Aid and Data Sharing.
- Roles and Responsibilities
    - FHWA
        - Project Management,

        - Financial management.
    - USGS
        - Project Management,
        - Maintenance and operations of ShakeCast Instance nationwide,
        - Support for participating DOTs (planning scenarios; post-event guidance),
        - Continued ShakeCast R&D, feature requests, software updates.
    - Participating DOTs:
        - Engineering expertise, Quality/Assurance
        - Guidance for features, futures,
        - Maintain NBI data and Q/A,
        - Maintain active list of DOT participants and POC,
        - Communication within organize, Public Relations.
    - Non-participating DOTs:
        - Notifications from FHWA.

6.3 USGS ShakeCast-Relevant Research and Development

As ShakeCast's userbase and feature list grow, we continue to adopt modern development standards to empower our small team to continue to build this ever-evolving application. In addition to maintaining the application codebase, below is a summarized list of ShakeCast-related research and development pertinent to the TPF project. While we intent to convert many of the listed features into micro-services, the actual implementation may vary and will depend on the hosting environment.

- Advanced Inventory and Fragility
    - ShakeCast update based on Specifications for National Bridge Inventory (SNBI) and InfoBridge Portal https://infobridge.fhwa.dot.gov/Data
    - Incorporate DOT-specific bridge fragility model
        - Caltrans generation 2 bridge fragility (g2F)
        - UT bridge fragility model
        - OrDOT's Next Generation Bridge Fragility Model
        - AKDOT&PF displacement-based fragility model (Bona, Kowalsky et al.)
    - Expanded inventory type to cover other structure types (attributes to designate process specifications), e.g., tunnel, roadway, building/maintenance station.
    - Integrate DOT earthquake response protocol (i.e., regulatory criteria exceedance based on inventory types)
- Near-Real-Time Bridge Replacement/Loss Estimation
    - Inventory update to the ShakeCast computation setup (NBI 2019)
    - Incorporate Hazus' default model
    - Long-term estimation based on NSHMP seismic hazard maps
- Ground Failure
    - USGS Earthquake Ground Failure Product https://earthquake.usgs.gov/data/ground-failure/

    - Integration into ShakeCast processing (automatic)
    - Default mode: Parsing USGS geogrid (hdf5) for site-specific landslide and liquefaction probability impact index.
    - Custom mode: Integrate with user's higher resolution geotechnical information (e.g. California Susceptibility Map)
- Add-on Alerts:
    - NOAA Tsunami Warning Bulletin (currently part of Alyeska's ShakeCast system)
    - Third-party messaging framework (e.g. MQTT, ntfy.sh)

6.4 New Research & Development Opportunities

It may be of interest to long-term ShakeCast operations and viability to engage in additional DOTs that reside in states with significant earthquake hazards. Participation of the Federal Highway Administration (FHWA) on a nationwide ShakeCast instance may serve as a way of further connecting the DOTs, even those not participating directly in the TPF.

County Bridge Engineering Departments also could benefit from ShakeCast reports and planning exercises. It may be of interest of each State to reach out to County engineers to see if there is interest in receiving State or customized County-level ShakeCast reports.

For U.S. states where bridge risks due to flooding and thus scouring of columns is more pervasive than earthquake shaking risks, these DOTs may be more interested in situational awareness concerning flooding and scouring with a system akin to ShakeCast. Such a "scour-casting" could be an addition service to ShakeCast that takes advantage of the ShakeCast architecture and DOT notifications. Collaboration with USGS/FHWA and individual states to develop best practices and appropriate fragilities is of interest to the USGS with our intensive stream gauge monitoring, modeling, and reporting systems.

7 ACKNOWLEGEMENTS

Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

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APPENDIX A Transportation Pooled Fund DOT ShakeCast Deployment Specifications

Primary and backup ShakeCast v3 instances on the USGS cloud are the operational systems under the TPF project for both Phase I and II. As part of the final project deliverables, we have provided snapshots of individual DOT systems in the format of Docker image and will assist DOT-specific on-premise, in-house deployment. Appendix A summaries the deployment requirements and specifications in 2024 for individual DOTs.

A.1 Caltrans ShakeCast Instance

Organization: California Department of Transportation (Caltrans)

DOT Contacts: Who are the primary contacts at your DOT for ShakeCast implementation?

Name	Title	Email & Phone	Role
Sharon Yen		sharon.yen@dot.ca.gov	Research Project Mgr
Richard Heninger		richard.heninger@dot.ca.gov	

ShakeCast Operational/Functional/IT Specifications: (e.g., In-house, platform, policies, security, monitoring, reporting, IT environment, USGS Cloud, local installation, ShakeCast Version, OS, hardware, etc.)

1. Do you foresee any organizational policies that prevent use of external cloud hosted solutions for your operational systems?

   Caltrans use of cloud-based services is governed by two policies:

   - Compliance with the California Department of General Services (DGS), *"Cloud Computing Services Special Provisions SaaS."*
   - Compliance with the California Department of Technology (CalTech), Technology Letter (TL) 14-04, *"Cloud Computing Policy"* 9 which directs Caltrans "to shift to the 'Cloud First' policy for all new reportable and non-reportable IT projects in accordance with SAM 4983."

2. What other software tools used in your emergency response practice require interoperability with ShakeCast?
   - *Microsoft Outlook Server* – Email notifications are sent via SMTP from the ShakeCast system to the Outlook server for broad group list distribution.
   - *GoogleMaps* – Caltrans has a site license for this, including an enterprise version with Caltrans-specific content. Responders view ShakeCast analysis outcomes within GoogleMaps.
   - *FileMaker Pro* – Bridge fragility assignment is currently done within a FileMaker Pro database. The database holds more comprehensive information about bridge inventory details than that found in the FHWA NBI. Caltrans building inventory data is also managed in a FileMaker Pro database.

- *ArcGIS* – Emergency Operations Centers use ArcGIS to produce various map products that may include ShakeCast analysis outcomes.
- *Structures Maintenance & Investigations (SMI) bridge inspection management web tool* – uses the KML product to populate their web tool used in managing response.

ShakeCast System Administration:

3. How many system administrators will be managing your ShakeCast system?
   Two admins.
4. How frequently do you anticipate update facility inventory data? (e.g., load/reload new bridges)

Four types of facilities initially, updated on an annual basis at different times throughout the year.

5. How frequently do you anticipate adding new subscribers?

   New subscribers added ad-hoc at any time.

6. Can a group mailing list be established on your Department mail server? This is the recommended approach for distributing notifications to large groups of subscribers.

   Yes.

7. How many different types of notification groups will you need? One message type for all users? Or, will different groups (e.g., by region, district, division, function, authority level, etc.) receive different notifications with different content?

   A single set of notifications will be used for all subscribers.

8. How many notification subscribers do you anticipate having?

   Approximately 1,000 subscribers.

ShakeCast Product Customization: (notification template, email)

9. Is there specific custom content (text, graphics, links, etc) that needs to be placed in ShakeCast email notifications in addition to the standard content (e.g., ShakeMap, magnitude, epicenter, date/time, facility impacts, etc.)?
   Yes. Caltrans-specific content to be included in ShakeCast notification emails:
   - Caltrans-specific disclaimer/usage statements.
   - Links to Caltrans emergency response protocols and policies.
   - Email and contact info for system admins and sponsors.
   - Link to Caltrans-specific full facility impact lists in various formats.

Facilities: (no. of State and local bridges, no. of buildings, other facilities; employing ShakeCast Workbook?)

- What types and quantities of highway infrastructure assets do you anticipate loading into the ShakeCast system?
  - 26,000+ State and local bridges, each with 10-20 component fragilities
  - 400+ building sites, each with several building sub-structures

- 43 tunnels (TBD)
- 15,000+ centerline miles of highways (TBD)

Fragilities: (Normally, NBI->Hazus model bridge type. Or, Hazus AEBM.)

- How will facility fragilities be assigned?

  Initially, HAZUS based fragilities will be used for system level "impact potential" assessments. The default red/orange/yellow/green/grey will be used, corresponding to high/medium-high/medium/low/none. Generation 2 Fragilities (G2F) under development at Georgia Tech will be implemented as available.

- Will you need guidance in assigning fragility parameters to structures?

  For the bridge inventory, we have those assigned already. We will be interesting in learning more about using AEBM for building fragility assignments.

Notifications: (Notification and triggering domain; recipients: who, what roles, where)

10. At what minimum magnitude would you like to trigger ShakeCast notifications?

    M4.0 and greater statewide (CA), GSM-only triggering.

11. ShakeCast can send updated notifications as ShakeMaps and magnitude estimates are updated in the hours and days following an earthquake. How large of a change in ground motions should trigger subsequent notifications?

    Limiting notification updates (manual override).

12. How many groups and types of notifications would you like to set up?

    A single group will receive all notifications.

Documentation: (Any case histories, publicity, Fact Sheets, operations manuals, response protocols, proceedings papers or meeting Abstracts, etc.)

Yes. Caltrans has two final reports (2010 and 2014) from previous contracts as well as a few PR information products. See *Research Reports on ShakeCast* under the Caltrans SharePoint Planner bucket list.

Scenario Exercises: Please describe any upcoming scenario exercises planned in your region.

13. Are there a sufficient number and variety of scenario events available for your region?

    Yes. (several hundred ShakeMaps for CA online)

14. How frequently do you anticipate running scenario events?

    Typically run 10-20 scenario events per year, some for general testing and others for organized Department-wide response exercises.

A.2 Idaho DOT ShakeCast Instance

Organization: Idaho Transportation Department (ITD)

DOT Contacts: Who are the primary contacts at your DOT for ShakeCast implementation?

Name	Title	Email & Phone	Role
Jared Levings		Jared.levings@itd.idaho.gov	Program Monitor
Amanda Laib		Amanda.laib@itd.idaho.gov	
Shanon Murgoitio		Shanon.murgoitio@itd.idaho.gov	
Notification Group		BridgeShakeCast@itd.idaho.gov	Notification Distribution List

ShakeCast Operational/Functional/IT Specifications: (e.g., In-house, platform, policies, security, monitoring, reporting, IT environment, USGS Cloud, local installation, ShakeCast Version, OS, hardware, etc.)

15. Do you foresee any organizational policies that prevent use of external cloud hosted solutions for your operational systems?

No. The data and information used, derived, and shared by this system fall into categories 1 and 2 per Idaho Technology Authority policy P4120. As such, no restriction exists for consuming external cloud capabilities.

16. What other software tools used in your emergency response practice require interoperability with ShakeCast?

We would expect some level of integration with our Microsoft Exchange environment, and possibly with our external alert capability provided by AlertSense.

ShakeCast System Administration:

17. How many system administrators will be managing your ShakeCast system?
    Two admins.
18. How frequently do you anticipate update facility inventory data? (e.g., load/reload new bridges)

    Updated on an annual basis unless there is a significant change to one of the facilities.

19. How frequently do you anticipate adding new subscribers?

    New subscribers added ad-hoc at any time.

20. Can a group mailing list be established on your Department mail server? This is the recommended approach for distributing notifications to large groups of subscribers.

    Yes.

21. How many different types of notification groups will you need? One message type for all users? Or, will different groups (e.g., by region, district, division, function, authority level, etc.) receive different notifications with different content?

4 different groups notifications will be made with different information.

22. How many notification subscribers do you anticipate having?

    Approximately 30 subscribers.

ShakeCast Product Customization: (notification template, email)

23. Is there specific custom content (text, graphics, links, etc) that needs to be placed on the ShakeCast home page for your DOT?

    Yes. IDT-specific content to be included on the ShakeCast website:
    - ITD logos.
    - Description of ITD-ShakeCast notification matrix, project background, USGS tools etc.
    - Email and contact info for system admins and sponsors.
    - Shakecast partners from other agencies /states

24. Is there specific custom content (text, graphics, links, etc) that needs to be placed in ShakeCast email notifications in addition to the standard content (e.g., ShakeMap, magnitude, epicenter, date/time, facility impacts, etc.)?

    Yes. ITD specific content to be included in ShakeCast notification emails:
    - ITD-specific disclaimer/usage statements.
    - Links to ITD emergency response protocols and policies.
    - Email and contact info for system admins and sponsors.

Facilities: (no. of State and local bridges, no. of buildings, other facilities; employing ShakeCast Workbook?)

- What types and quantities of highway infrastructure assets do you anticipate loading into the ShakeCast system?
    - 4343 State and local bridges
    - 8 tunnels (TBD)
    - (54) Housing Structures (TBD)
    - (118) Maintenance Buildings (TBD)
    - (21) Administrative/Office Buildings (TBD)

Fragilities: (Normally, NBI->Hazus model bridge type. Or, Hazus AEBM.)

- How will facility fragilities be assigned?

  Default Hazus-HWB. Open to any and all suggestions.

- Will you need guidance in assigning fragility parameters to structures?

  We will be interesting in learning more about the tools for building and bridges fragility assignments.

Notifications: (Notification and triggering domain; recipients: who, what roles, where)

25. At what minimum magnitude would you like to trigger ShakeCast notifications?

    M4.5 and greater statewide (ID and northwest region)

26. ShakeCast can send updated notifications as ShakeMaps and magnitude estimates are updated in the hours and days following an earthquake. How large of a change in ground motions should trigger subsequent notifications?

    Changes greater than 25% should trigger new event notifications.

27. How many groups and types of notifications would you like to set up?

    Four groups will receive separate notifications based on their level of response.

Documentation: (Any case histories, publicity, Fact Sheets, operations manuals, response protocols, proceedings papers or meeting Abstracts, etc.)

No, but would like to incorporate into our Operations Manual and use our State Communications protocols.

Scenario Exercises: Please describe any upcoming scenario exercises planned in your region.

28. Are there a sufficient number and variety of scenario events available for your region?

    Not currently but Idaho Office of Emergency Management is working an exercise calendar.

29. How frequently do you anticipate running scenario events?

    Plan is currently under review and the frequency will be determined at a later date.

A.3 Missouri DOT ShakeCast Instance

Organization: Missouri Department of Transportation (MoDOT)

DOT Contacts: Who are the primary contacts at your DOT for ShakeCast implementation?

Name	Title	Email & Phone	Role
Chris Engelbrecht	Emergency Management Liaison	Christopher.Engelbrecht@modot.mo.gov (573) 526-4842	ShakeCast TAC Member/Project Technical Coordinator
Michael White		Michael.white@modot.mo.gov	

ShakeCast Operational/Functional/IT Specifications: (e.g., In-house, platform, policies, security, monitoring, reporting, IT environment, USGS Cloud, local installation, ShakeCast Version, OS, hardware, etc.)

30. Do you foresee any organizational policies that prevent use of external cloud hosted solutions for your operational systems?
    There are no policies currently preventing MoDOT from using cloud hosted solutions.

31. What other software tools used in your emergency response practice require interoperability with ShakeCast?
    - *Microsoft Outlook* – Email notifications will be sent to the Outlook server for distribution.
    - *GoogleMaps* – Responders may view ShakeCast analysis outcomes within GoogleMaps.
    - *ArcGIS* – Emergency Operations Centers may use ArcGIS to produce various map products that may include ShakeCast analysis outcomes.

ShakeCast System Administration:

32. How many system administrators will be managing your ShakeCast system?
    Two administrators are planned at this time.
33. How frequently do you anticipate update facility inventory data? (e.g., load/reload new bridges)
    Annually with NBI update.
34. How frequently do you anticipate adding new subscribers?
    New subscribers may be added as needed, updated at least quarterly.
35. Can a group mailing list be established on your Department mail server? This is the recommended approach for distributing notifications to large groups of subscribers.
    Yes
36. How many different types of notification groups will you need? One message type for all users? Or, will different groups (e.g., by region, district, division, function, authority level, etc.) receive different notifications with different content?
    We may consider different notifications by district.
37. How many notification subscribers do you anticipate having?
    Approx 1000

ShakeCast Product Customization: (notification template, email)

38. Is there specific custom content (text, graphics, links, etc) that needs to be placed on the ShakeCast home page for your DOT?
    Yes. MoDOT-specific content to be included on the ShakeCast website:
    - MoDOT logos.
    - Description of MoDOT-ShakeCast notification protocols, project background, USGS tools etc.
    - Buttons/links to request to be new subscriber.
    - Email and contact info for system admins and sponsors.

39. Is there specific custom content (text, graphics, links, etc) that needs to be placed in ShakeCast email notifications in addition to the standard content (e.g., ShakeMap, magnitude, epicenter, date/time, facility impacts, etc.)?
    Yes. MoDOT-specific content to be included in ShakeCast notification emails:
    - MoDOT-specific disclaimer/usage statements.
    - Links to MoDOT emergency response protocols and policies.
    - Email and contact info for system admins and sponsors.
    - Link to MoDOT-specific full facility impact lists in various formats.

Facilities: (no. of State and local bridges, no. of buildings, other facilities; employing ShakeCast Workbook?)

- What types and quantities of highway infrastructure assets do you anticipate loading into the ShakeCast system?
  Initially, approx. 10,400 state bridges (from NBI)

Fragilities: (Normally, NBI->Hazus model bridge type. Or, Hazus AEBM.)

- How will facility fragilities be assigned?
  NBI information
- Will you need guidance in assigning fragility parameters to structures?
  Not if NBI information is utilized

Notifications: (Notification and triggering domain; recipients: who, what roles, where)

40. At what minimum magnitude would you like to trigger ShakeCast notifications?
    Initially, we will start with M3.5

41. ShakeCast can send updated notifications as ShakeMaps and magnitude estimates are updated in the hours and days following an earthquake. How large of a change in ground motions should trigger subsequent notifications?
    Would like USGS recommendation on this.

42. How many groups and types of notifications would you like to set up?

Initial thoughts are 7 groups (districts), may change as implementation moves forward.

Documentation: (Any case histories, publicity, Fact Sheets, operations manuals, response protocols, proceedings papers or meeting Abstracts, etc.)

MoDOT incident response manual/protocols

Scenario Exercises: Please describe any upcoming scenario exercises planned in your region.

43. Are there a sufficient number and variety of scenario events available for your region?
    Not currently, need to develop event scenarios.

44. How frequently do you anticipate running scenario events?
    Would anticipate 10-20 scenarios per year for testing and exercises

A.4 Oklahoma DOT ShakeCast Instance

Organization: **Oklahoma Department of Transportation (ODOT)**

DOT Contacts: Who are the primary contacts at your DOT for ShakeCast implementation?

Name	Title	Email & Phone	Role
Walt Peters, PE	Assistant Bridge Engineer - Maintenance	wpeters@odot.org (405) 521-2606	ShakeCast Pooled Research Representative
Lance Underwood		lunderwood@oktransportation.org	ShakeCast Software
Jason Giebler	Bridge Engineer	jgiebler@odot.org	
Wes Kellogg		wkellogg@odot.org	

ShakeCast Operational/Functional/IT Specifications: (e.g., In-house, platform, policies, security, monitoring, reporting, IT environment, USGS Cloud, local installation, ShakeCast Version, OS, hardware, etc.)

45. Do you foresee any organizational policies that prevent use of external cloud hosted solutions for your operational systems?

    Office of Management and Enterprise Services (OMES) Information Services strictly limits websites which ODOT employees can use (firewall). Further, we have had issues with emails being blocked by the spam filter when sent from ShakeCast. Our current workaround is to route the notification emails through a Gmail account.

46. What other software tools used in your emergency response practice require interoperability with ShakeCast?
    - *Microsoft Outlook Server* – Email notifications are sent via SMTP from the ShakeCast system to the Outlook server for broad group list distribution.
    - *GoogleMaps* – ODOT has a site license for this software.
    - *ArcGIS* – Presently, ODOT hydraulic engineers are using ArcGIS software and the number of licenses is limited. Our understanding is that Emergency Operations Centers use ArcGIS to produce various map products that may include ShakeCast analysis outcomes.
    - Excel – the responders/inspectors have been copying and pasting the list of potentially impacted bridges from the email (html) notification into GIS to map the locations of the bridges.

ShakeCast System Administration:

47. How many system administrators will be managing your ShakeCast system?
    One administrator
48. How frequently do you anticipate update facility inventory data? (e.g., load/reload new bridges)

    Updated on an annual basis when data is submitted to the FHWA for annual NBIS submission.

49. How frequently do you anticipate adding new subscribers?

    New subscribers added ad-hoc at any time.

50. Can a group mailing list be established on your Department mail server? This is the recommended approach for distributing notifications to large groups of subscribers.

    Yes.

51. How many different types of notification groups will you need? One message type for all users? Or, will different groups (e.g., by region, district, division, function, authority level, etc.) receive different notifications with different content?

    A notification will be sent to all subscribers plus an additional notification will be sent to the affected field division(s).

52. How many notification subscribers do you anticipate having?

    Approximately 35 subscribers (all ODOT personnel).

ShakeCast Product Customization: (notification template, email)

53. Is there specific custom content (text, graphics, links, etc) that needs to be placed on the ShakeCast home page for your DOT?

    Not at this time.

54. Is there specific custom content (text, graphics, links, etc) that needs to be placed in ShakeCast email notifications in addition to the standard content (e.g., ShakeMap, magnitude, epicenter, date/time, facility impacts, etc.)?

    Yes. ODOT- specific content to be included in ShakeCast notification emails:
    - NBI number, Structure number, facility carried, feature intersected, latitude, longitude.
    - Email and contact info for system administrator.

Facilities: (no. of State and local bridges, no. of buildings, other facilities; employing ShakeCast Workbook?)

- What types and quantities of highway infrastructure assets do you anticipate loading into the ShakeCast system?
    - **Our main goal was to get the 3,800 On-System span bridges (excluding RCBs) into ShakeCast which has been done and prioritized.**
    - Expand ShakeCast to include Turnpike bridges (would require coordination with Turnpike a separate State Agency).
    - Off-System bridges in Oklahoma City and Tulsa with known fragility parameters might be a candidate for ShakeCast, but our current plan for the Off-system is to use the Magnitude/Radius protocol in our Post Earthquake Bridge Inspection Manual.
    - [TBS] – Study Expanding ShakeCast to include building sites such as the central office and the 8 field division offices and communication towers using resources/funding provided solely by pooled research.
    - No tunnels

- [TBS] – Study expanding ShakeCast to include centerline miles of highways on NHS (National Highway System) where there is potential for liquefaction or lateral spreading if this can be done with resources provided solely with pooled research funding.

Fragilities: (Normally, NBI->Hazus model bridge type. Or, Hazus AEBM.)

- How will facility fragilities be assigned?

  Initially, HAZUS based fragilities will be used for system level "impact potential" assessments. The University of Oklahoma has implemented modifications to the standard HAZUS fragility curves to account for structural deficiency (SD), fracture criticality (FC), and variable skew, as well as adjusting the base (green) fragility value to better represent Oklahoma bridges.

- Will you need guidance in assigning fragility parameters to structures?

  For the On-System bridge inventory, we have those assigned already. It will be interesting to learn more about building fragility parameters which could be used for ODOT central office and field division offices.

Notifications: (Notification and triggering domain; recipients: who, what roles, where)

55. At what minimum magnitude would you like to trigger ShakeCast notifications?

    M4.4 and greater for Local Governments/Turnpikes that do not currently use ShakeCast.

56. ShakeCast can send updated notifications as ShakeMaps and magnitude estimates are updated in the hours and days following an earthquake. How large of a change in ground motions should trigger subsequent notifications?

    A 5.6%g 1-sec spectral acceleration and greater currently triggers ShakeCast notifications. Should an updated ShakeMap indicate an S1 > 5.6%g at sites previously below this threshold, a notification should be sent out.

57. How many groups and types of notifications would you like to set up?

    Presently, a single group will receive all notifications plus additional notification to the field division(s) affected. ODOT has eight field divisions. Below is an example of a HTML notification for field division 8 (DIV8) that includes only their affected bridges.

List of Potentially Impacted Facilities: DIV8

DIV8 presented in the table below are sorted in order of impact potential. The list includes the top 200 facilities in the area of shaking. The complete list is available on the web server.

DIV8	Facility ID	Location	Impact Potential	PSA10
S.H. 18 / COAL CREEK	5914 0740 X / 39950	36.4435, -96.8001	Low	10
U.S. 60 / CHARLEY CREEK	5702 0830 X / 18551	36.687, -96.9192	Low	7.46
S.H. 20 / GREY HORSE CREEK *** SD ***	5718 0166 X / 13214	36.5021, -96.6915	Low	5.5
U.S. 64 / PANTHER CREEK	5902 0092 X / 29986	36.3191, -96.9083	Low	11.36
U.S. 64 / PEPPER CREEK	5902 0485 X / 25802	36.3238, -96.8388	Low	9.82
S.H. 20 / SYCAMORE CREEK *** SD ***	5718 0786 X / 13215	36.4586, -96.5938	Low	5
U.S. 64 / HELL ROARING CREEK *** SD ***	5904 0829 X / 21360	36.2886, -96.6421	Low	4.61
S.H. 18 / ARKANSAS RIVER	5914 1566 X / 30096	36.5033, -96.73	Low	6.98
U.S. 60 / ARK RIVER & CO RD UNDER	5702 0000 X / 22424	36.6804, -97.0676	Low	5.91
S.H. 18 / SALT CREEK *** FC, SD ***	5712 0189 X / 95290	36.5312, -96.7194	Low	5.07

Documentation: (Any case histories, publicity, Fact Sheets, operations manuals, response protocols, proceedings papers or meeting Abstracts, etc.)

Yes: Manuals, Protocol, and two papers.

Manuals: (1) Post-Earthquake Bridge Inspection Manual, Revised October 2017 (2) Post-Earthquake Response Plan for Oklahoma Bridges, Revised October 2017

Protocol for Local Government Bridges: 4.4-4.7 (5 miles), 4.8-5.3 (15 miles), 5.4-5.8 (30 miles), 5.9-6.2 (60 miles), >6.3 (120 miles)

Papers: [1] "Earthquake Preparedness and Response – Oklahoma DOT's Proactive Approach for Bridges"
[2] Harvey, Heinrich, and Muraleetharan, "A Framework for Post-Earthquake Response Planning in Emerging Seismic Regions: An Oklahoma Case Study," *Earthquake Spectra* (in press).

Scenario Exercises: Please describe any upcoming scenario exercises planned in your region.

58. Are there a sufficient number and variety of scenario events available for your region?

    Yes, base scenarios on historic seismic events greater than 5.0: M5.1 Cushing, M5.8 Pawnee, and M5.7 Prague. Additionally, USGS has provided a scenario M6.0 in Edmond; this scenario has never been used.

59. How frequently do you anticipate running scenario events?

    Typically run 1-2 scenario events per year.

A.5 Oregon DOT ShakeCast Instance

Organization: Oregon Department of Transportation (ODOT)

DOT Contacts: Who are the primary contacts at your DOT for ShakeCast implementation?

Name	Title	Email & Phone	Role
Albert Nako	Seismic Standards Engineer Bridge Engineering Section Technical Services	Albert.Nako@odot.state.or.us (503) 986 - 3333	ShakeCast TAC member / Project Technical Coordinator
Ray Bottenberg		Raymond.D.BOTTENBERG @odot.oregon.gov	

ShakeCast Operational/Functional/IT Specifications: (e.g., In-house, platform, policies, security, monitoring, reporting, IT environment, USGS Cloud, local installation, ShakeCast Version, OS, hardware, etc.)

60. Do you foresee any organizational policies that prevent use of external cloud hosted solutions for your operational systems?

    Yes. There are organizational policies that prevent use of external cloud hosted solutions for our operational system. An extensive analysis with the following components must occur before any cloud hosted solutions can be considered:

    1. An analysis of the benefits, costs, and risks to the state must be conducted prior to contracting for a cloud solution.
    2. An assessment of the readiness of a cloud vendor to deliver a solution that meets the state's requirements.
    3. Planning must be conducted to ensure that state information and financial assets are appropriately protected when adopting a cloud solution.

    ODOT use of cloud-based services is governed by the following statutes, policies, and rules.

    - Information Technology Investment Review/Approval Policy 107-004-130
    - Information Security Policy 107-004-052
    - Information Security Incident Response Policy 107-004-120
    - Information Asset Classification Policy 107-004-050
    - Cloud Computing Procedure 107-004-150 PR
    - ORS 291.047, ORS 192.410 to 192.505, ORS 279A.157
    - ORS 165.800 and ORS 646A.600 to 646A.628
    - ORS 182.122 and OAR 125-800-0005 to 125-800-0020
    - SB 1538 (Chapter 110, 2016 Laws)

61. What other software tools used in your emergency response practice require interoperability with ShakeCast?

    - ***Microsoft Exchange Server:*** Email notifications are sent via SMTP from the ShakeCast system to the Outlook server for broad group list distribution.
    - ***ArcGIS*:** Emergency Operations Centers use ArcGIS to produce various map products that may include ShakeCast analysis outcomes. This is a commercial

Geographic Information System software with a SQL database used for spatial analysis.

- **TransGIS:** A web mapping tool which presents complex data in an interactive map format offering multi-level views of Oregon's transportation system needs and accomplishments. It provides detailed information regarding transportation management system's data, asset inventory, Statewide Transportation Improvement Program projects, and environmental data for analysis, planning, and research needs. TransGIS serves as the standard foundation for ODOT web mapping applications.
- **TripCheck:** TripCheck is an internet web application that provides traveler information to the public. This information includes weather conditions, road conditions, and trucking information. The most popular aspect is the presentation of current images from our ODOT cameras, which are located on roadways throughout the state.
- **Bridge Fragility:** We will need to build it. Data may come for HAZUS.
- **ODOT Bridge Scour Alert System:** A database that pulls together existing information on each identified bridge from multiple data sources, including PONTIS, STIP, a Detour-Routes database, and the MS Exchange server to provide response plans under all conceivable scenarios for each bridge in its unique situation. The system offers weather monitoring alerts, taking stream discharge readings and predictions and rainfall measurements, in near real time, from all over the state, coupled with e-mail and text-message alerts to ODOT personnel.
- **Transportation Operations Centers System (TOCS):** The primary software utilized in ODOT's Transportation Operations Centers for managing events and dispatching maintenance and incident response employees. The system combines the ability to track field units and their information, on or off duty, as well as actions taken in response to an event or incident including device control and providing information to the public
- **Integrated Network for Viewing Incidents and Employees on the Web (INVIEW):** A web application that provides access to highway status information and incident details from TOCS for those outside of the Transportation Operations Centers. It allows ODOT field personnel to access an intranet-based, streamlined version of TOCS. It also has a subscription-based notification component where employees can sign up for the incidents types and areas that they want to know about.
- **Web Emergency Operation Center (WebEOC):** Is a secure internet-based crisis information management system that resides on independent servers which facilitates information sharing in real time. It's a web tool used by ODOT for emergency operations.

ShakeCast System Administration:

62. How many system administrators will be managing your ShakeCast system?

Two System Administrators from the business.

63. How frequently do you anticipate update facility inventory data? (e.g., load/reload new bridges)

    Four types of facilities initially, which will be updated on an annual basis.

    1. **Bridges (Local and State):** List of bridges from the BrM (Bridge Management) system.
    2. **Tunnel:** List of tunnels from the BrM system.
    3. **Buildings:** Active Building List from the Facilities Services Branch website
    4. **Centerline Miles of Highways:** Oregon Mileage Report from the Road Assets and Mileage website - http://www.oregon.gov/odot/data/pages/road-assets-mileage.aspx.

64. How frequently do you anticipate adding new subscribers?

    New subscribers added ad-hoc at any time.

65. Can a group mailing list be established on your Department mail server? This is the recommended approach for distributing notifications to large groups of subscribers.

    Yes. The distribution list created for this effort is ShakeCast@odot.state.or.us.

66. How many different types of notification groups will you need? One message type for all users? Or, will different groups (e.g., by region, district, division, function, authority level, etc.) receive different notifications with different content?

    A notification group by region with specific content for each region to the Bridge Inspectors is needed. ODOT has five regions.

    An additional notification statewide notification group may potentially be needed at a later time.

67. How many notification subscribers do you anticipate having?

    We anticipate having approximately 250 subscribers.

ShakeCast Product Customization: (notification template, email)

68. Is there specific custom content (text, graphics, links, etc.) that needs to be placed on the ShakeCast home page for your DOT?

    Yes. Oregon-specific content is to be included on the Oregon ShakeCast website:
    - ODOT logos
    - Description of ODOT-ShakeCast notification protocols, project background, USGS tools etc.
    - Buttons/links to request to be new subscriber.
        - This functionality will only be available for state/local inspection and emergency response staff.

- Email and contact info for system admins and sponsors.

69. Is there specific custom content (text, graphics, links, etc.) that needs to be placed in ShakeCast email notifications in addition to the standard content (e.g., ShakeMap, magnitude, epicenter, date/time, facility impacts, etc.)?

    Yes. ODOT-specific content to be included in ShakeCast notification emails:
    - ODOT-specific disclaimer/usage statements.
    - Links to ODOT emergency response protocols and policies.
    - Email and contact info for system admins and sponsors.
    - Links to Oregon-specific full facility impact lists in various formats.

Facilities: (no. of State and local bridges, no. of buildings, other facilities; employing ShakeCast Workbook?)

- What types and quantities of highway infrastructure assets do you anticipate loading into the ShakeCast system?
    - 6,000+ State and local bridges, we anticipate initially using HAZUS fragilities curves
    - 330+ building sites
    - 17 tunnels
    - 8,000+ centerline miles of highways
      (what is relationship to Ferries WSDOT?)

Fragilities: (Normally, NBI->HAZUS model bridge type. Or, HAZUS AEBM.)

- How will facility fragilities be assigned?

  Initially, HAZUS based fragilities will be used for system level "impact potential" assessments. The default red/orange/yellow/green/grey will be used, corresponding to high/medium-high/medium/low/none.

- Will you need guidance in assigning fragility parameters to structures?

  Yes, we will need assistance in assigning fragility parameters to structures.

  If we decide to include buildings, we will be interested in learning more about using AEBM for building fragility assignments.

Notifications: (Notification and triggering domain; recipients: who, what roles, where)

70. At what minimum magnitude would you like to trigger ShakeCast notifications?

    The minimum magnitude to trigger ShakeCast notifications is M4.0 and greater statewide (OR)

71. ShakeCast can send updated notifications as ShakeMaps and magnitude estimates are updated in the hours and days following an earthquake. How large of a change in ground motions should trigger subsequent notifications?

    Subsequent notifications should be triggered by changes greater than 20% for an earthquake magnitude equal or less than 8.0 and changes greater than 10% for an earthquake magnitude higher than 8.0.

72. How many groups and types of notifications would you like to set up?

Five groups. One for each region. See above.

Documentation: (Any case histories, publicity, Fact Sheets, operations manuals, response protocols, proceedings papers or meeting Abstracts, etc.)

No. ODOT currently does not have any documentation.

Scenario Exercises: Please describe any upcoming scenario exercises planned in your region.

73. Are there a sufficient number and variety of scenario events available for your region?

We're not aware of any scenario exercises available for Oregon.

Also Atlas

74. How frequently do you anticipate running scenario events?

Typically run up to 10 scenario events per year, some for general testing and others for organized Department-wide response exercises.

A.6 Texas DOT ShakeCast Instance

Organization: Texas Department of Transportation (TxDOT)

DOT Contacts: Who are the primary contacts at your DOT for ShakeCast implementation?

Name	Title	Email & Phone	Role
Steven Austin	Director of Field Operations	Steven.Austin@txdot.gov 512-416-2265	Project Member and Implementation/Notifications to Districts
Istiaque Hasan		Istiaque.hasan@txdot.gov	

ShakeCast Operational/Functional/IT Specifications: (e.g., In-house, platform, policies, security, monitoring, reporting, IT environment, USGS Cloud, local installation, ShakeCast Version, OS, hardware, etc.)

- Do you foresee any organizational policies that prevent use of external cloud hosted solutions for your operational systems?
  There are no policies currently preventing TxDOT from using cloud hosted solutions.
- What other software tools used in your emergency response practice require interoperability with ShakeCast?
  - *Microsoft Outlook* – Email notifications will be sent to the Outlook server for distribution.
  - *GoogleMaps* – Responders may view ShakeCast analysis outcomes within GoogleMaps.
  - *ArcGIS* – Emergency Operations Centers may use ArcGIS to produce various map products that may include ShakeCast analysis outcomes.

ShakeCast System Administration:

- How many system administrators will be managing your ShakeCast system?
  Two – Drake Builta will be the primary administrator and Sean Yoon will be the backup.
- How frequently do you anticipate update facility inventory data? (e.g., load/reload new bridges)
  Annually with NBI update.
- How frequently do you anticipate adding new subscribers?
  New subscribers may be added as needed, updated at least quarterly.
- Can a group mailing list be established on your Department mail server? This is the recommended approach for distributing notifications to large groups of subscribers.
  Yes
- How many different types of notification groups will you need? One message type for all users? Or, will different groups (e.g., by region, district, division, function, authority level, etc.) receive different notifications with different content?
  We may consider different notifications by district.
- How many notification subscribers do you anticipate having?
  Five - the list for the DOT Contacts will be the only notification subscribers at this time. If required, more individuals can be added.

ShakeCast Product Customization: (notification template, email)

- Is there specific custom content (text, graphics, links, etc) that needs to be placed on the ShakeCast home page for your DOT?
  Yes. TxDOT-specific content to be included on the ShakeCast website:
  - TxDOT logos.
  - Description of TxDOT-ShakeCast notification protocols, project background, USGS tools etc.
  - Buttons/links to request to be new subscriber.
  - Email and contact info for system admins and sponsors.

- Is there specific custom content (text, graphics, links, etc) that needs to be placed in ShakeCast email notifications in addition to the standard content (e.g., ShakeMap, magnitude, epicenter, date/time, facility impacts, etc.)?
  - DO NOT DISCLOSE – INFORMATION CONFIDENTIAL UNDER THE TEXAS HOMELAND SECURITY ACTION AND SECTION 23 USC SECTION 409, SAFETY SENSITIVE INFORMATION
  - Include the following hyperlink:
    - Seismic Activity Rapid Response Plan

Facilities: (no. of State and local bridges, no. of buildings, other facilities; employing ShakeCast Workbook?)

- What types and quantities of highway infrastructure assets do you anticipate loading into the ShakeCast system?
- TxDOT will only load its span bridges into ShakeCast. All facilities are of the "Bridge" type, and we have approximately 35,000 such facilities. TxDOT will update this list at least once each year to sync up with new NBI data.

Fragilities: (Normally, NBI->Hazus model bridge type. Or, Hazus AEBM.)

- How will facility fragilities be assigned?
  TxDOT developed a computer program to assign fragility functions based on NBI data. TxDOT developed custom fragility functions for several bridge classes which encompasses approximately 85% of the inventory. HAZUS functions are assigned for the remaining structures. TxDOT defines its custom fragility functions using PGV, while HAZUS functions are defined using PGA. TxDOT excludes culverts from its ShakeCast inventory.
- Will you need guidance in assigning fragility parameters to structures?
  We developed an updated spreadsheet to facilitate the use of multiple intensity measures and dispersion estimates.

Notifications: (Notification and triggering domain; recipients: who, what roles, where)

- At what minimum magnitude would you like to trigger ShakeCast notifications?
  We are still working this out. It seems that the event notification must be triggered by magnitude, and the damage notification must be triggered by a raw intensity measure.

Ideally, we could specify four triggers for notifications: a threshold probability for each damage state.

- ShakeCast can send updated notifications as ShakeMaps and magnitude estimates are updated in the hours and days following an earthquake. How large of a change in ground motions should trigger subsequent notifications?
  Ideally, this should be based on a change in the number of potentially impacted facilities.

- How many groups and types of notifications would you like to set up?
  TxDOT has requested two email notifications (event and damage) for any Texas earthquake with $M_w > 3.5$. This email goes to three users in the central Bridge Division. One of the users also receives email notifications from test scenario events.

Documentation: (Any case histories, publicity, Fact Sheets, operations manuals, response protocols, proceedings papers or meeting Abstracts, etc.)

Refer to the final reports from TxDOT Research Projects 0-6916 and 5-6916, each led by Dr. Patricia Clayton at UT-Austin (clayton@utexas.edu). TxDOT does have a Seismic Activity Rapid Response Plan, but it is a work in progress as we continue to implement ShakeCast.

Scenario Exercises: Please describe any upcoming scenario exercises planned in your region.

- Are there a sufficient number and variety of scenario events available for your region?
  TxDOT is interested in running a few test scenario cases following each inventory update to ensure that data was imported properly.

- How frequently do you anticipate running scenario events?
  Just a few test scenarios each year after the inventory is updated.

A.7 Utah DOT ShakeCast Instance

Organization: Utah Department of Transportation (UDOT)

DOT Contacts: Who are the primary contacts at your DOT for ShakeCast implementation?

Name	Title	Email & Phone	Role
Rebecca Nix	Bridge Management Engineer	RNix@utah.gov (801) 633-2810	Shakecast TAC Member / Project Manager

ShakeCast Operational/Functional/IT Specifications: (e.g., In-house, platform, policies, security, monitoring, reporting, IT environment, USGS Cloud, local installation, ShakeCast Version, OS, hardware, etc.)

75. Do you foresee any organizational policies that prevent use of external cloud hosted solutions for your operational systems?

    None that we are aware of at this time.

76. What other software tools used in your emergency response practice require interoperability with ShakeCast?

    Google Mail Server: Email notifications are sent via SMTP from the ShakeCast system to the Outlook server for broad group list distribution.

    Other items that would not be required but would be advantageous are:

    - ***ArcGIS*:** UDOT shares a lot of spatial data through ArcGIS / UPlan Data Portal. This is a commercial Geographic Information System software with a SQL database used for spatial analysis.
    - ***Bridge Management (AASHTOWare BrM):*** UDOT uses BrM to store current condition data. BrM uses an Oracle 12g database to store data. It could be advantageous to have a live connection to this data to ensure ShakeMaps generated are as accurate as possible.

ShakeCast System Administration:

77. How many system administrators will be managing your ShakeCast system?

    Three System Administrators from the business.

78. How frequently do you anticipate update facility inventory data? (e.g., load/reload new bridges)

    Three types of facilities initially, which will be updated on an annual basis.

    5. **Bridges (Local and State):** List of bridges from the BrM (Bridge Management) system.

6. **Tunnel:** List of tunnels from the BrM system.
7. **Centerline Miles of Highways may be added at a later date annually**

79. How frequently do you anticipate adding new subscribers?

    New subscribers added ad-hoc at any time.

80. Can a group mailing list be established on your Department mail server? This is the recommended approach for distributing notifications to large groups of subscribers.

    Yes

81. How many different types of notification groups will you need? One message type for all users? Or, will different groups (e.g., by region, district, division, function, authority level, etc.) receive different notifications with different content?

    A notification group by region with specific content for each region to the Bridge Inspectors is needed. UDOT has 4 regions.

    An additional notification statewide notification group will be needed as well.

82. How many notification subscribers do you anticipate having?

    We anticipate having approximately 150 subscribers.

ShakeCast Product Customization: (notification template, email)

83. Is there specific custom content (text, graphics, links, etc.) that needs to be placed on the ShakeCast home page for your DOT?

    Yes. Utah specific content is to be included on the Utah ShakeCast website:
    - UDOT logos
    - Description of UDOT ShakeCast notification protocols, project background, USGS tools etc.
    - Buttons/links to request to be new subscriber.
        - This functionality will only be available for state/local inspection and emergency response staff.
    - Email and contact info for system admins and sponsors.
    - Link to the UDOT Structures Emergency Response Plan.

84. Is there specific custom content (text, graphics, links, etc.) that needs to be placed in ShakeCast email notifications in addition to the standard content (e.g., ShakeMap, magnitude, epicenter, date/time, facility impacts, etc.)?

    Yes. UDOT specific content to be included in ShakeCast notification emails:
    - Links to UDOT Structures Emergency Response Plan.
    - Email and contact info for system admins and sponsors.

Facilities: (no. of State and local bridges, no. of buildings, other facilities; employing ShakeCast Workbook?)

- What types and quantities of highway infrastructure assets do you anticipate loading into the ShakeCast system?
    - 3020+ State and local bridges, we anticipate initially using HAZUS fragilities curves
    - 4 tunnels (TBD)

Fragilities: (Normally, NBI->HAZUS model bridge type. Or, HAZUS AEBM.)

- How will facility fragilities be assigned?

  Initially, HAZUS based fragilities will be used for system level "impact potential" assessments. The default red/orange/yellow/green/grey will be used, corresponding to high/medium-high/medium/low/none.

- Will you need guidance in assigning fragility parameters to structures?

  Yes, we will need assistance in assigning fragility parameters to structures.

Notifications: (Notification and triggering domain; recipients: who, what roles, where)

85. At what minimum magnitude would you like to trigger ShakeCast notifications?

    The minimum magnitude to trigger ShakeCast notifications is M4.0 and greater.

86. ShakeCast can send updated notifications as ShakeMaps and magnitude estimates are updated in the hours and days following an earthquake. How large of a change in ground motions should trigger subsequent notifications?

    Subsequent notifications should be triggered by changes greater than 20% for an earthquake magnitude equal or less than 8.0 and changes greater than 10% for an earthquake magnitude higher than 8.0.

87. How many groups and types of notifications would you like to set up?

    Five groups. One for each region and one statewide.

Documentation: (Any case histories, publicity, Fact Sheets, operations manuals, response protocols, proceedings papers or meeting Abstracts, etc.)

Yes. UDOT Structures Emergency Maintenance Manual. This will need to be updated for new version of ShakeCast.

Scenario Exercises: Please describe any upcoming scenario exercises planned in your region.

88. Are there a sufficient number and variety of scenario events available for your region?

    UDOT has performed scenarios for seven sample earthquakes throughout the state. They are currently outdated and will need to be rerun based on the new version of ShakeCast. UDOT will evaluate if these seven scenarios are still applicable.

    How frequently do you anticipate running scenario events?

    Utah participates in a statewide emergency preparedness event every April. It would be beneficial to be able to run a scenario for the ShakeOut event annually for training purposes.

A.8 Washington DOT ShakeCast Instance

Organization: Washington State Department of Transportation (WSDOT)

DOT Contacts: Who are the primary contacts at your DOT for ShakeCast implementation?

Name	Title	Email & Phone	Role
John Himmel	Emergency Manager	himmelj@wsdot.wa.gov (360) 705-7973	Project Sponsor
Amy Leland		lelanda@wsdot.wa.gov	

ShakeCast Operational/Functional/IT Specifications: (e.g., In-house, platform, policies, security, monitoring, reporting, IT environment, USGS Cloud, local installation, ShakeCast Version, OS, hardware, etc.)

89. Do you foresee any organizational policies that prevent use of external cloud hosted solutions for your operational systems?

    No

90. What other software tools used in your emergency response practice require interoperability with ShakeCast?
    - *Microsoft Outlook Server* – Email notifications are sent via SMTP from the ShakeCast system to the Outlook server for broad group list distribution.
    - *FileMaker Pro* – Bridge fragility assignment is currently done within a FileMaker Pro database. The database holds more comprehensive information about bridge inventory details than that found in the FHWA NBI. WSDOT building inventory data is also managed in a FileMaker Pro database.
    - *ArcGIS* – Emergency Operations Centers use ArcGIS to produce various map products that may include ShakeCast analysis outcomes.

ShakeCast System Administration:

91. How many system administrators will be managing your ShakeCast system?
    One admin.
92. How frequently do you anticipate update facility inventory data? (e.g., load/reload new bridges)

    Four types of facilities initially, updated on an annual basis at different times throughout the year.

93. How frequently do you anticipate adding new subscribers?

    New subscribers added ad-hoc at any time.

94. Can a group mailing list be established on your Department mail server? This is the recommended approach for distributing notifications to large groups of subscribers.

    Yes.

95. How many different types of notification groups will you need? One message type for all users? Or, will different groups (e.g., by region, district, division, function, authority level, etc.) receive different notifications with different content?

This has yet to be determined. Potentially two at a minimum; one for WSDOT Highways and one for Washington State Ferries.

How many notification subscribers do you anticipate having?

This has yet to be determined.

ShakeCast Product Customization: (notification template, email)

96. Is there specific custom content (text, graphics, links, etc) that needs to be placed on the ShakeCast home page for your DOT?

    Yes. WSDOT-specific content to be included on the ShakeCast website:
    - WSDOT logos.
    - Description of WSDOT-ShakeCast notification protocols, project background, USGS tools etc.
    - Buttons/links to request to be new subscriber.
    - Email and contact info for system admins and sponsors.

97. Is there specific custom content (text, graphics, links, etc) that needs to be placed in ShakeCast email notifications in addition to the standard content (e.g., ShakeMap, magnitude, epicenter, date/time, facility impacts, etc.)?

    Yes. WSDOT-specific content to be included in ShakeCast notification emails:
    - WSDOT-specific disclaimer/usage statements.
    - Links to WSDOT emergency response protocols and policies.
    - Email and contact info for system admins and sponsors.
    - Link to WSDOT-specific full facility impact lists in various formats.

Facilities: (no. of State and local bridges, no. of buildings, other facilities; employing ShakeCast Workbook?)

- What types and quantities of highway infrastructure assets do you anticipate loading into the ShakeCast system?
    - 8,000+ State and local bridges/tunnels
    - 200+ building sites, each with several building sub-structures

Fragilities: (Normally, NBI->Hazus model bridge type. Or, Hazus AEBM.)

- How will facility fragilities be assigned?

  Initially, HAZUS based fragilities will be used for system level "impact potential" assessments. The default red/orange/yellow/green/grey will be used, corresponding to high/medium-high/medium/low/none. When we are able we would like to refine the fragilities to improve damage estimates.

- Will you need guidance in assigning fragility parameters to structures?

  Yes We will be interesting in learning more about using AEBM for building fragility assignments.

Notifications: (Notification and triggering domain; recipients: who, what roles, where)

98. At what minimum magnitude would you like to trigger ShakeCast notifications?

    M4.0 and greater statewide (WA)

99. ShakeCast can send updated notifications as ShakeMaps and magnitude estimates are updated in the hours and days following an earthquake. How large of a change in ground motions should trigger subsequent notifications?

    Changes greater than 20% should trigger new event notifications.

100. How many groups and types of notifications would you like to set up?

    Yet to be determined.

Documentation: (Any case histories, publicity, Fact Sheets, operations manuals, response protocols, proceedings papers or meeting Abstracts, etc.)

    N/A

Scenario Exercises: Please describe any upcoming scenario exercises planned in your region.

101. Are there a sufficient number and variety of scenario events available for your region?

    Yes. (Several ShakeMaps for WA online)

102. How frequently do you anticipate running scenario events?

    Yet to be determined.

A.9 Illinois DOT ShakeCast Instance

Organization: Illinois State Department of Transportation (IDOT)

DOT Contacts: Who are the primary contacts at your DOT for ShakeCast implementation?

Name	Title	Email & Phone	Role
Brandon Keller		Brandon.Keller@illinois.gov	
Joe Gasparich		Joe.Gasparich@illinois.gov	

A.10 South Carolina DOT ShakeCast Instance

Organization: South Carolina State Department of Transportation (ScDOT)

DOT Contacts: Who are the primary contacts at your DOT for ShakeCast implementation?

Name	Title	Email & Phone	Role
Chris Lacy		lacycr@scdot.org	
Terry Koon		koontb@scdot.org	

A.11 FHWA ShakeCast Instance

Organization: Federal Highway Administration (FHWA)

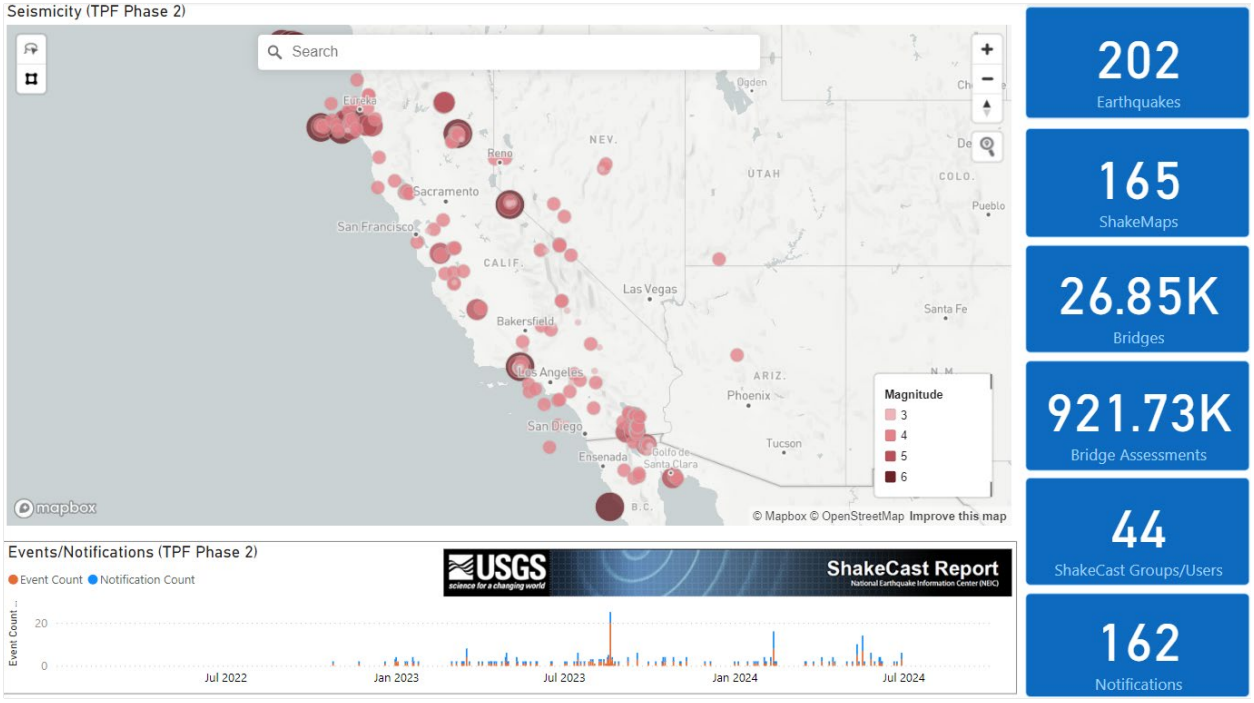
FHWA Contacts: Who are the primary contacts for ShakeCast implementation?

Name	Title	Email & Phone	Role
Jerry Shen		jia-dzwan.shen@dot.gov	
Jeffrey Ger		Jeffrey.ger@dot.gov	

APPENDIX B Notable Earthquakes of each DOT ShakeCast Instance

Appendix B provides summary plots of the number, magnitude, and locations of earthquakes that were processed by each DOT ShakeCast instance during the life of the TPF Phase II and examples of recent significant earthquakes and earthquake scenarios delivered to each state Department of Transportation.

B.1 Caltrans ShakeCast Instance



USGS science for a changing world | Caltrans

ShakeCast Report

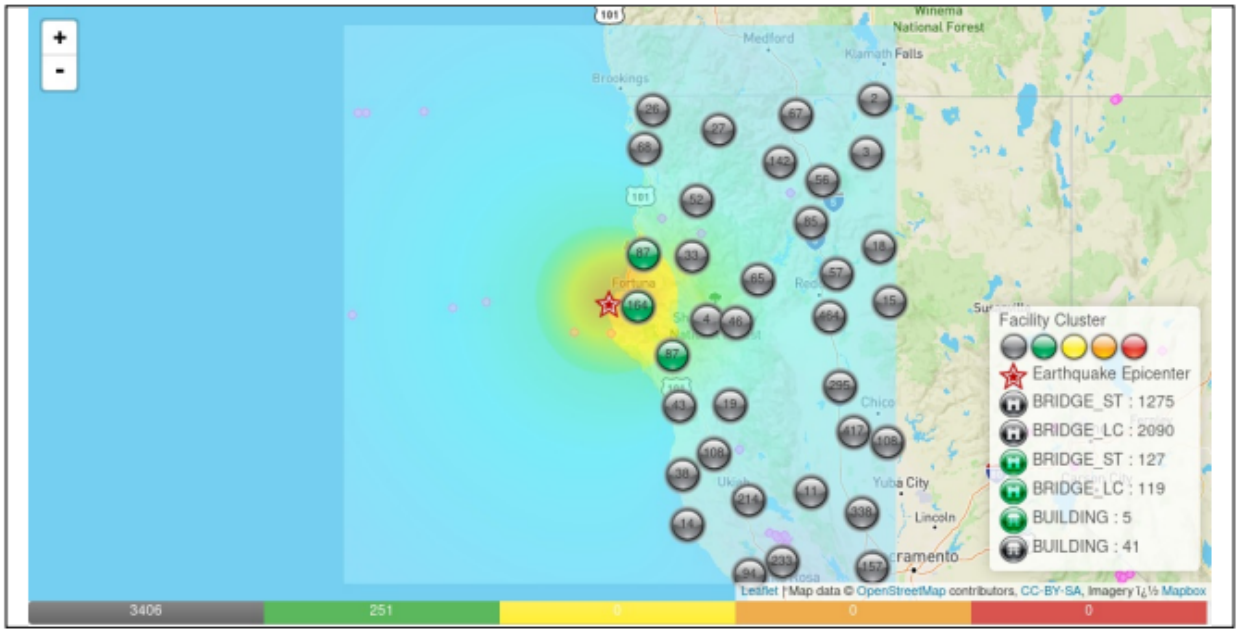
National Earthquake Information Center (NEIC)

Magnitude 6.1 - 12.4 km (7.7 mi) WSW of Ferndale, CA Version 1

Origin Time: 2022-12-20 02:34:25PST Process Time: 2022-12-20 02:45:42PST

Latitude: 40.5233 Longitude: -124.3933 Depth: 16.1 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_LC	04C0175	04C0175 - FLEENER CREEK	5.23	Low	29.47	25.59	27.2	VII	451.1
BRIDGE_LC	04C0077	04C0077 - BEAR RIVER	6.83	Low	21.4	25.47	25.68	VII	469.1
BRIDGE_LC	04C0184	04C0184 - JOHNSON GULCH	8.5	Low	19.41	23.06	22.85	VII	468.6
BRIDGE_LC	04C0147	04C0147 - SINGLEY CREEK	10.22	Low	22.36	23.89	25.45	VII	438.5
BRIDGE_LC	04C0163	04C0163 - BONANZA GULCH	10.45	Low	19.83	19.36	17.89	VII	466.4
BRIDGE_LC	04C0082	04C0082 - BEAR RIVER	11.21	Low	19.65	18.9	18.15	VII	468.2
BRIDGE_LC	04C0241	04C0241 - DRY CREEK	11.79	Low	21.97	23.65	26.1	VII	379.7
BRIDGE_LC	04C0012	04C0012 - SALT RIVER	12.78	Low	28.9	30.51	44.02	VII	231.9
BRIDGE_LC	04C0149	04C0149 - ARROYO CREEK	12.86	Low	19.44	18.11	18.3	VII	470.4
BRIDGE_LC	04C0249	04C0249 - FRANCIS CREEK	13.16	Low	28.02	28.96	43.44	VII	228.3
BRIDGE_LC	04C0192	04C0192 - MORGAN SLOUGH	13.18	Low	30.1	33.79	45.87	VII	225.2
BRIDGE_LC	04C0050	04C0050 - BEAR RIVER	13.21	Low	19.43	17.79	18.23	VII	470.9
BRIDGE_LC	04C0257	04C0257 - WILLIAMS CREEK	13.24	Low	27.3	23.61	32.19	VII	317.1
BRIDGE_LC	04C0262	04C0262 - FRANCIS CREEK	13.81	Low	28.55	30.24	44.6	VII	223.9
BRIDGE_LC	04C0208	04C0208 - WILLIAMS CREEK	13.95	Low	24.61	19.01	22.51	VII	446.7
BRIDGE_LC	04C0122	04C0122 - SALT RIVER OVERFLOW	14.22	Low	28.44	30.19	44.27	VII	225.3

USGS science for a changing world

Caltrans

ShakeCast Report

National Earthquake Information Center (NEIC)

Magnitude 7.6 - S. San Andreas; Parkfield

Version 4

Origin Time: 2013-10-10 06:00:00UTC

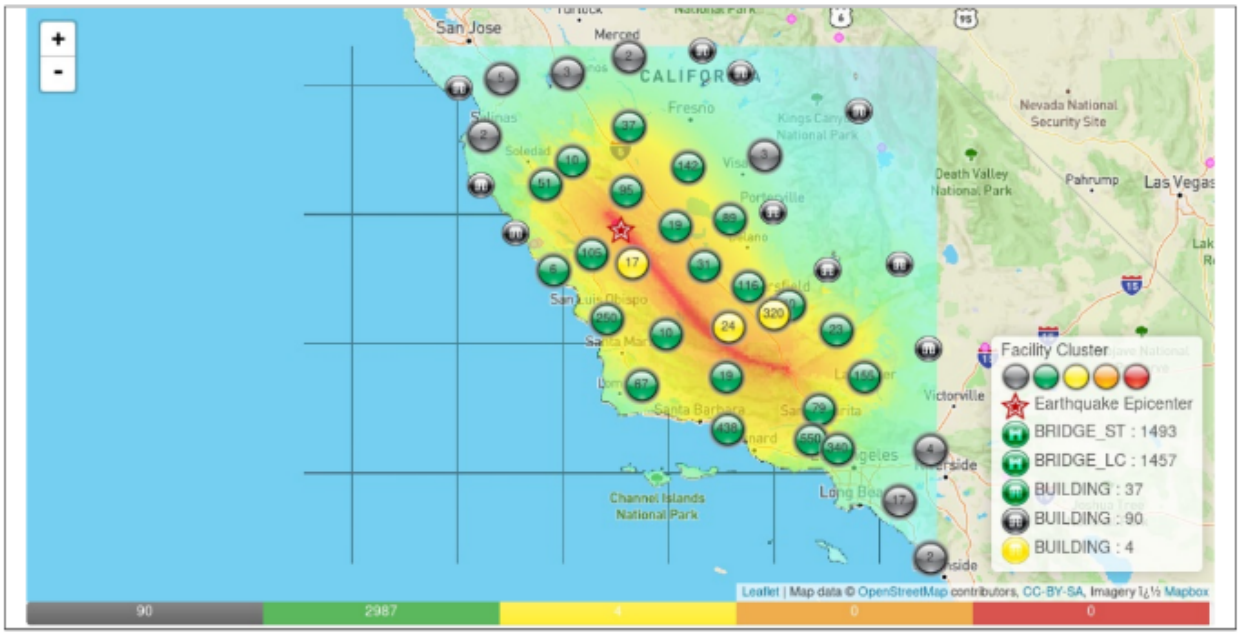
: 2024-07-18 06:02:06UTC

Latitude: 35.902400 Longitude: -120.457000

SCENARIO

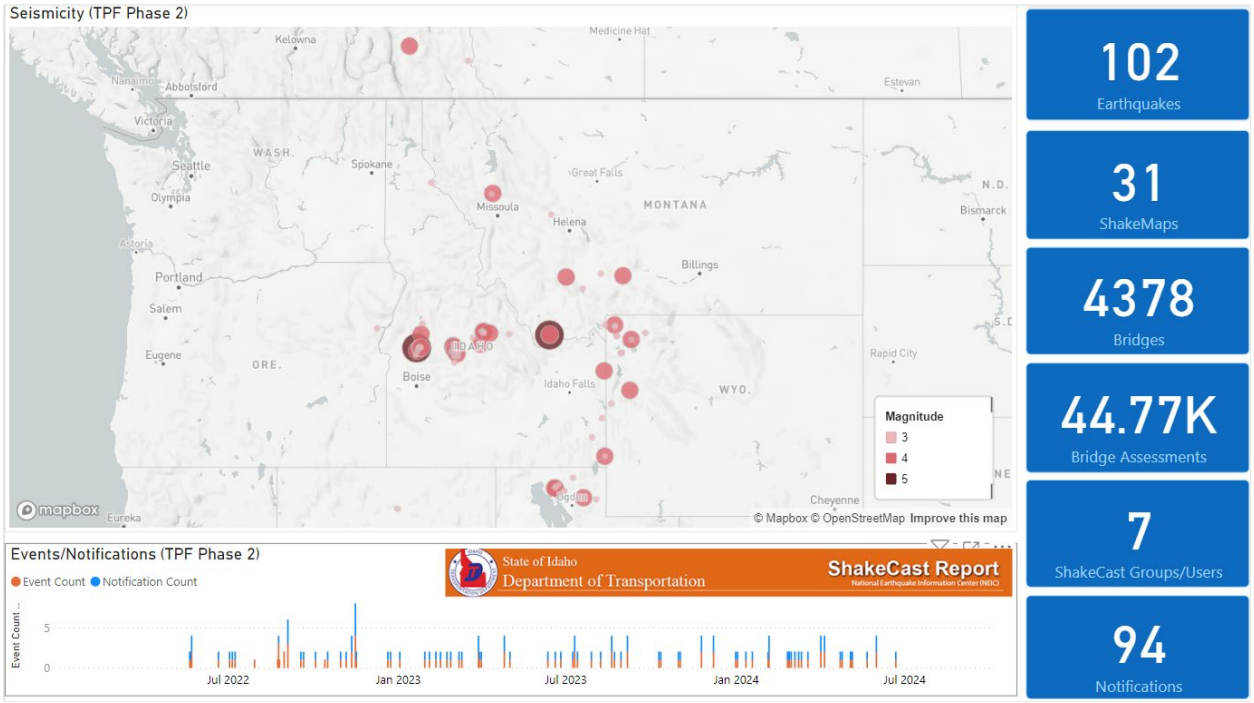
Depth: 9.7 km

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)
BUILDING	MTC-5-114	Shandon Maintenance Station	28.3	Moderate	31.42	43.69	33.4	VIII	
BUILDING	MTC-6-132	Taft Maintenance Station	120.88	Moderate	30.98	42.62	32.62	VIII	
BUILDING	WS-6-19	Grapevine Commercial Vehicle Enforcement Facility B - SB	172.89	Moderate	28.46	37.05	28.48	VIII	
BUILDING	MTC-7-157	Lebec Maintenance Station	187.21	Moderate	41.17	47.38	32.81	VIII	
BRIDGE_LC	44C0145	44C0145 - LITTLE CHOLAME CREEK	1.96	Low	53.9	96.77	64.58	IX	
BRIDGE_LC	44C0141	44C0141 - LITTLE CHOLAME CREEK	2.17	Low	53.9	96.77	64.58	IX	
BRIDGE_LC	44C0036	44C0036 - LITTLE CHOLAME CREEK	2.61	Low	58.22	101.56	67.43	IX	
BRIDGE_LC	44C0146	44C0146 - LITTLE CHOLAME CREEK	2.97	Low	46.93	85.23	57.75	IX	
BRIDGE_LC	44C0140	44C0140 - CHOLAME CREEK	4.92	Low	47.65	77.89	52.68	IX	
BRIDGE_LC	44C0147	44C0147 - LITTLE CHOLAME CREEK	4.98	Low	46.69	84.77	57.54	IX	
BRIDGE_LC	44C0148	44C0148 - LITTLE CHOLAME CREEK	5.87	Low	46.69	84.77	57.54	IX	
BRIDGE_LC	44C0144	44C0144 - CHOLAME CREEK	9.43	Low	48.6	79.53	53.66	IX	
BRIDGE_LC	44C0143	44C0143 - CHOLAME CREEK	12.39	Low	57.89	101.25	67.25	IX	
BRIDGE_LC	44C0149	44C0149 - BIG SANDY CREEK	17.14	Low	35.89	50.92	38.03	VIII	
BRIDGE_LC	49C0419	49C0419 - RANCHITA CREEK	17.98	Low	25.77	28.05	21.28	VII	
BRIDGE_LC	44C0150	44C0150 - BIG SANDY CREEK	18.81	Low	32.13	42.17	31.72	VIII	

B.2 Idaho DOT ShakeCast Instance



State of Idaho
Department of Transportation

ShakeCast Report
National Earthquake Information Center (NEIC)

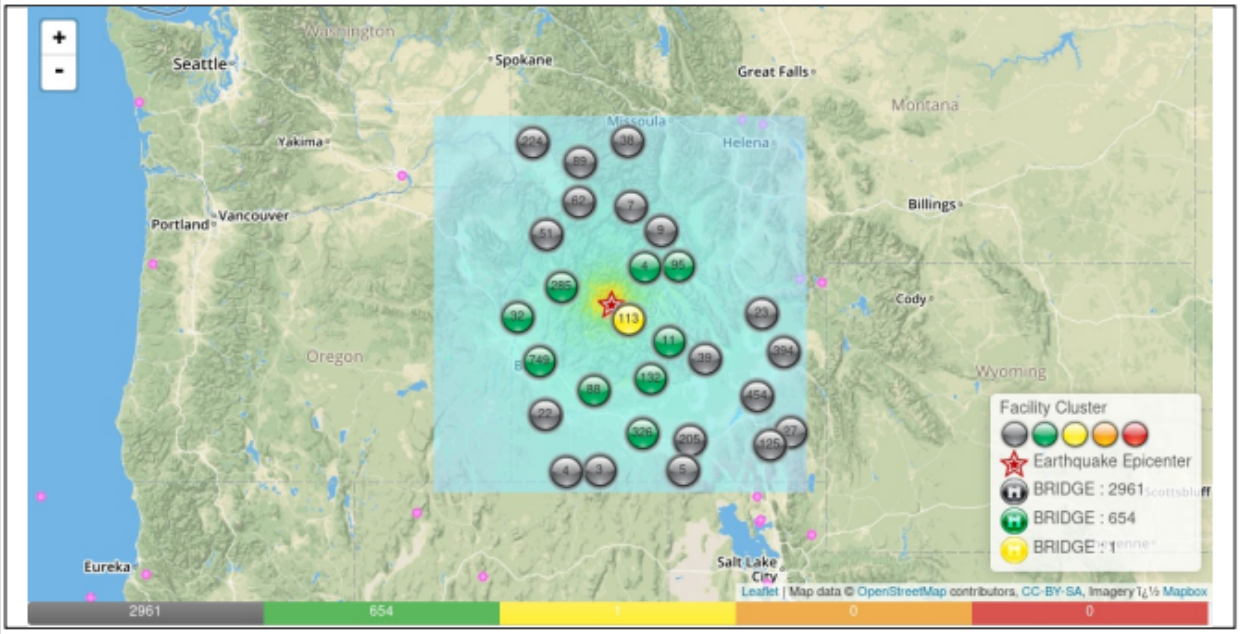
Magnitude 6.5 - 72 km W of Challis, Idaho,

Version 3

Origin Time: 2020-03-31 17:52:31MDT
Process Time: 2020-03-31 19:23:22MDT

Latitude: 44.4484 Longitude: -115.1361
Depth: 10.0 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	16_040601000001105	040601000001105 - MARSH CREEK	6.38	Moderate	42.08	38.31	44.47	VIII	284
BRIDGE	16_040604000001119	040604000001119 - BEAVER CREEK	4.06	Low	40.89	28.85	28.56	VII	516.7
BRIDGE	16_000000000012955	000000000012955 - CAPE HORN CREEK	6.65	Low	42.08	38.31	44.47	VIII	284
BRIDGE	16_040603000001158	040603000001158 - BEAVER CREEK	6.92	Low	37.33	24.96	23.9	VII	585.3
BRIDGE	16_040603000001173	040603000001173 - KNAPP CREEK	8.92	Low	38.78	32.81	37.01	VII	332.1
BRIDGE	16_040603000001159	040603000001159 - BEAVER CREEK	10.74	Low	31.7	19.75	18.04	VII	699.1
BRIDGE	16_040601000001123	040601000001123 - SEAFOAM CREEK	11.66	Low	32.37	21.01	19.92	VII	618.3
BRIDGE	16_040601000001124	040601000001124 - FLOAT CREEK	13.47	Low	26.19	15.57	13.87	VI	779.1
BRIDGE	16_041403000001087	041403000001087 - VALLEY CREEK	15.2	Low	30.41	23.51	25.71	VII	392.5
BRIDGE	16_040205000001120	040205000001120 - WYOMING CREEK	15.22	Low	32.29	27.34	31.72	VII	305.6

State of Idaho
Department of Transportation

ShakeCast Report
National Earthquake Information Center (NEIC)

Magnitude 7.03 - Squaw Creek fault

Version 3

Origin Time: 2017-05-12 14:14:14MDT

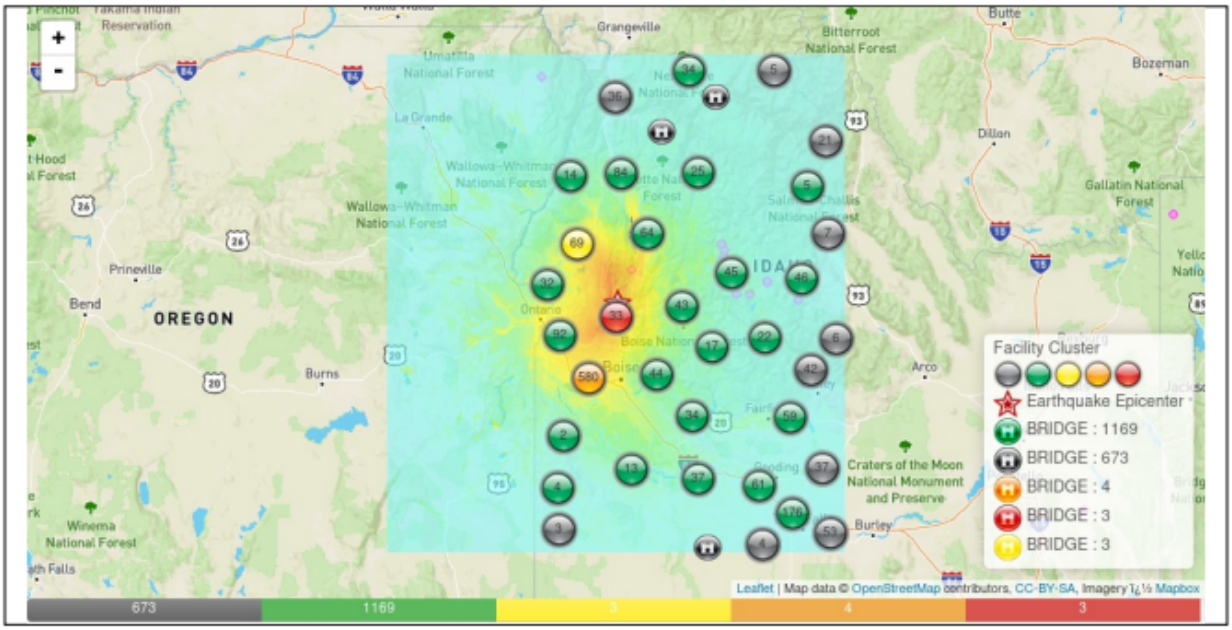
SCENARIO

2021-07-20 15:36:31MDT

Latitude: 44.145510 Longitude: -116.238400

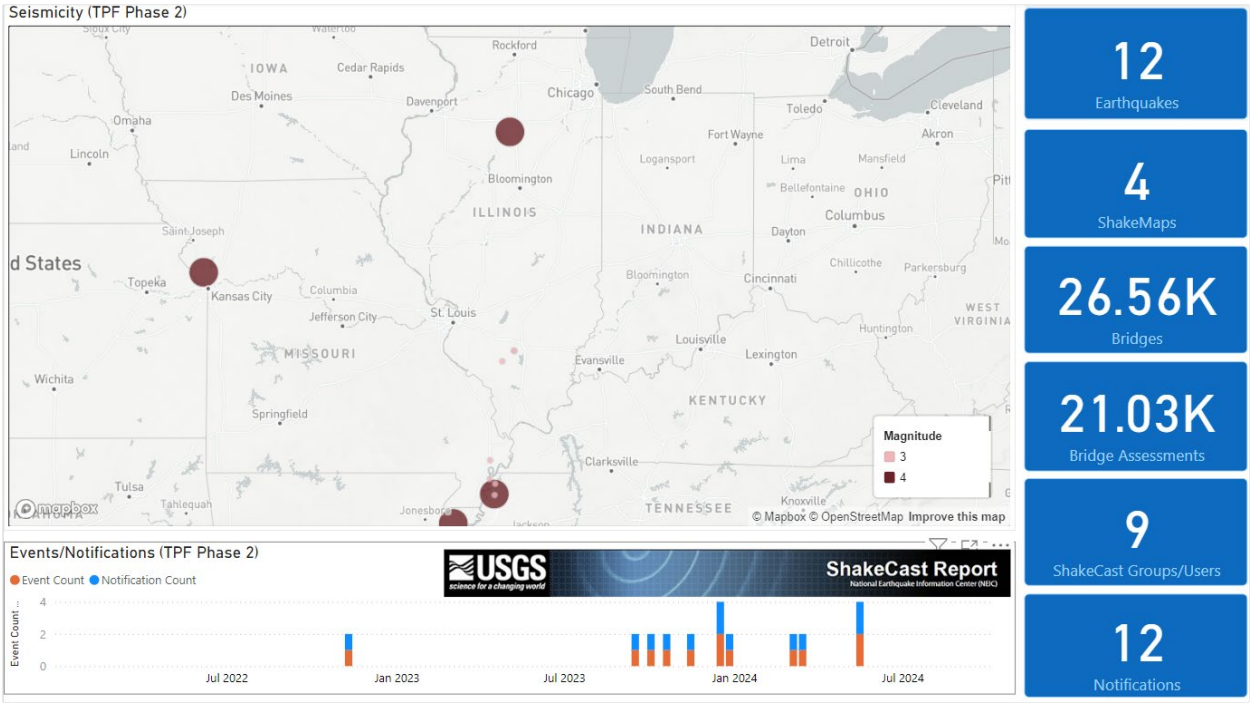
Depth: 9.0044 km

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	16_000000000019965	000000000019965 - SQUAW CREEK	12.16	High	58.64	74.44	78.74	VIII	
BRIDGE	16_000000000028185	000000000028185 - SQUAW CREEK	19.55	High	59.14	70.25	71.68	VIII	
BRIDGE	16_000000000014655	000000000014655 - SQUAW CREEK	23.3	High	54.98	69.8	82.82	VIII	
BRIDGE	16_000000000019945	000000000019945 - PAYETTE RVR(MONTOUR BR)	24.99	Moderate High	54.8	55.22	61.34	VIII	
BRIDGE	16_000000000019940	000000000019940 - PAYETTE RIVER;PLAZA BR.	29.79	Moderate High	50.43	64.5	62.43	VIII	
BRIDGE	16_000000000014650	000000000014650 - PAYETTE RIVER;EMMETT BR.	36.05	Moderate High	32.88	46.75	50.8	VIII	
BRIDGE	16_000000000028180	000000000028180 - FARMERS COOP CANAL	36.74	Moderate High	31.17	46.4	52.11	VIII	
BRIDGE	16_000000000014760	000000000014760 - PAYETTE RIVER	27.04	Moderate	31.13	31.79	35.99	VII	
BRIDGE	16_000000000028425	000000000028425 - BIG WILLOW CREEK	27.92	Moderate	24.01	34.28	39.81	VII	
BRIDGE	16_000000000028760	000000000028760 - SHIRTS	34.88	Moderate	28.12	37.87	41.24	VIII	

B.3 Illinois DOT ShakeCast Instance



USGS science for a changing world

ShakeCast Report

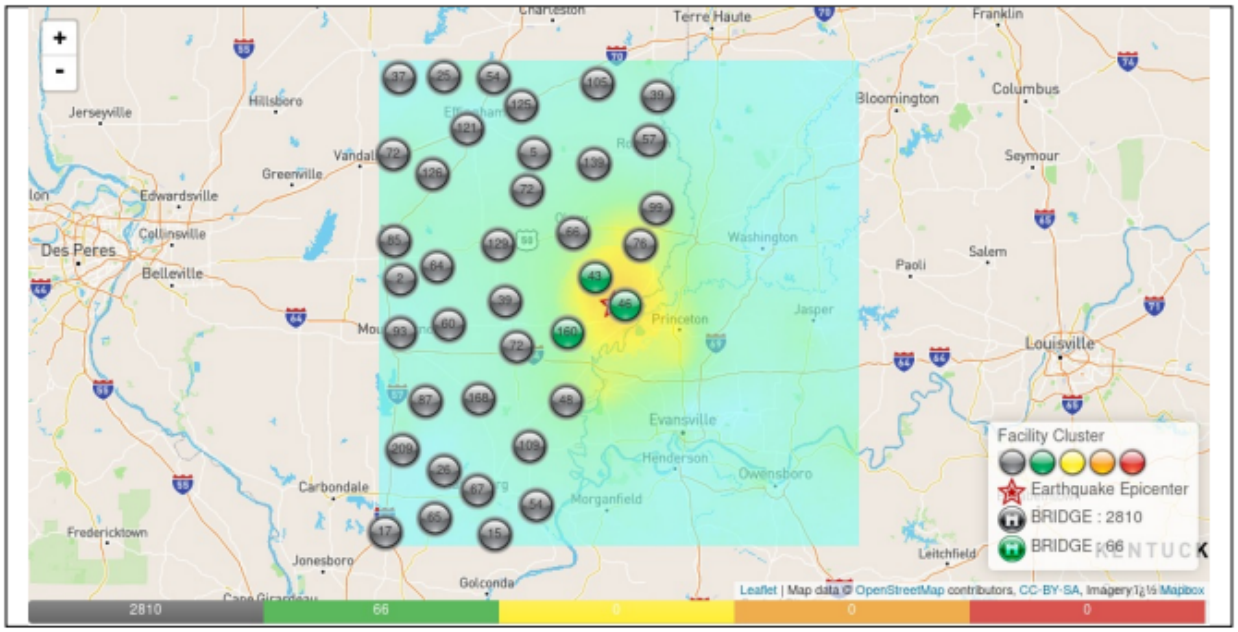
National Earthquake Information Center (NEIC)

Magnitude 5.2 - 11km WNW of Mount Carmel, Illinois Version 1

Origin Time: 2008-04-18 03:36:59UTC Process Time: 2022-02-24 13:44:15UTC

Latitude: 38.4515 Longitude: -87.8862 Depth: 14.2 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	17_093313900000000	093313900000000 - Fordice Creek	0.22	Low	28.22	15.88	15.81	VII	283.4
BRIDGE	17_093304600000000	093304600000000 - DRAINAGE DITCH	1.28	Low	28.69	16.31	15.15	VII	308.1
BRIDGE	17_093313400000000	093313400000000 - DRAINAGE DITCH	1.32	Low	28.41	16.1	15.46	VII	296.7
BRIDGE	17_093312800000000	093312800000000 - DRAINAGE DITCH	1.51	Low	28.41	16.1	15.46	VII	296.7
BRIDGE	17_093312600000000	093312600000000 - FORDICE CR LATERAL	2.17	Low	26.74	14.39	15.72	VII	236.1
BRIDGE	17_093312300000000	093312300000000 - FORDICE CREEK	2.22	Low	26.74	14.39	15.72	VII	236.1
BRIDGE	17_093312500000000	093312500000000 - FORDICE CR LATERAL	2.32	Low	28.54	16.41	14.26	VII	339.1
BRIDGE	17_093307800000000	093307800000000 - CREEK	2.74	Low	27.71	15.64	15.51	VII	284.8
BRIDGE	17_093303900000000	093303900000000 - FORDICE CREEK	3.1	Low	28.32	16.4	14.8	VII	322.4
BRIDGE	17_093309800000000	093309800000000 - FORDICE CREEK	3.93	Low	25.38	13.51	14.73	VII	235.7
BRIDGE	17_093311900000000	093311900000000 - CREEK	4.31	Low	26.02	14.36	15.31	VII	258.8

USGS science for a changing world

ShakeCast Report

National Earthquake Information Center (NEIC)

Magnitude 6.3 - eastern Missouri

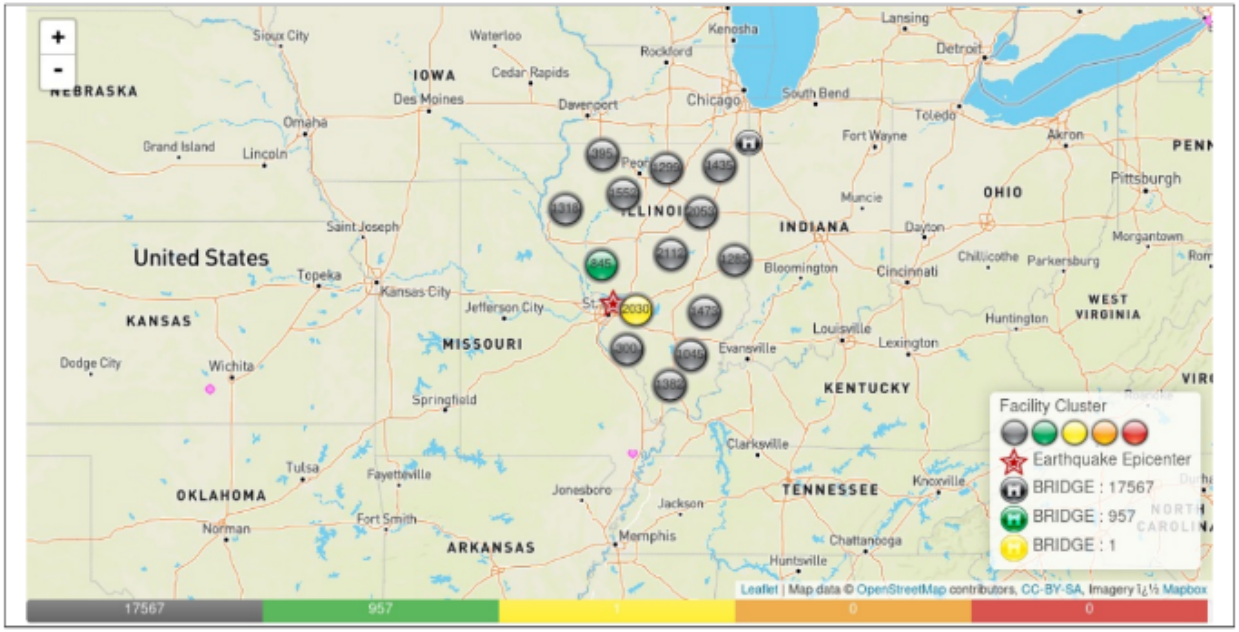
Version 1

Origin Time: 2023-03-11 11:26:28 GMT Pr[SCENARIO]d: 2023-03-01 23:06:58 GMT

Latitude: 38.8000 Longitude: -90.1000

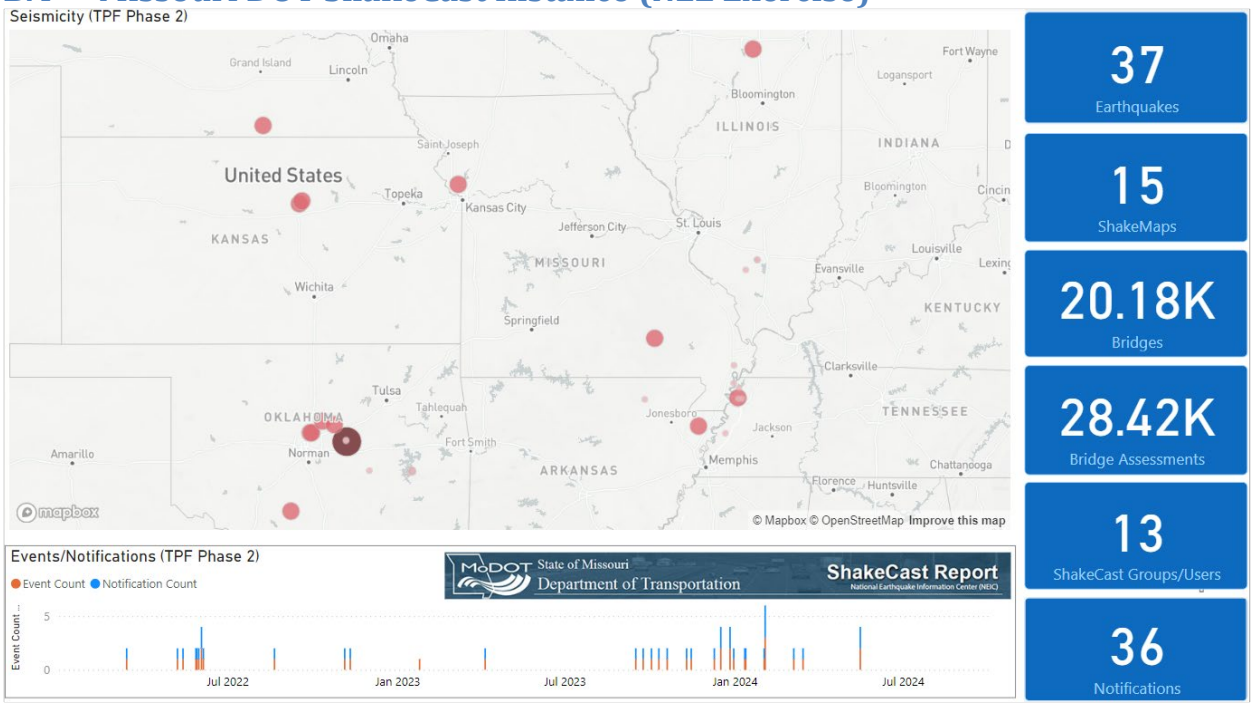
Depth: 5.0 km

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	17_060020200000000	060020200000000 - RR YARD	12.63	Moderate	57.1	30.3	35.82	VIII	237.7
BRIDGE	17_059332900000000	059332900000000 - MAY BRANCH	41.76	Low	16.56	8.9	10.05	VI	236.9
BRIDGE	17_060301800000000	060301800000000 - SUGAR CK	41.57	Low	16.88	9.077	10.25	VI	239.5
BRIDGE	17_082415000000000	082415000000000 - RICHLAND CREEK	41.5	Low	16.66	8.955	10.11	VI	237.4
BRIDGE	17_067314600000000	067314600000000 - CARR CREEK	41.48	Low	16.64	8.936	10.09	VI	236.4
BRIDGE	17_082019100000000	082019100000000 - FAI-64	41.39	Low	16.97	9.181	10.32	VI	250.2
BRIDGE	17_059004000000000	059004000000000 - TR 439	41.38	Low	16.98	9.199	10.33	VI	253.1
BRIDGE	17_060323200000000	060323200000000 - LITTLE SILVER	41.38	Low	16.56	8.85	10.02	VI	228.9
BRIDGE	17_059004100000000	059004100000000 - TR 439	41.37	Low	16.98	9.199	10.33	VI	253.1
BRIDGE	17_059200100000000	059200100000000 - GILLESPIE LAKE CREEK	41.16	Low	16.83	8.86	10.07	VI	212.9
BRIDGE	17_067600800000000	067600800000000 - WILSON CR. MSS 1296	41.13	Low	16.87	9.055	10.23	VI	237.1
BRIDGE	17_082006300000000	082006300000000 - SILVER CREEK	41.13	Low	17.32	9.439	10.09	VI	275.5
BRIDGE	17_059005100000000	059005100000000 - BIG BRANCH	41.12	Low	16.69	8.948	10.11	VI	234.3
BRIDGE	17_067600200000000	067600200000000 - CARR CREEK	41.11	Low	16.87	9.055	10.23	VI	237.1

B.4 Missouri DOT ShakeCast Instance (NLE Exercise)



State of Missouri Department of Transportation

ShakeCast Report

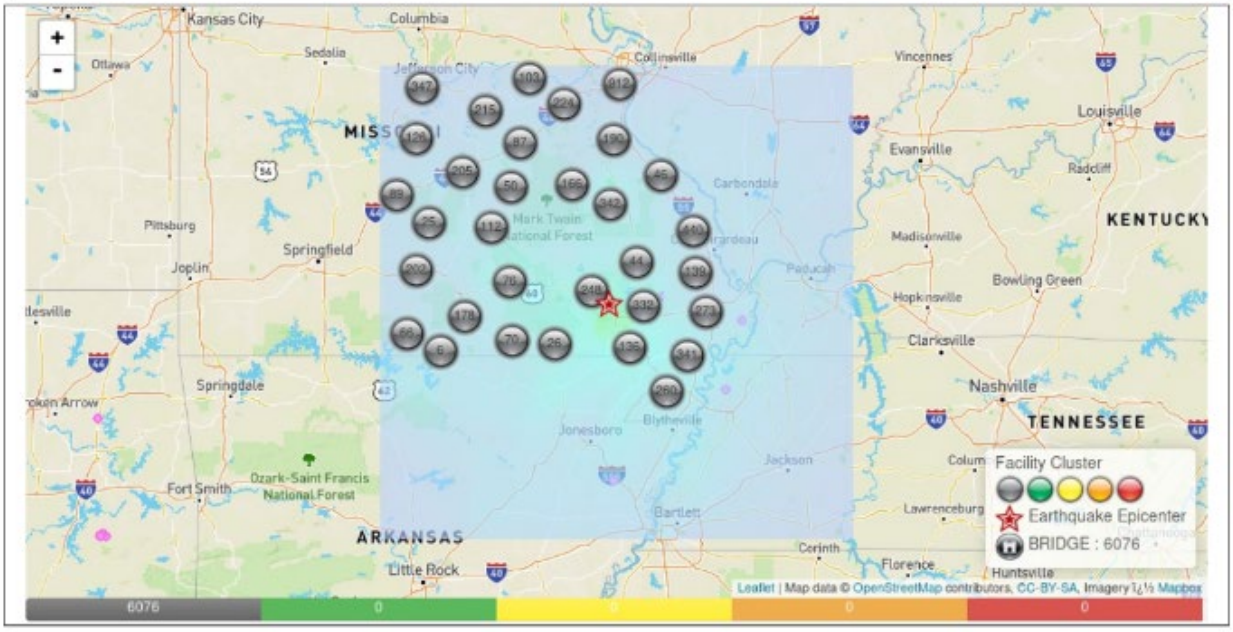
National Earthquake Information Center (NEIC)

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

State of Missouri Department of Transportation

ShakeCast Report

National Earthquake Information Center (NEIC)

Magnitude 6.7 - eastern Missouri

Version 1

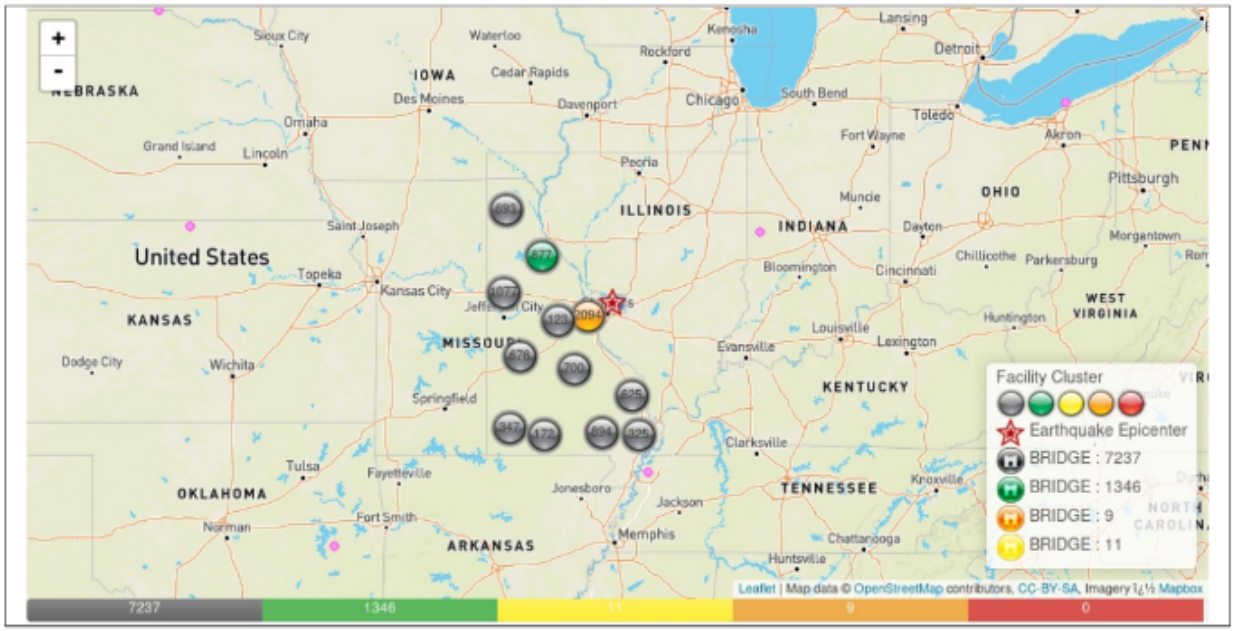
Origin Time: 2023-03-11 11:26:28 GMT Pr[illegible]d: 2023-03-09 13:18:53 GMT

Latitude: 38.8000 Longitude: -90.1000

SCENARIO

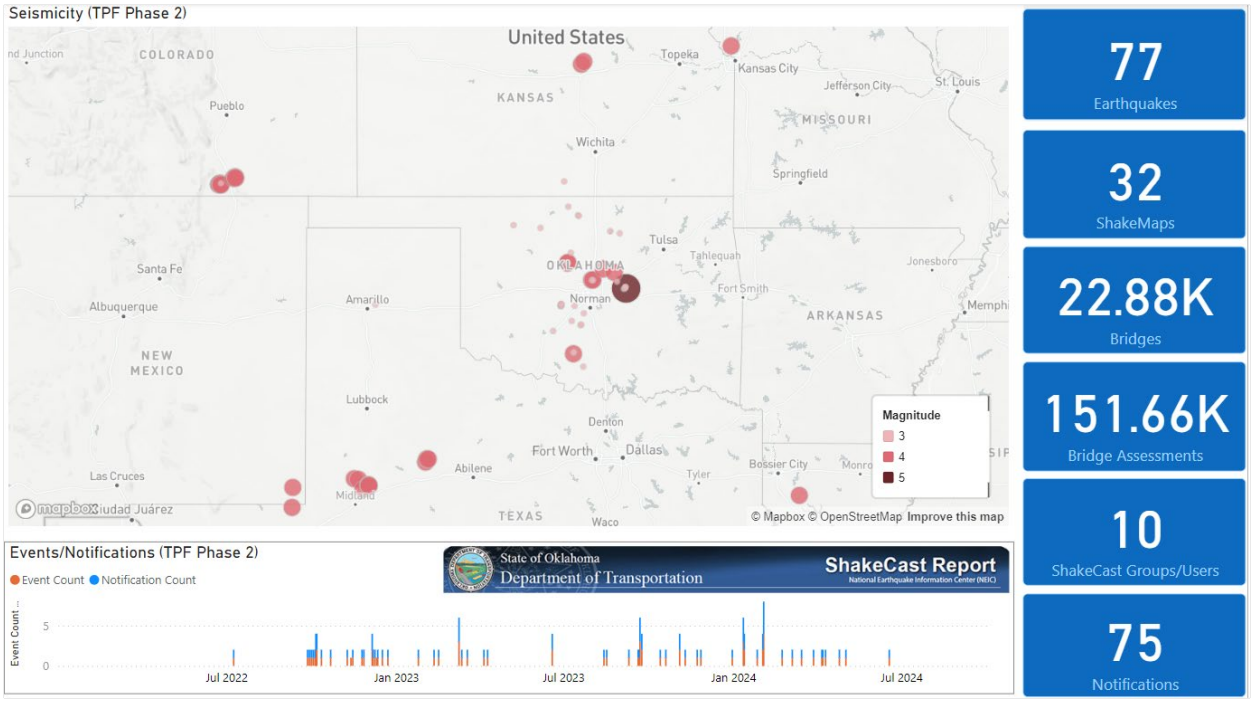
Depth: 5.0 km

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	300.09	13140 - TRRA and UP RR	21.57	Moderate High	84.32	57.35	55.05	VIII	341.6
BRIDGE	300.03	13135 - UP and TRRA RR	21.64	Moderate High	84.32	57.35	55.05	VIII	341.6
BRIDGE	L0667	6418 - CST VANDEVENTER AVE CST	22.51	Moderate High	66.48	42.45	51.92	VIII	237.4
BRIDGE	nbi_29_12947	12947 - METROLINK	22.94	Moderate High	68.94	46.66	44.47	VIII	340.6
BRIDGE	250.07	12950 - METROLINK	23.13	Moderate High	65.55	43.53	48.33	VIII	280.2
BRIDGE	100.09	12432 - RVR DES PERES	24.99	Moderate High	61.18	39.24	47.58	VIII	241.7
BRIDGE	nbi_29_12880	12880 - UP RR	25.11	Moderate High	71.35	48.15	45.4	VIII	349.1
BRIDGE	100.11	12434 - RVR DES PERES	25.24	Moderate High	63.9	42.57	45.95	VIII	289.4
BRIDGE	A1057	852 - RIVER DES PERES CST GER	31.17	Moderate High	70.89	48.13	46.28	VIII	334.3
BRIDGE	096B106	15529 - BLACK JACK CR	14.21	Moderate	61.3	41.46	39.88	VIII	332.9
BRIDGE	MCKINLY	32776 - MISSISSIPPI RVR	16.77	Moderate	73.16	46.42	57.68	VIII	232.9
BRIDGE	096B142	15547 - MALINE CR	18.36	Moderate	57.57	38.02	34.64	VIII	378.1
BRIDGE	A1500	1244 - MISSISSIPPI RVR CST WHA	21.45	Moderate	88.98	60.78	59.28	VIII	333.4
BRIDGE	4520002	24033 - BR RVR DES PERES	22.65	Moderate	61.05	41.25	39.53	VIII	335.5

B.5 Oklahoma DOT ShakeCast Instance



State of Oklahoma
Department of Transportation

ShakeCast Report

National Earthquake Information Center (NEIC)

Magnitude 5.1 - 6 km NW of Prague, Oklahoma,

Version 1

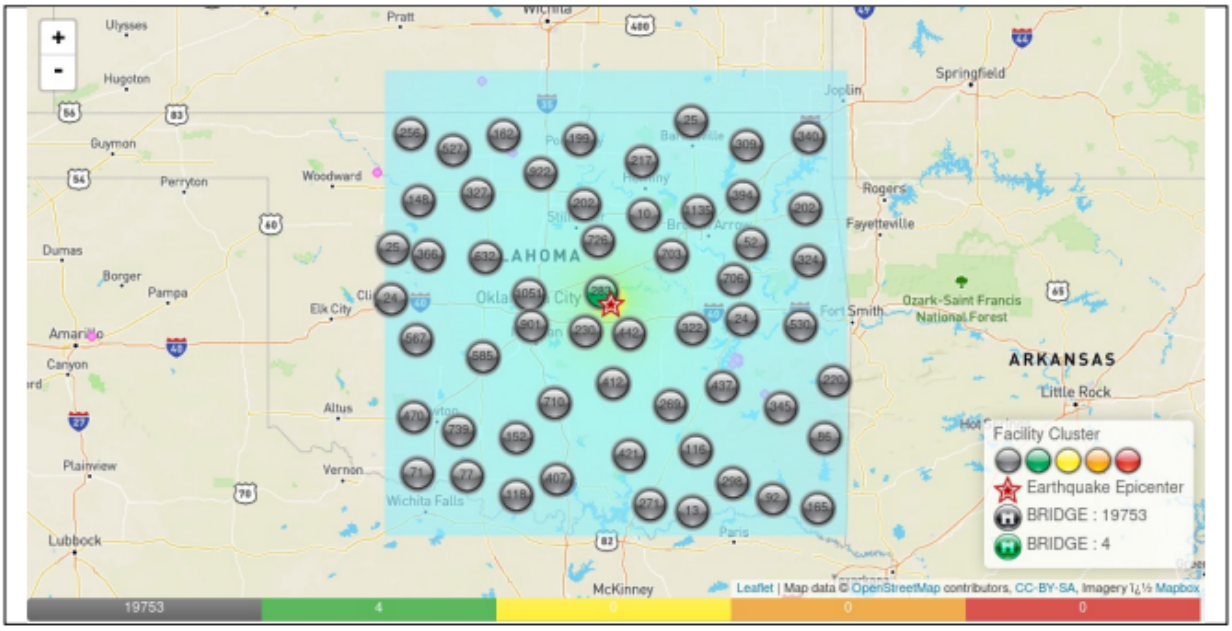
Origin Time: 2024-02-02 23:24:28CST

Process Time: 2024-02-02 23:43:31CST

Latitude: 35.5346 Longitude: -96.7337

Depth: 6.0 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	40_207400000000000	207400000000000 - SAND CREEK	0.63	Low	45.81	14.31	10.63	VII	350.7
BRIDGE	40_003140000000000	003140000000000 - ROBINSON CREEK	1.24	Low	45.48	14.04	10.16	VII	371
BRIDGE	40_030840000000000	030840000000000 - CREEK	2.05	Low	44.79	13.86	10.26	VII	355.5
BRIDGE	40_024220000000000	024220000000000 - WARSHAM CREEK	3.06	Low	43.27	13.28	10.04	VII	342.7
BRIDGE	40_116900000000000	116900000000000 - SAND CREEK	1.11	Below Threshold	47.81	14.18	9.063	VII	441.9
BRIDGE	40_028150000000000	028150000000000 - ROBINSON CREEK	2.1	Below Threshold	44.16	13.55	9.966	VII	361.6
BRIDGE	40_227300000000000	227300000000000 - CREEK	3.47	Below Threshold	47.72	12	6.09	VII	591.4
BRIDGE	40_013910000000000	013910000000000 - CREEK	3.52	Below Threshold	46.47	12.57	7.065	VII	517.2
BRIDGE	40_100810000000000	100810000000000 - CREEK	3.74	Below Threshold	41.21	12.41	9.382	VII	345.8
BRIDGE	40_108090000000000	108090000000000 - CREEK	3.85	Below Threshold	39.72	11.82	8.743	VII	364
BRIDGE	40_074890000000000	074890000000000 - CREEK	3.9	Below Threshold	40.85	12.2	9.019	VII	363.4
BRIDGE	40_023040000000000	023040000000000 - ROBINSON CREEK	4.06	Below Threshold	36.37	10.25	9.874	VII	241.8

State of Oklahoma
Department of Transportation

ShakeCast Report

National Earthquake Information Center (NEIC)

Magnitude 7.24 - Meers

SCENARIO

Version 5

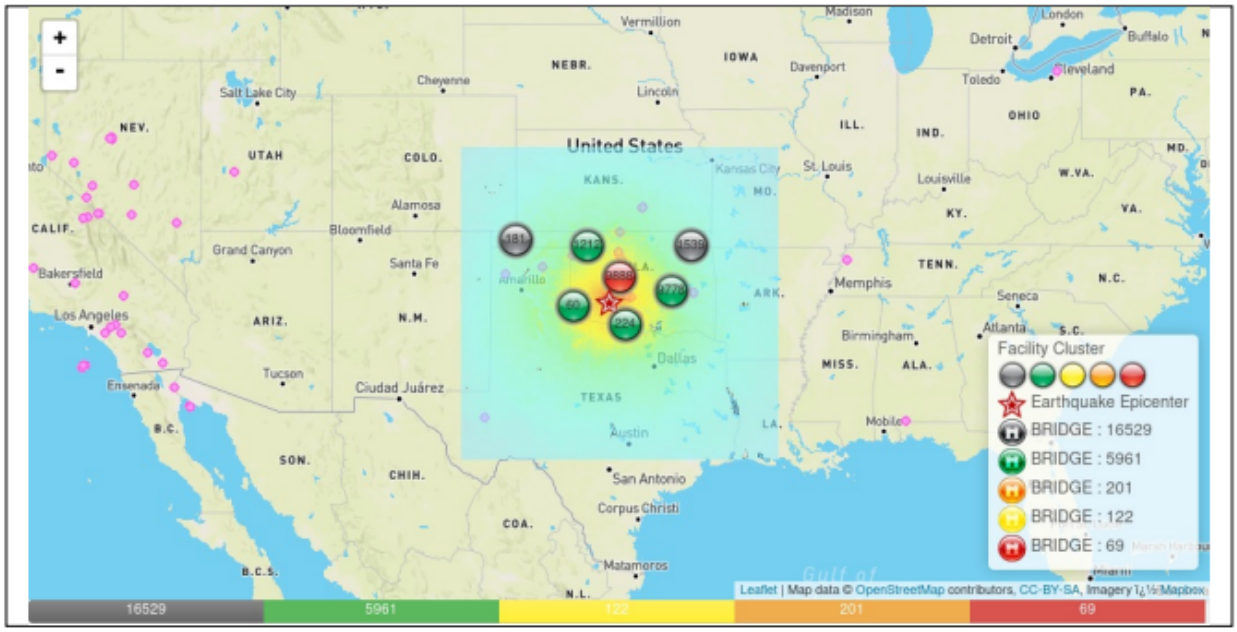
Origin Time: 2017-05-12 13:52:32CDT

Time: 2021-05-27 08:39:19CDT

Latitude: 34.802030 Longitude: -98.530780

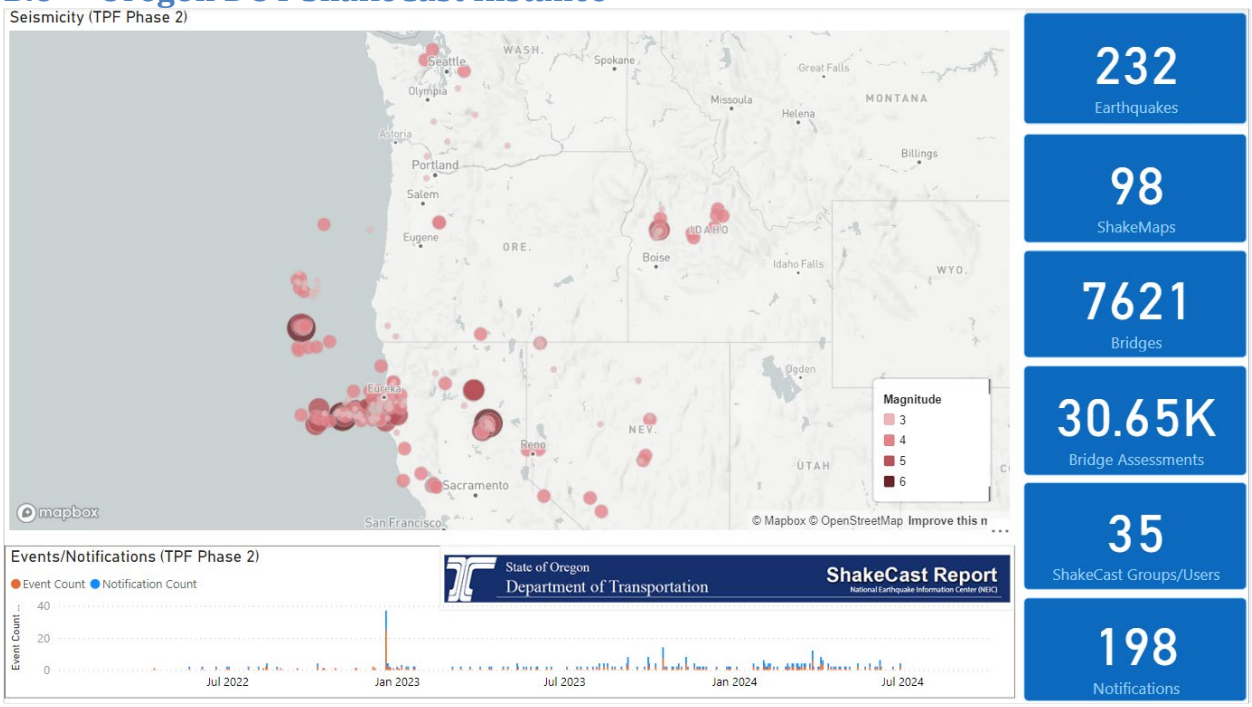
Depth: 11.0102 km

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	40_191980000000000	191980000000000 - CANYON CREEK	2.22	High	144.26	121.45	114.68	IX	
BRIDGE	40_191220000000000	191220000000000 - CREEK	2.66	High	140.59	77.13	69.52	IX	
BRIDGE	40_014570000000000	014570000000000 - CREEK	3.2	High	153.04	112.39	103.75	IX	
BRIDGE	40_191210000000000	191210000000000 - CREEK	3.49	High	127.73	57.45	50.81	IX	
BRIDGE	40_198600000000000	198600000000000 - KETCH CREEK	5.11	High	157.11	114.45	105.25	IX	
BRIDGE	40_019610000000000	019610000000000 - CREEK	8.05	High	161.97	106.25	96.23	IX	
BRIDGE	40_110070000000000	110070000000000 - FRIZZIE HEAD CREEK	9	High	140.27	85.67	78.26	IX	
BRIDGE	40_117950000000000	117950000000000 - KETCH CREEK	10.23	High	132.25	77.63	70.9	IX	
BRIDGE	40_110090000000000	110090000000000 - CREEK	10.38	High	146.2	103.03	95.24	IX	
BRIDGE	40_133080000000000	133080000000000 - CREEK	11.41	High	117.67	80.09	75.27	IX	
BRIDGE	40_134310000000000	134310000000000 - CREEK	11.55	High	117.67	80.09	75.27	IX	
BRIDGE	40_133070000000000	133070000000000 - CREEK	11.59	High	117.67	80.09	75.27	IX	
BRIDGE	40_191420000000000	191420000000000 - CREEK	11.63	High	150.09	115.68	107.4	IX	

B.6 Oregon DOT ShakeCast Instance



State of Oregon
Department of Transportation

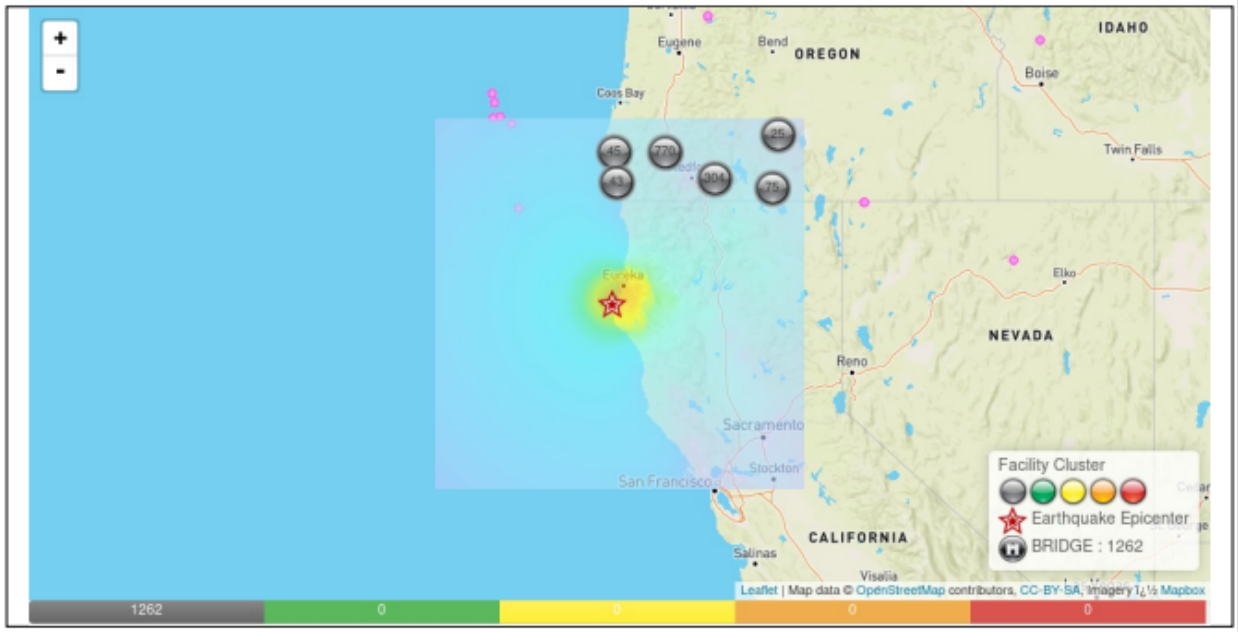
ShakeCast Report
National Earthquake Information Center (NEIC)

Magnitude 6.4 - 12.4 km (7.7 mi) WSW of Ferndale, CA Version 3

Origin Time: 2022-12-20 02:34:25PST Process Time: 2022-12-20 04:13:00PST

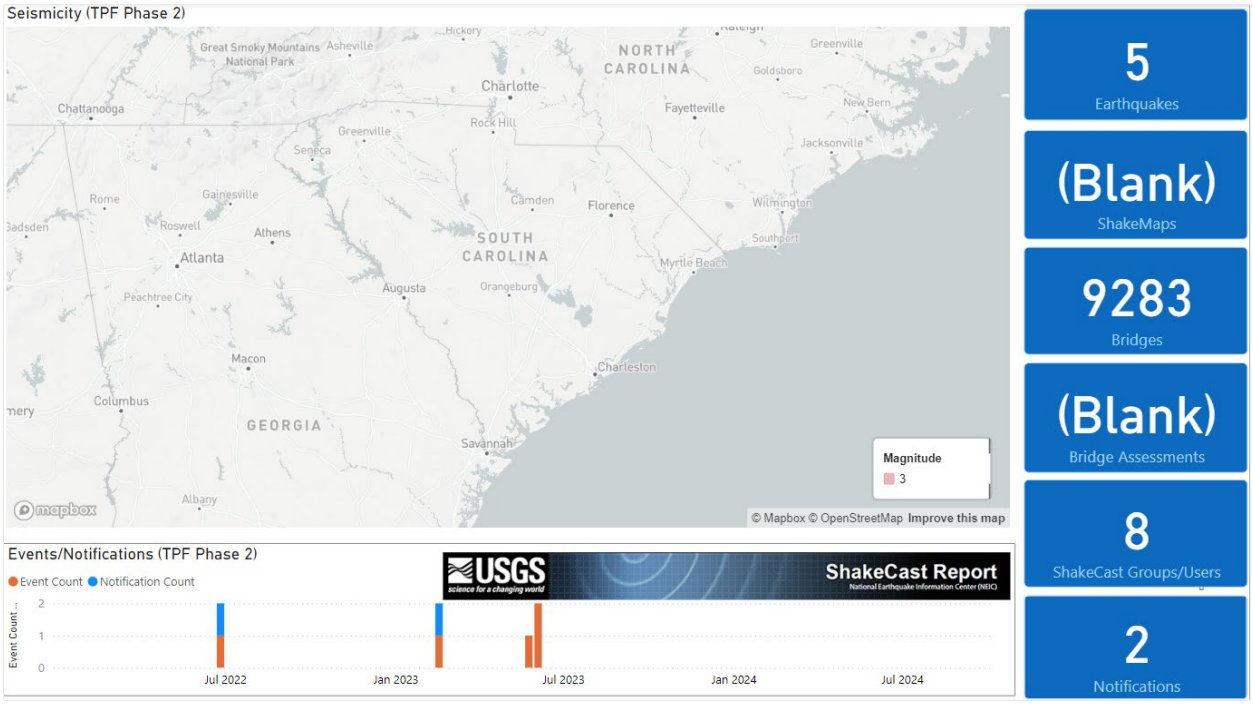
Latitude: 40.5233 Longitude: -124.3933 Depth: 16.1 km

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	41_09091A009_36261	09091A009_36261 - WINCHUCK RIVER	165.31	Below Threshold	0.4714	0.5263	0.5495	III	600
BRIDGE	41_061101000001163	061101000001163 - WINCHUCK RIVER	167.9	Below Threshold	0.5181	0.6717	0.7575	III	436.9
BRIDGE	41_20530_000_00600	20530_000_00600 - CAT CREEK	168.14	Below Threshold	0.4757	0.566	0.6035	III	532.6
BRIDGE	41_061104000001076	061104000001076 - N FK DIAMOND CREEK	169.77	Below Threshold	0.5156	0.6924	0.7859	III	476.8
BRIDGE	41_061101000001157	061101000001157 - WHEELER CREEK	169.82	Below Threshold	0.4655	0.5604	0.5959	III	591.3
BRIDGE	41_01143D009_35798	01143D009_35798 - CHETCO RIVER	170.42	Below Threshold	0.6339	0.978	1.124	III	179.4
BRIDGE	41_061101000001164	061101000001164 - EAST FK WINCHUCK RIVER	171.26	Below Threshold	0.4995	0.6347	0.7006	III	478.1
BRIDGE	41_19606_808_00338	19606_808_00338 - JACK'S CREEK	171.55	Below Threshold	0.4953	0.5883	0.6294	III	363.2
BRIDGE	41_21490_784_00165	21490_784_00165 - N FORK CHETCO RIVER	172.51	Below Threshold	0.463	0.51	0.5215	III	388.1
BRIDGE	41_15C14_784_00537	15C14_784_00537 - N FORK CHETCO RIVER	173.03	Below Threshold	0.4519	0.5178	0.5334	III	444.3
BRIDGE	41_15C23_808_00579	15C23_808_00579 - MILL CREEK	173.73	Below Threshold	0.4524	0.5291	0.5496	III	496.6

B.7 South Carolina DOT ShakeCast Instance



South Carolina State Department of Transportation

ShakeCast Report

National Earthquake Information Center (NEIC)

Magnitude 7.1 - Charleston flt

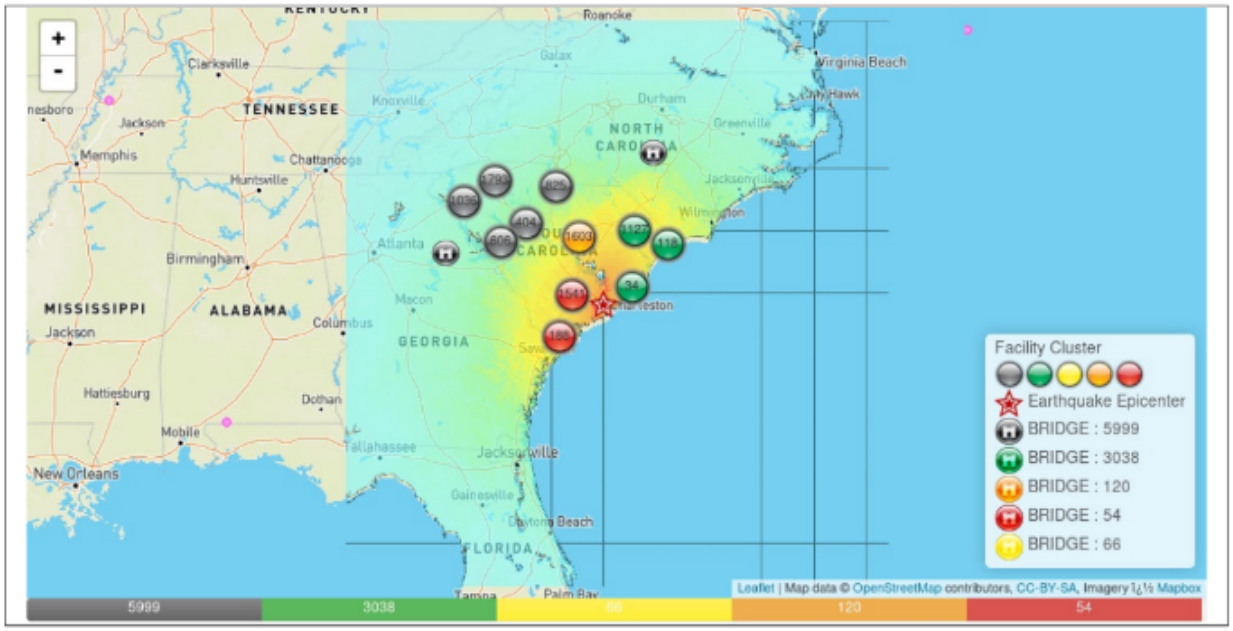
SCENARIO

Version 5

Origin Time: 2017-05-12 12:52:32 GMT Proc 2023-02-07 20:55:06 GMT

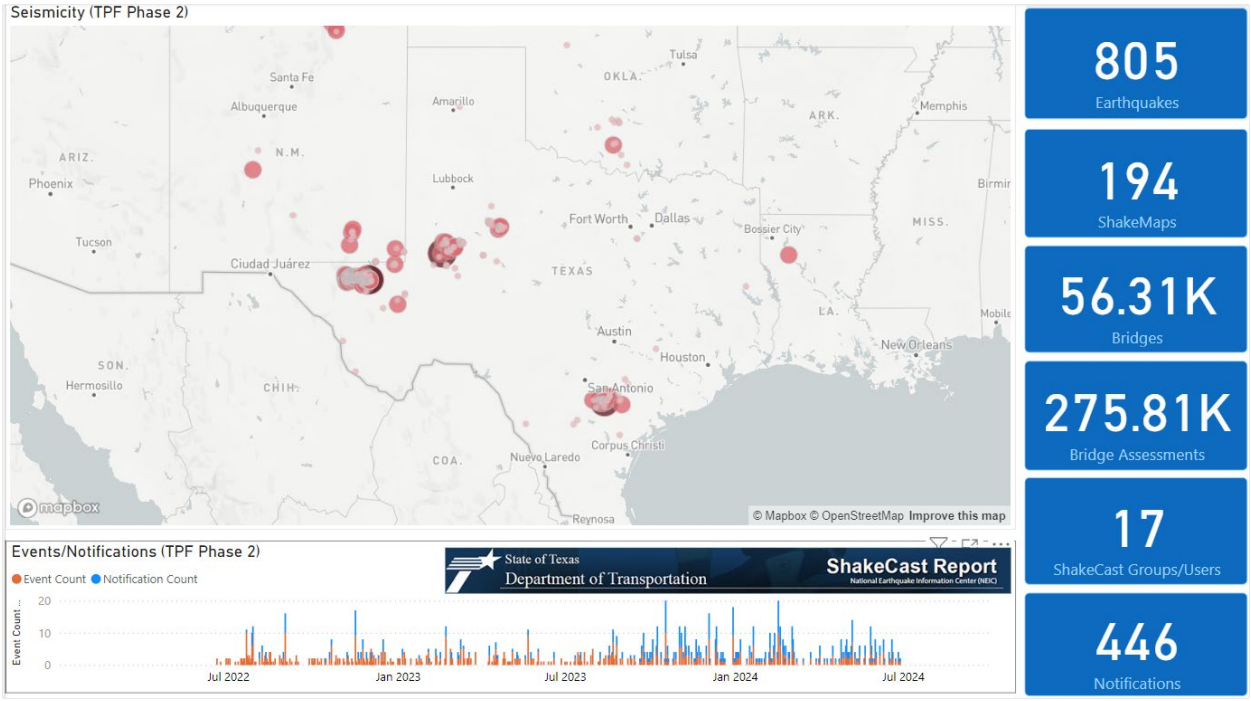
Latitude: 32.936400 Longitude: -80.015140 Depth: 20.0845 km

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	45_000000000006841	000000000006841 - TRIB TO GOOSE CR	2.34	High	128.92	92.85	88.74	IX	
BRIDGE	45_000000000004055	000000000004055 - U.S. 52 E.B.LANE	2.51	High	131.85	104.81	101.02	IX	
BRIDGE	45_000000000004270	000000000004270 - MIDLAND PARK RD.-S-1187	2.6	High	92.48	81.18	78.77	VIII	
BRIDGE	45_000000000004063	000000000004063 - I-26	2.83	High	113.23	92.77	89.67	IX	
BRIDGE	45_000000000005900	000000000005900 - LOCAL STREAM	3.09	High	115.61	81.38	78.21	IX	
BRIDGE	45_000000000004477	000000000004477 - FILBIN CREEK	4.79	High	115.92	88.39	85.49	IX	
BRIDGE	45_000000000008136	000000000008136 - GOOSE CREEK	5.03	High	134.55	105.59	101.66	IX	
BRIDGE	45_000000000007979	000000000007979 - FILBIN CREEK	5.15	High	115.92	88.39	85.49	IX	
BRIDGE	45_000000000004267	000000000004267 - SOUTHERN RWY	5.15	High	79.79	70.68	68.87	VIII	
BRIDGE	45_000000000005905	000000000005905 - UNNAMED STREAM	5.16	High	132.91	102.89	98.96	IX	

B.8 Texas DOT ShakeCast Instance



State of Texas
Department of Transportation

ShakeCast Report

National Earthquake Information Center (NEIC)

Magnitude 5.3 - 51 km WNW of Pecos, Texas,

Version 1

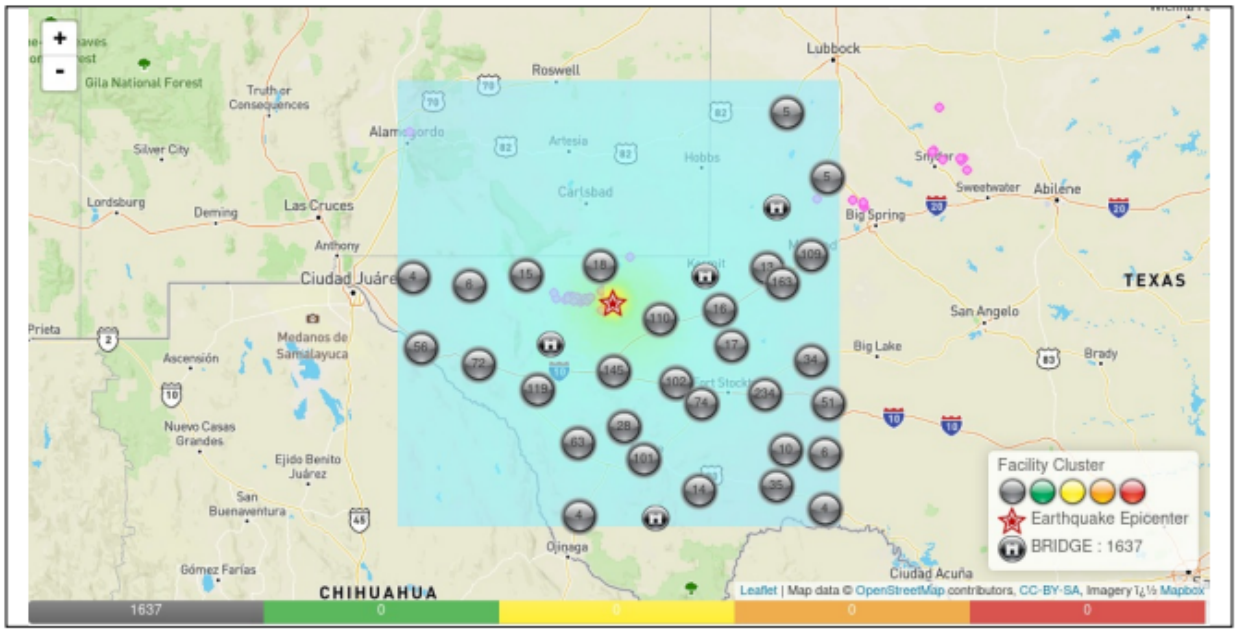
Origin Time: 2022-11-16 15:32:44CST

Process Time: 2022-11-16 16:35:24CST

Latitude: 31.6219 Longitude: -103.9880

Depth: 9.8 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)	Damage State Probability	PGA (%g)	PGV (cm/s)	PSA 1s (%g)	MMI	Vs30 (m/s)
BRIDGE	48_061950013903056	061950013903056 - DRAW	19.45	Below Threshold	7.545	2.915	2.464	V	295.2
BRIDGE	48_061950013903057	061950013903057 - Draw	19.45	Below Threshold	7.078	2.69	2.11	V	358
BRIDGE	48_061950013903014	061950013903014 - FOUR MILE DRAW RELIEF	19.46	Below Threshold	7.545	2.915	2.464	V	295.2
BRIDGE	48_061950013903060	061950013903060 - Four Mile Draw	19.47	Below Threshold	7.545	2.915	2.464	V	295.2
BRIDGE	48_061950013903012	061950013903012 - FOUR MILE DRAW RELIEF	19.49	Below Threshold	7.545	2.915	2.464	V	295.2
BRIDGE	48_061950013903015	061950013903015 - W. T. Draw	19.9	Below Threshold	7.425	2.982	2.385	V	346.4
BRIDGE	48_061950013903016	061950013903016 - W.T. Draw	19.99	Below Threshold	7.063	2.833	2.251	V	358.7
BRIDGE	48_061950013903011	061950013903011 - SAND BEND DRAW	21.64	Below Threshold	6.302	2.266	1.802	V	319.1
BRIDGE	48_061950245103001	061950245103001 - Salt Creek	22.34	Below Threshold	5.713	1.837	1.521	V	267.3
BRIDGE	48_061950013903017	061950013903017 - HORSE HEAD DRAW	23.81	Below Threshold	5.729	2.469	2.027	V	343
BRIDGE	48_061950013902010	061950013902010 - DRAW	23.97	Below Threshold	5.256	1.836	1.465	V	307.3
BRIDGE	48_061950013903018	061950013903018 - JOHN D	24.33	Below Threshold	5.36	2.281	1.835	V	376.5

State of Texas
Department of Transportation

ShakeCast Report

National Earthquake Information Center (NEIC)

Magnitude 7.03 - East Franklin Mountains fault

Version 3

Origin Time: 2017-05-12 15:14:13CDT

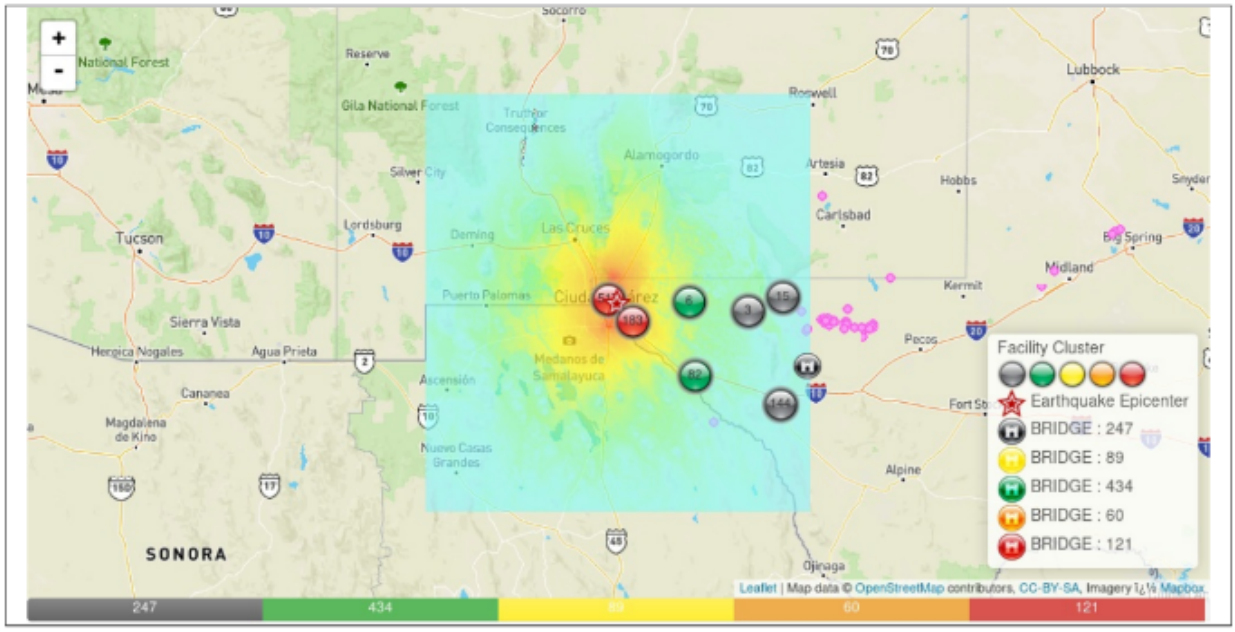
SCENARIO

e: 2022-05-30 16:39:47CDT

Latitude: 31.807440 Longitude: -106.387630

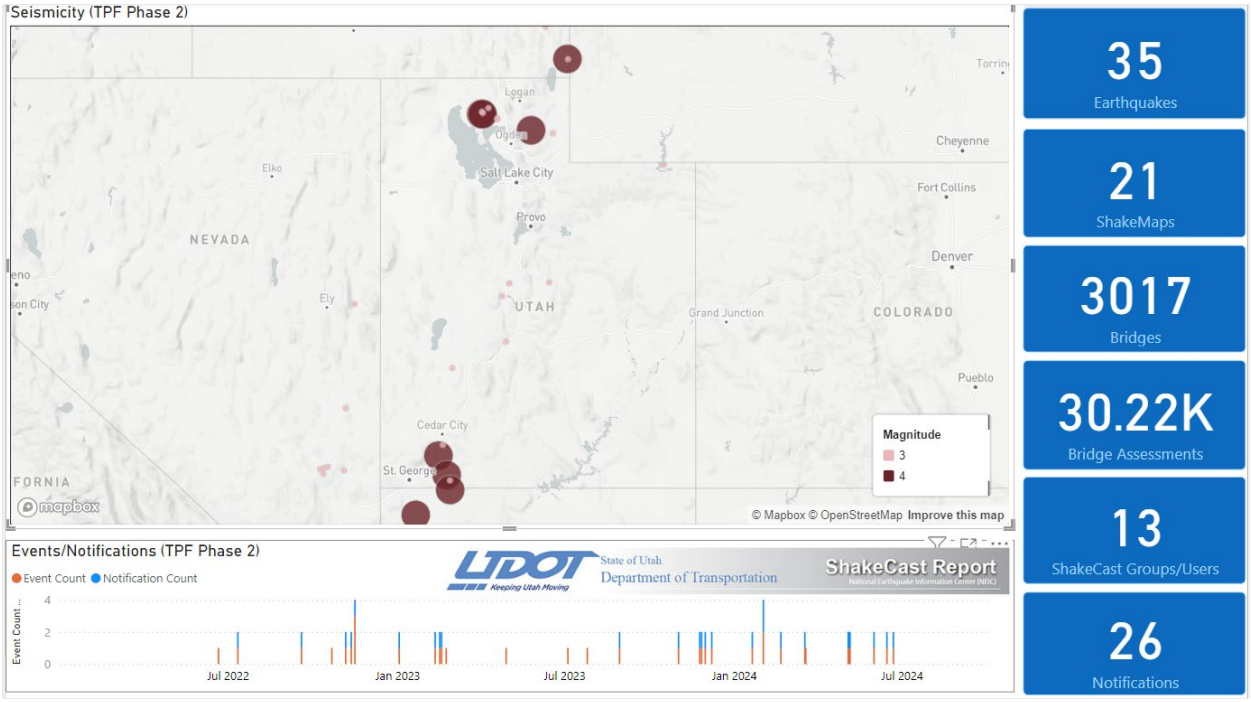
Depth: 9.0026 km

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)	Damage State Probability	PGA (%g)	PGV (cm/s)	PSA 1s (%g)	MMI	Vs30 (m/s)
BRIDGE	48_240720B00600006	240720B00600006 - AIRWAY BLVD NB	1.57	Complete	53.1	70.79	87.06	VIII	
BRIDGE	48_240720212103163	240720212103163 - TROWBRIDGE DRIVE	4.09	Complete	58.66	65.66	72.5	VIII	
BRIDGE	48_240720212103164	240720212103164 - TROWBRIDGE DRIVE	4.17	Complete	58.66	65.66	72.5	VIII	
BRIDGE	48_240720212102161	240720212102161 - US 62 (PAISANO)	4.65	Complete	58.52	69.75	78.41	VIII	
BRIDGE	48_240720B31640007	240720B31640007 - PHELPS DODGE CHANNEL	4.89	Complete	54.43	55.13	62.56	VIII	
BRIDGE	48_240720000216083	240720000216083 - FRANKLIN CANAL	4.96	Complete	54.9	72.21	86.93	VIII	
BRIDGE	48_240720B42270003	240720B42270003 - UP RR and RAILROAD DRIVE	4.96	Complete	58.36	78.32	86.88	IX	
BRIDGE	48_240720B15360001	240720B15360001 - FRANKLIN CANAL	5	Complete	54.9	72.21	86.93	VIII	
BRIDGE	48_240720016701085	240720016701085 - HAYES ST. DRAIN	5.09	Complete	59.11	75.02	78.74	VIII	
BRIDGE	48_240720016701044	240720016701044 -	5.12	Complete	58.12	76.11	83.63	VIII	

B.9 Utah DOT ShakeCast Instance



State of Utah
Department of Transportation

ShakeCast Report

National Earthquake Information Center (NEIC)

Magnitude 5.7 - 3.1 km (1.9 mi) SE of Saltair, UT

Version 2

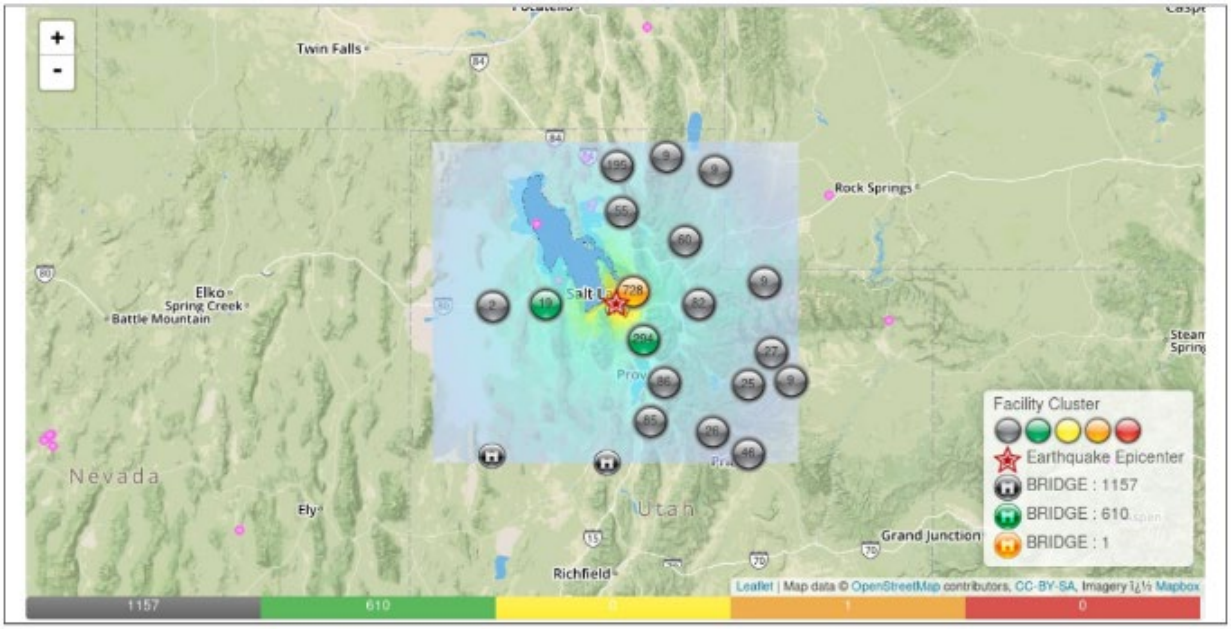
Origin Time: 2020-03-18 07:09:31MDT

Process Time: 2020-03-18 07:52:18MDT

Latitude: 40.751800 Longitude: -112.077500

Depth: 10.63 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	49_1E1322	1E1322 - DRAINAGE CANAL	12.78	Moderate High	25.33	28.86	40.26	VII	196.93
BRIDGE	49_035122F	035122F - PRIVATE ACCESS ROAD	2.28	Low	18.13	18.18	18.34	VII	198
BRIDGE	49_0C_635	0C_635 - I-80 (SR-80)	2.42	Low	18.13	18.18	18.34	VII	198
BRIDGE	49_2C_710	2C_710 - SLandamp;GW RAILWAY	3.84	Low	31.99	35.2	31.34	VIII	198
BRIDGE	49_4C_710	4C_710 - SLandGW RAILWAY	3.9	Low	31.99	35.2	31.34	VIII	198
BRIDGE	49_035142E	035142E - RITER CANAL	4.02	Low	17.6	17.52	17.75	VII	198
BRIDGE	49_0F_344	0F_344 - SLandamp;GWRR andamp; BRIGHT	4.81	Low	31.55	34.58	30.79	VIII	198
BRIDGE	49_0C_669	0C_669 - I-80 (SR-80) EBL andamp; W	4.91	Low	31.55	34.58	30.79	VIII	198
BRIDGE	49_4C_919	4C_919 - COPPER CO. HAUL ROAD	5.07	Low	17.21	15.97	16.13	VII	226.755
BRIDGE	49_2C_919	2C_919 - COPPER CO. HAUL ROAD	5.11	Low	17.21	15.97	16.13	VII	226.755
BRIDGE	49_0F_523	0F_523 - SR-201	5.33	Low	16.8	28.7	28.16	VII	198
BRIDGE	49_2C_732	2C_732 - I-80 (SR-80) EBL and WBL	6.4	Low	30.18	32.7	29.2	VIII	198

State of Utah
Department of Transportation

ShakeCast Report

National Earthquake Information Center (NEIC)

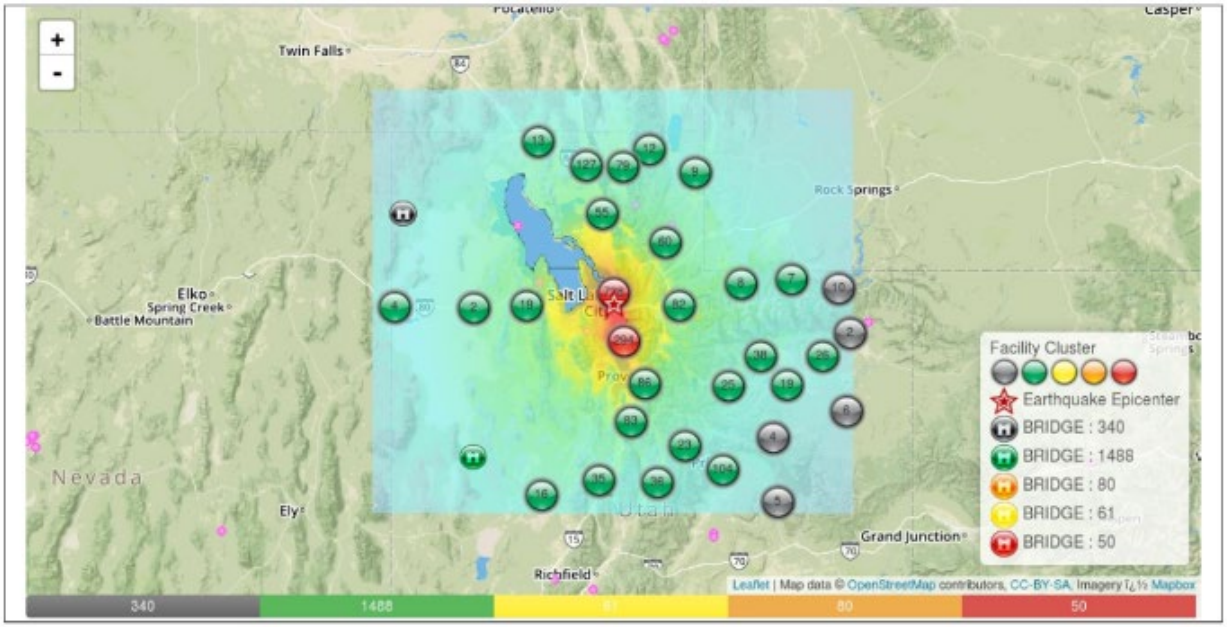
Magnitude 7.0 - The Great Utah ShakeOut

Version 5

Origin Time: 2012-04-17 10:15:00MDT SCENARIO e: 2019-09-06 10:18:49MDT

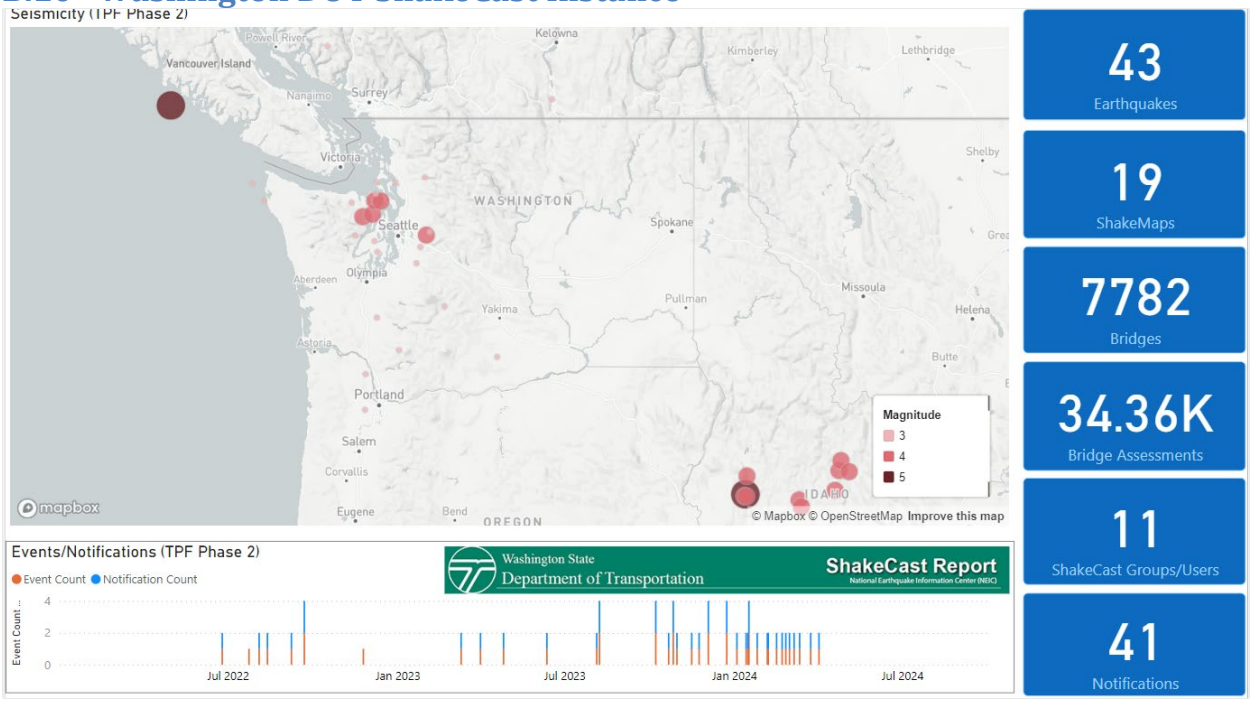
Latitude: 40.760000 Longitude: -111.920000 Depth: 12.0 km

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	49_035097F	035097F - JORDAN RIVER	0.34	High	53.41	91.99	93.34	IX	
BRIDGE	49_0C_377	0C_377 - UNION PACIFIC RAILROAD	1.45	High	53.42	92	93.34	IX	
BRIDGE	49_0F_33	0F_33 - UNION PACIFIC RAILROAD	1.68	High	53.42	92	93.34	IX	
BRIDGE	49_0F_34	0F_34 - 200 SOUTH STREET	1.71	High	53.42	92	93.34	IX	
BRIDGE	49_0F_35	0F_35 - I-80 (SR-80) EBL andamp; W	1.73	High	53.42	92	93.34	IX	
BRIDGE	49_2C_400	2C_400 - 400 WEST STREET	2.02	High	53.41	91.99	93.34	IX	
BRIDGE	49_4C_400	4C_400 - 400 WEST STREET	2.03	High	53.41	91.99	93.34	IX	
BRIDGE	49_0C_401	0C_401 - 300 WEST STREET andamp; UP	2.14	High	53.41	91.99	93.34	IX	
BRIDGE	49_4C_402	4C_402 - 200 W.ST.andamp; UTA. TRAC	2.41	High	53.41	91.99	93.34	IX	
BRIDGE	49_2C_402	2C_402 - 200 W. andamp; WEST TEMPLE	2.43	High	53.41	91.99	93.34	IX	
BRIDGE	49_035091F	035091F - JORDAN RIVER	2.96	High	53.41	91.99	93.34	IX	
BRIDGE	49_035107F	035107F - JORDAN RIVER	3.04	High	53.41	91.99	93.34	IX	

B.10 Washington DOT ShakeCast Instance



Washington State Department of Transportation

ShakeCast Report

National Earthquake Information Center (NEIC)

Magnitude 6.9 - Birch Bay Fault

Version 1

Origin Time: 2024-02-19 10:00:00PDT

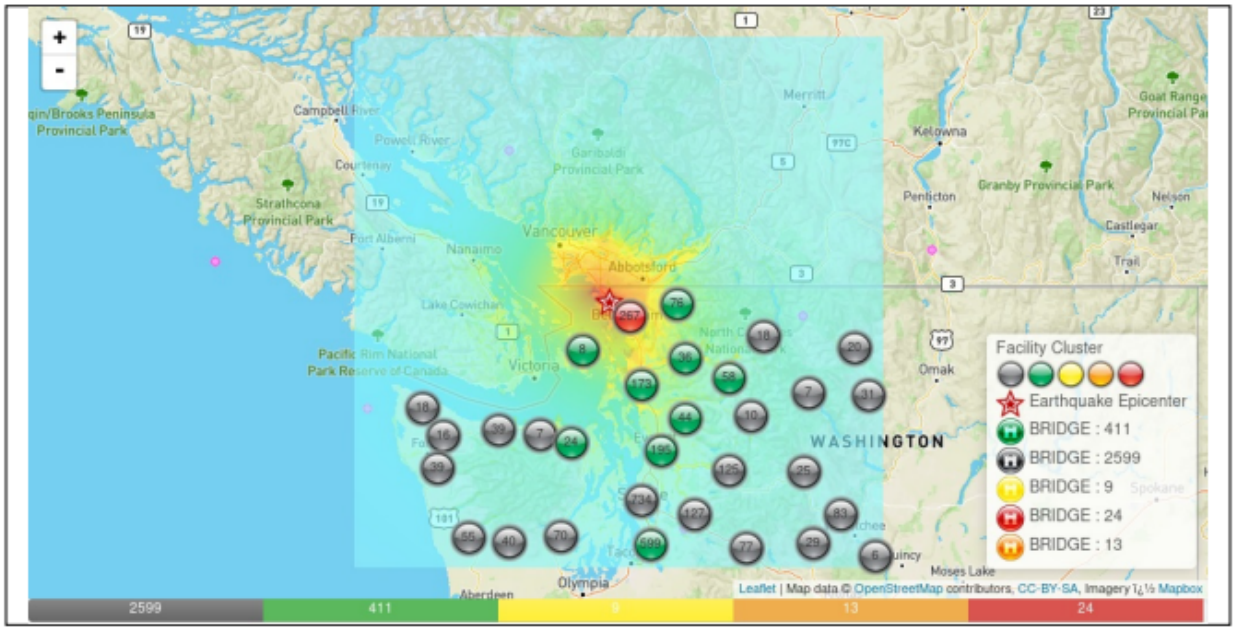
SCENARIO

Time: 2024-03-22 16:30:11PDT

Latitude: 48.9050 Longitude: -122.6530

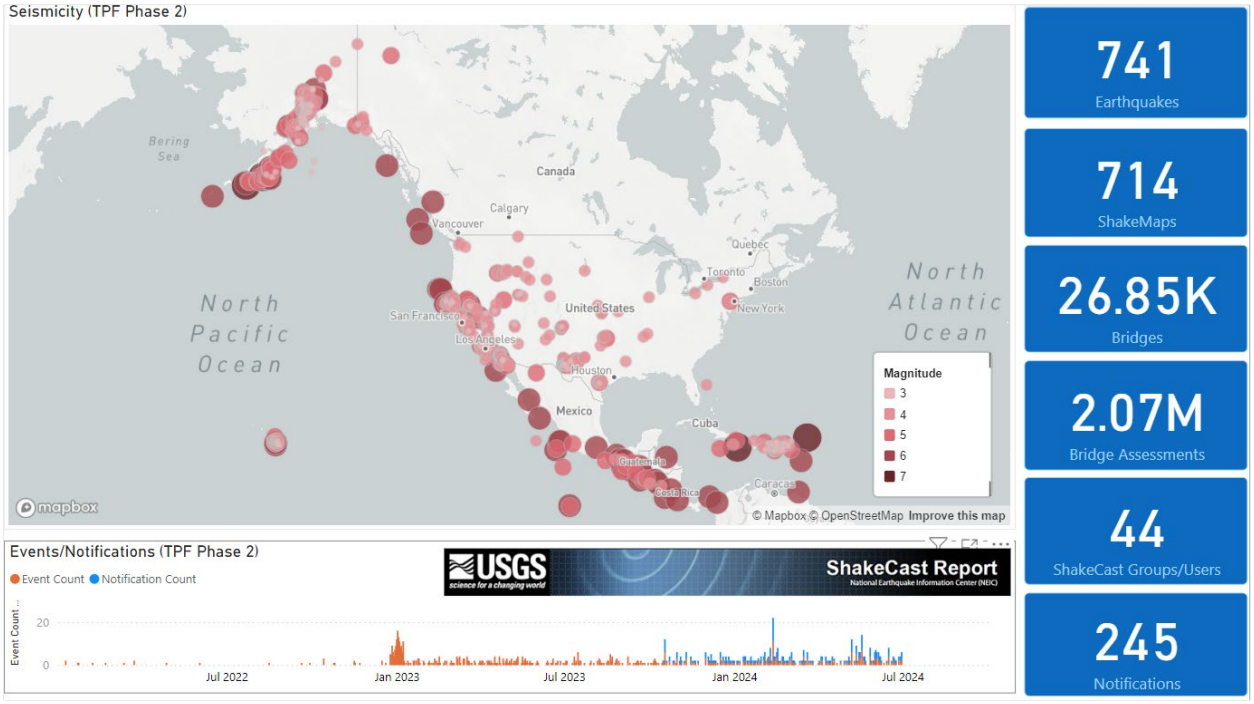
Depth: 7.5 km

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	53_0006857B0000000	0006857B0000000 - I-5	2.27	High	62.39	72.68	79.01	VIII	327.6
BRIDGE	53_0006926C0000000	0006926C0000000 - I-5	3.45	High	63.45	73.17	78.65	VIII	338.6
BRIDGE	53_0006857A0000000	0006857A0000000 - I-5	4.39	High	65.39	76.9	81.49	IX	341.9
BRIDGE	53_0006568A0000000	0006568A0000000 - I-5	5.26	High	67.01	76.81	79.4	IX	367
BRIDGE	53_0006926D0000000	0006926D0000000 - I-5	5.39	High	62.09	70.46	76.31	VIII	338.4
BRIDGE	53_081834000000000	081834000000000 - DAKOTA CR.	5.86	High	55.59	66.67	75.07	VIII	287.4
BRIDGE	53_085799000000000	085799000000000 - TERRELL CREEK	6.92	High	68.54	91.34	91.45	IX	331.9
BRIDGE	53_084159000000000	084159000000000 - TERRELL CR.	7.02	High	66.68	94.39	95.34	IX	301.9
BRIDGE	53_0006926A0000000	0006926A0000000 - PORTAL WAY	7.16	High	67.83	87.13	89.76	IX	329.8
BRIDGE	53_0006926B0000000	0006926B0000000 - PORTAL WAY	7.17	High	67.83	87.13	89.76	IX	329.8
BRIDGE	53_082365000000000	082365000000000 - CALIFORNIA CR	7.68	High	61.47	76.98	84.86	IX	292.5
BRIDGE	53_082653000000000	082653000000000 - BARRETT CREEK	8.17	High	52.2	92.82	101.8	IX	186.1
BRIDGE	53_082367000000000	082367000000000 - CALIFORNIA CR	8.64	High	63.58	76.81	83.13	IX	318.3

B.11 FHWA ShakeCast Instance



U.S. Department of Transportation
Federal Highway Administration

ShakeCast Report

National Earthquake Information Center (NEIC)

Magnitude 7.8 - 130 km ESE of Sand Point, Alaska,

Version 6

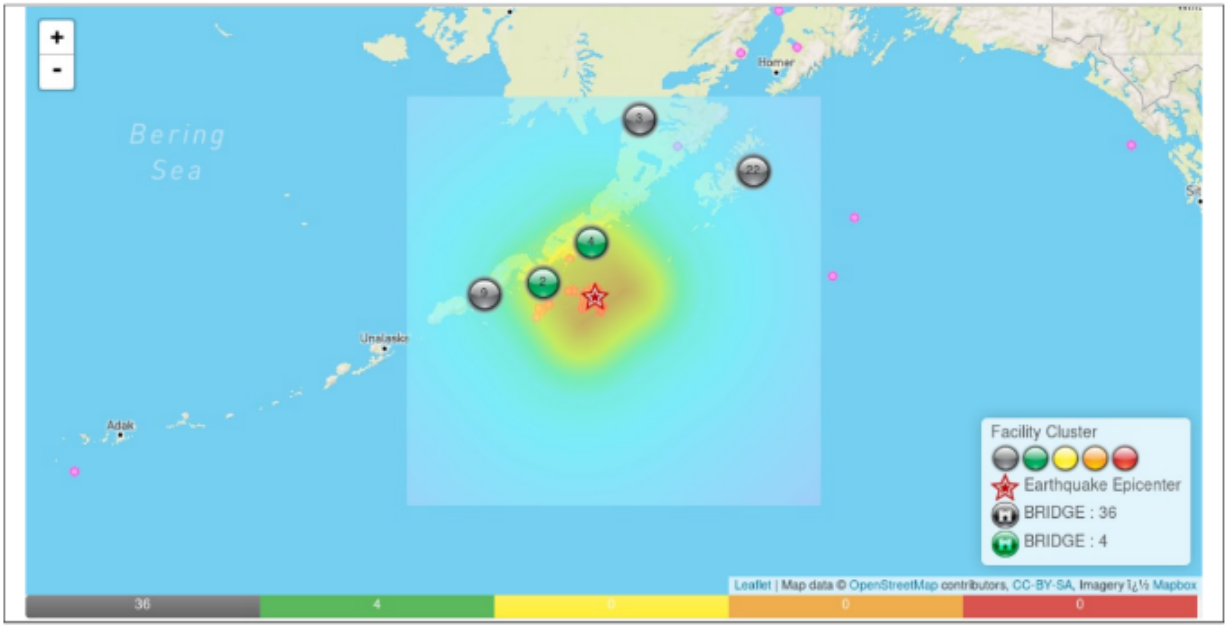
Origin Time: 2020-07-22 02:12:44EDT

Process Time: 2020-07-22 13:25:22EDT

Latitude: 55.0298 Longitude: -158.5217

Depth: 28.0 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.



ID	Name	Owner	Latitude	Longitude	Ep. Distance (km)	Inspection Priority	PGA (%g)	PGV (cm/s)	PSA 1s (%g)	MMI
02_1512	1512 - PERRYVILLE CREEK	1	55.9116	-159.1492	105.9	Low	20.48	14.64	15.62	VI
02_1972	1972 - HUMBOLT SLOUGH	4	55.3363	-160.4965	130.35	Low	16.97	12.32	13.97	VI
02_1756	1756 - SAND POINT CITY DOCK	4	55.3319	-160.5040	130.69	Low	18.79	14.59	16.27	VI
02_1764	1764 - INDIAN CREEK	4	56.3007	-158.4154	141.66	Low	16.27	9.814	10.55	VI
02_1932	1932 - CHIGNIK CREEK	4	56.2969	-158.4092	141.26	Below Threshold	13.08	7.41	7.968	VI
02_1800	1800 - PACKERS CREEK	4	56.3093	-158.5370	142.46	Below Threshold	16.92	9.192	9.958	VI
02_2220	2220 - DELTA CREEK	2	55.1215	-162.2748	239.95	Below Threshold	6.131	7.287	7.773	V
02_1890	1890 - KING COVE ACCESS BRIDGE	4	55.0561	-162.3249	243.15	Below Threshold	4.519	3.265	3.483	IV
02_2216	2216 - DELTA CREEK TRIBUTARY	2	55.1233	-162.3311	243.55	Below Threshold	6.107	4.847	5.17	V
02_2213	2213 - BARNEY CREEK	2	55.1496	-162.4307	249.96	Below Threshold	4.804	3.55	3.787	IV
02_1755	1755 - COLD BAY DOCK	2	55.2073	-162.6959	267.08	Below Threshold	4.621	3.572	3.81	IV
02_000074520-00030	000074520-00030 - FROSTY CREEK	63	55.1660	-162.8087	274.11	Below Threshold	4.442	3.493	3.727	IV

U.S. Department of Transportation
Federal Highway Administration

ShakeCast Report

National Earthquake Information Center (NEIC)

Magnitude 7.29 - Eastern Bear Lake fault

Version 3

Origin Time: 2017-05-12 16:14:13EDT

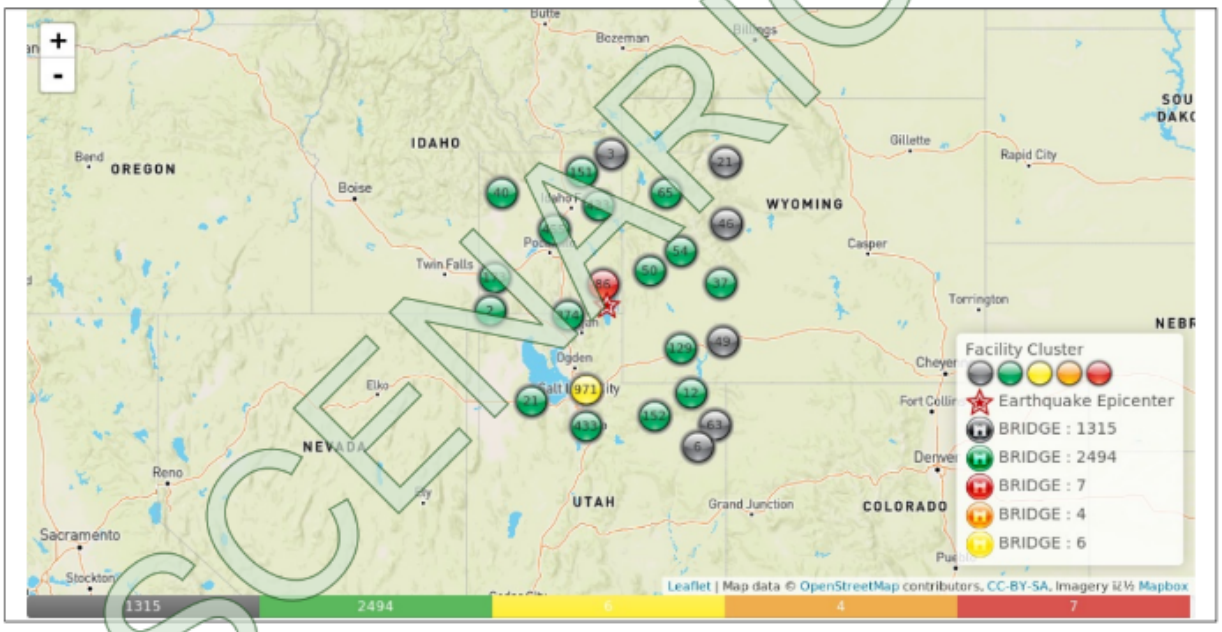
Latitude: 42.127210 Longitude: -111.353710

SCENARIO

e: 2024-08-07 14:05:47EDT

Depth: 9.0034 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.



ID	Name	Owner	Latitude	Longitude	Ep. Distance (km)	Inspection Priority	PGA (%g)	PGV (cm/s)	PSA 1s (%g)	MMI
16_0000000000022259	000000000022259 - ST. CHARLES CR N. BRIDGE	4	42.1239	-111.3917	3.16	High	55.65	63.87	76.09	VIII
16_0000000000022225	000000000022225 - BEAR RIVER	2	42.2522	-111.2883	14.9	High	50.87	94.4	105.25	IX
16_0000000000019190	000000000019190 - BEAR RIVER;N.DINGLE BR.	2	42.2483	-111.2708	15.1	High	52.44	80.77	78.88	IX
16_0000000000016695	000000000016695 - BEAR LAKE CANAL	1	42.3056	-111.3589	19.81	High	48.36	86.13	107.38	IX
16_0000000000016700	000000000016700 - BEAR RIVER	1	42.3089	-111.3456	20.19	High	48.51	89.51	108.9	IX
16_0000000000022250	000000000022250 - BEAR RIVER;BERN BRIDGE	2	42.3286	-111.3511	22.37	High	48.21	87.75	108.48	IX
16_0000000000022245	000000000022245 - BEAR R;W.GEORGETOWN BR	2	42.4556	-111.3867	36.57	High	56.41	83.6	101.06	IX
16_0000000000022220	000000000022220 - BEAR RIVER;E.DINGLE BR	2	42.2294	-111.2456	14.45	Moderate High	45.25	53.49	45.78	VIII
16_0000000000019195	000000000019195 - BEAR RIVER;PEGRAM BRIDGE	2	42.1331	-111.1381	17.84	Moderate High	30.92	48.98	54.07	VIII
16_0000000000016705	000000000016705 - UPRR;12TH ST.;MONTPELIER	1	42.3175	-111.3144	21.38	Moderate High	55.22	92.47	105.15	IX

APPENDIX C Docker Image for Production ShakeCast Instances

USGS provides each DOT a replication ShakeCast instance if they desire to run an independently of USGS. Most DOTs have chosen to continue to have USGS host their ShakeCast operations, but the approach outlined below allows an alternative.

C.1 Retrieve a copy of Production (cast1) ShakeCast V3 Instance for Your Organization

Go to the ShakeCast SharePoint Site, and locate the specific zip file prepared for your organization.

The following instructions have been verified using Windows for Linux (WSL2) and Docker. Prior to running the ShakeCast Docker image, it is assumed that the user has the above environment set up or has access to a generic Linux environment with the Docker engine installed.

C.2 Steps to launch the production copy of ShakeCast

1. **Unzip the zip file into a folder, default at *cast1_org_docker***. Change work folder to the unzipped ShakeCast folder,

```
> `klin@igskci164lw0098:~/cast1_org_docker$`
>
Command:
> `klin@igskci164lw0098:~/cast1_org_docker$ ls`
>
Output:
> `bin  db_dump  docker-compose.yml  entrypoint.sh  img_export`
```

2. **Import the pre-built ShakeCast Docker image**. In this example, I have downloaded the ShakeCast image for DOI, then the image in the import folder has the included image **sc_doi_v3.tgz** under the folder **img_export**.

```
**Command**:
>
> `klin@igskci164lw0098:~/cast1_org_docker$ docker load <
img_export/sc_doi_v3.tgz`
>
**Output**:
> `Loaded image: shakecast:sc_doi_v3`
```

```
>
```

3. **Start the MySQL database service**. It is required to set the *SC_ORG* environment variable prior to running the Docker services. In the example below, it is set to *sc_doi* and passed to the Docker command in the same statement.

```
**Command**:
>
> `klin@igskci164lw0098:~/cast1_org_docker$ SC_ORG=sc_doi docker compose up sc_db
-d`

**Output**:
> `[+] Running 1/1`
>  `✓ Container cast1_org_docker-sc_db-1
Started                                                                  0.4s`
>
```

4. **Initialize the ShakeCast database**. Once the MySQL database service is activated, we can proceed to create the ShakeCast database and to upload the database snapshot. The initialize script (*entrypoint.sh*) will verify the missing database before recreating it.

```
**Command**:
> `klin@igskci164lw0098:~/cast1_org_docker$ SC_ORG=sc_doi docker compose run sc-
server ls /usr/local/shakecast`

**Output**:
> `[+] Running 1/0`
>  `✓ Container cast1_org_docker-sc_db-
1  Running                                                                0.
0s`
> `ERROR 1045 (28000): Access denied for user 'sc_doi'@'172.23.0.3' (using
password: YES)`
> `No DB detected! Initating DB.!`
>
>
`LICENSE  README.md  admin  bin  conf  data  db_dump  entrypoint.sh  etc  sc  sc_
doi  template  var  wkhtmltopdf`
>
```

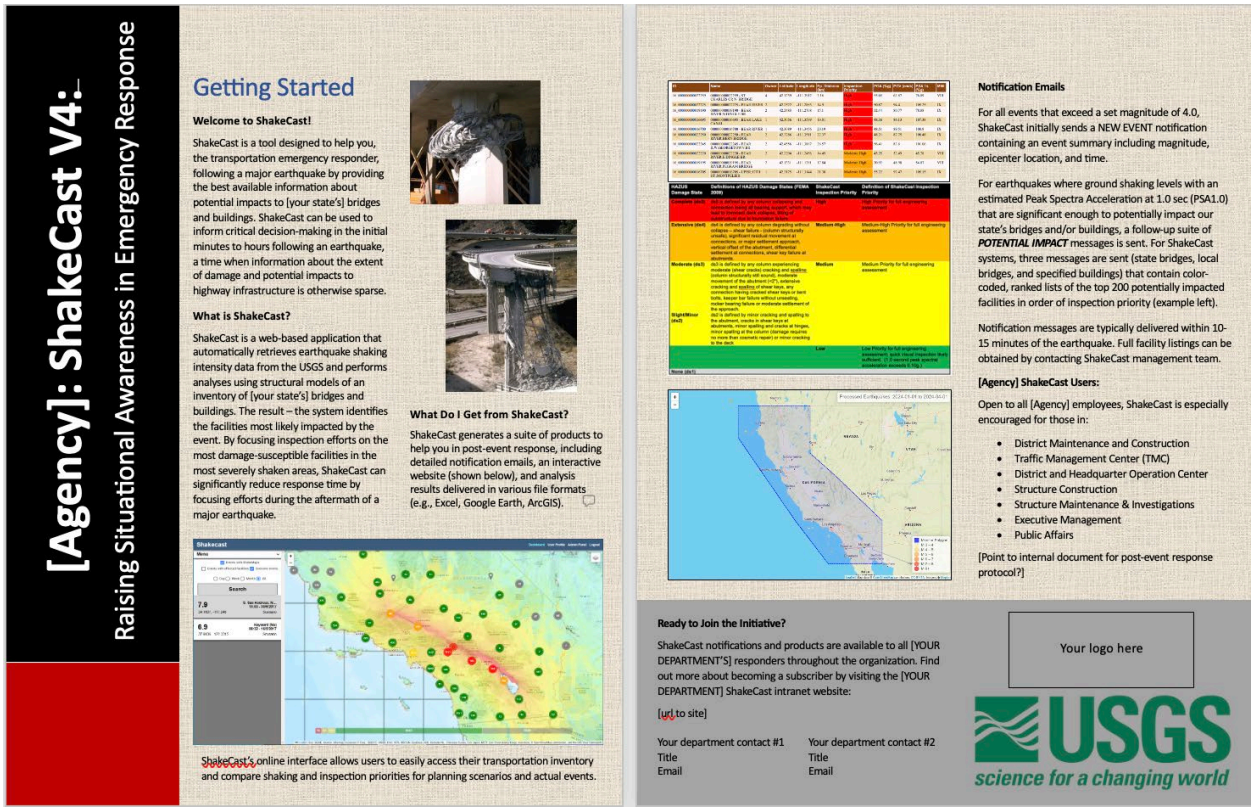
5. **Start the ShakeCast Dispatcher service**. The last step in launching the ShakeCast service is to rerun the Docker compose command to let the Docker daemon takes over service management.

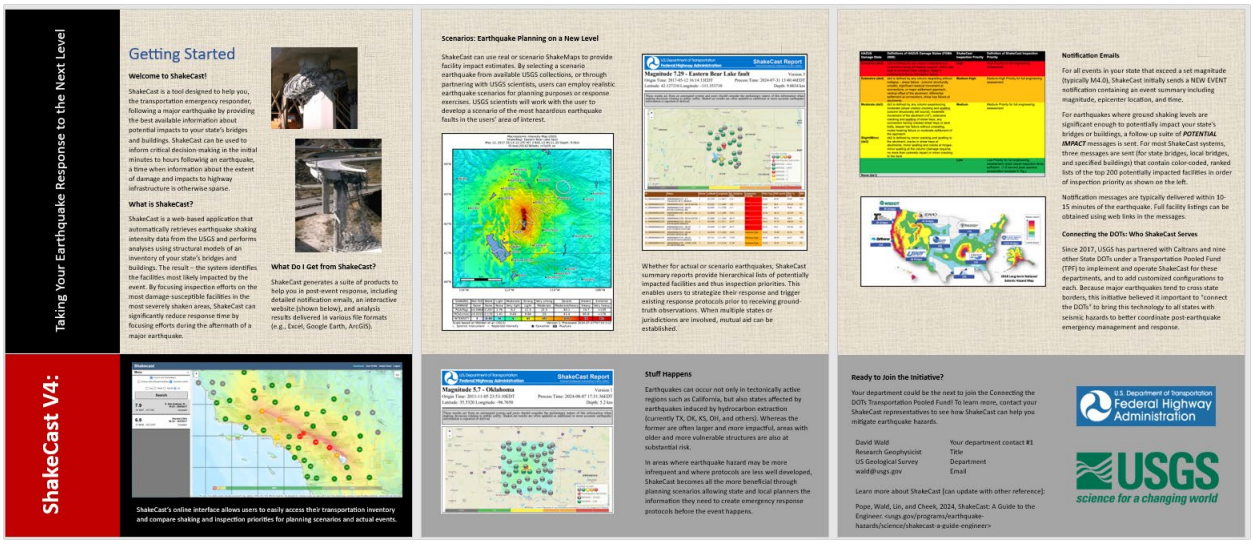
```
**Command**:
> `klin@igskci164lw0098:~/cast1_org_docker$ SC_ORG=sc_doi docker compose up -d`
```

```
>
**Output**:
> [+] Running 3/3
> ✓ Container cast1_org_docker-sc_db-
1      Running                                                          0.
0s
> ✓ Container cast1_org_docker-adminer-
1    Started                                                          0.6s
> ✓ Container cast1_org_docker-sc-server-
1  Started                                                          0.5s

If everything is up and running smoothly, new earthquake products and ShakeCast
results will appear in the newly created **data** folder.  Please keep in mind
that the notification service is turned off by default as we can not anticipate
the email server.

**Command**:
> `klin@igskci164lw0098:~/cast1_org_docker$ ls data`
>
**Output**:
> `eq_product  sc_doigroup.json  us6000lbqg-1`
```

APPENDIX D ShakeCast DOT Factsheet

USGS developed Fact Sheet templates for DOTs to modify as they wish and share with their users. The two-page version is aimed at a specific DOT for promoting ShakeCast within their DOT user community. The three-page version is for FHWA to promote the next phase of a TPF (managed by FHWA) to potential new and existing DOT participants.





DOT-Specific Factsheets

APPENDIX E ShakeCast Client/NBI Workbook

The ShakeCast Client/NBI Workbook is a no-macros variant of the Inventory Workbook. The Excel Workbook is lightweight in comparison and the spreadsheets have been expanded as a client tool that allows users to investigate facility performance after earthquakes. The basic functions of the Client Workbook are similar to the Inventory Workbook and implements several data connectors for import and export of user inventory regarding facilities and optional sheets for notification groups and users. Once the data has been collected, XML files of individual inventory types can be exported to be uploaded to ShakeCast.

The workbook utilizes Microsoft's Power Query to integrate data from the USGS earthquake data feed (GeoJson), the NBI dataset (CSV), and the ShakeCast notifications (CSV/Json). The default NBI Workbook consists of four to five worksheets and data connections:

- National Bridge Inventory (NBI) Sheet
- ShakeCast Bridge Sheet
- Bridge Fragility Sheet
- ShakeCast Exposure Notification Sheet
- USGS Near-Real-Time Earthquake Data Feed Sheet

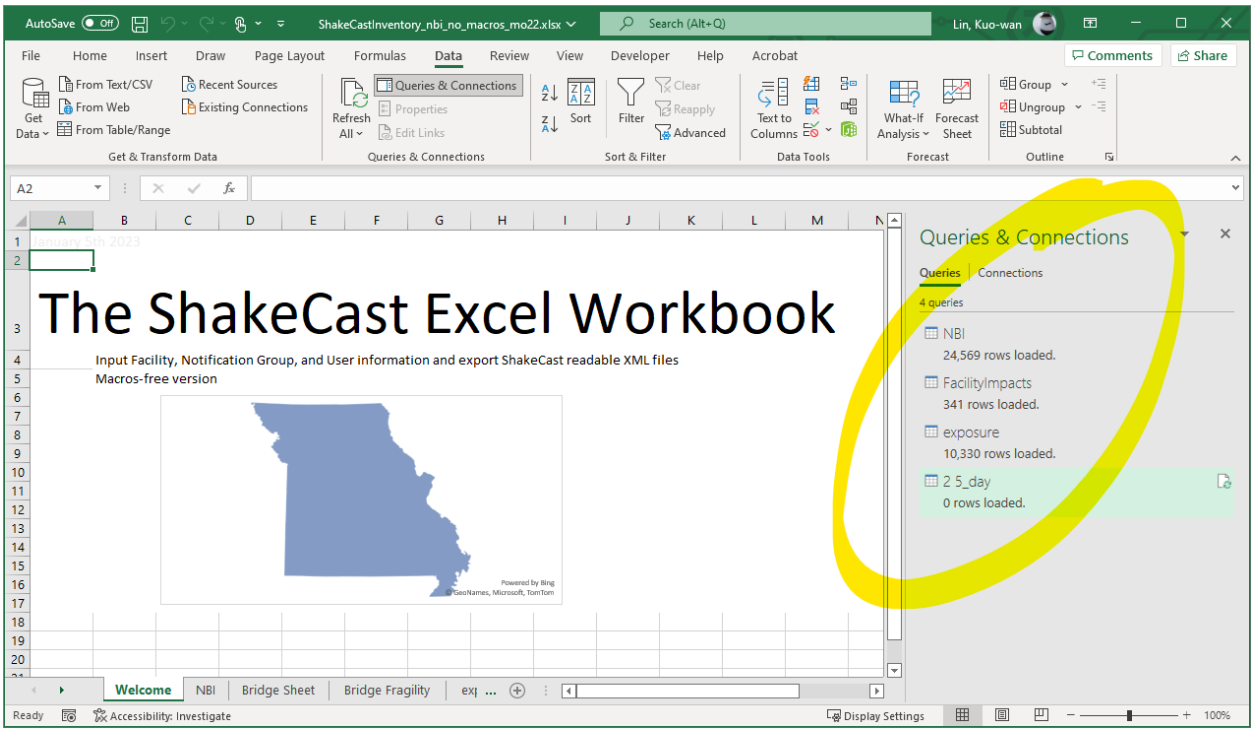


Figure E.1 The Welcome sheet of the ShakeCast Bridge Workbook (no-macro version). The right side panel shows the embedded data connections for exchange and import/export with external sources.

E.1 National Bridge Inventory (NBI) Sheet

The NBI Client Workbook has an added data connector to import the NBI dataset in CSV format via the "NBI" Power Query data connection. The NBI spreadsheet also includes the NBI to HAZUS HWB mapping scheme and thus removes the dependency on the conversion script.

For the NBI Workbook that has been pre-loaded with NBI dataset, the Welcome page will include information on the State code (graphic), dataset (A17 cell), and import timestamp (A1 cell).

There are two top-level modifiers for the NBI bridge class to the Hazus Highway Bridge (HWB) model mapping scheme:

- Conventional or California model (**Model**)
- Seismic retrofit year (**Seismic Retrofit Year**)

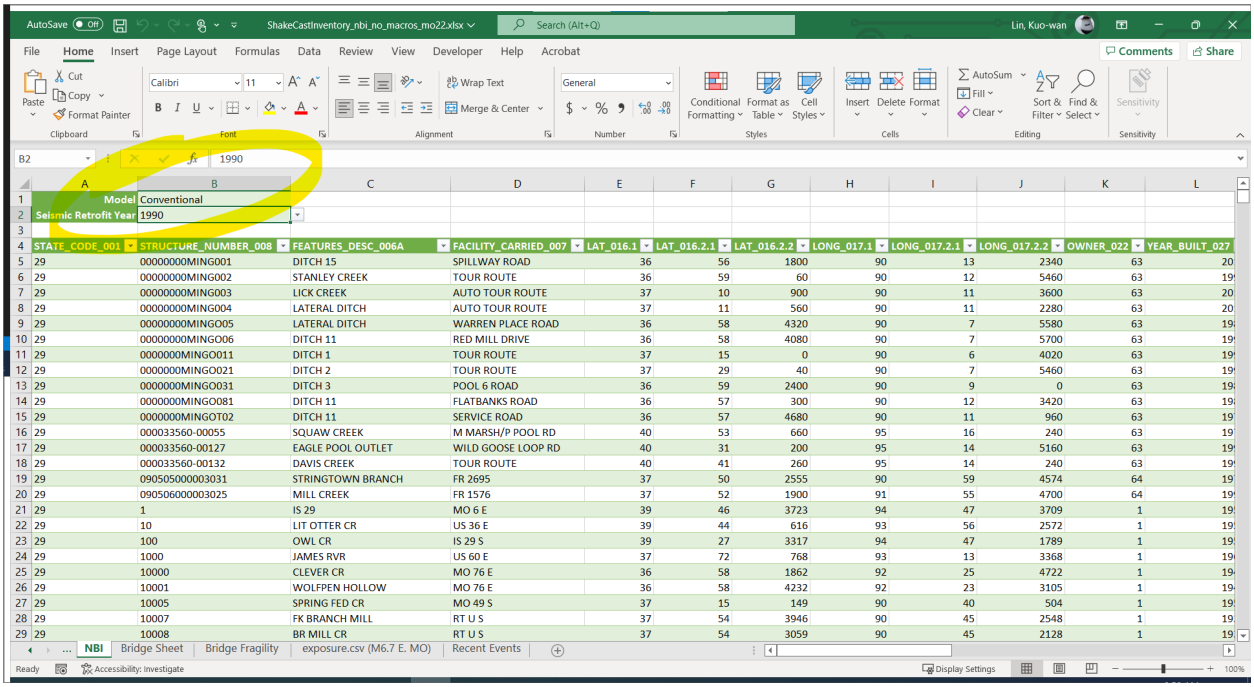


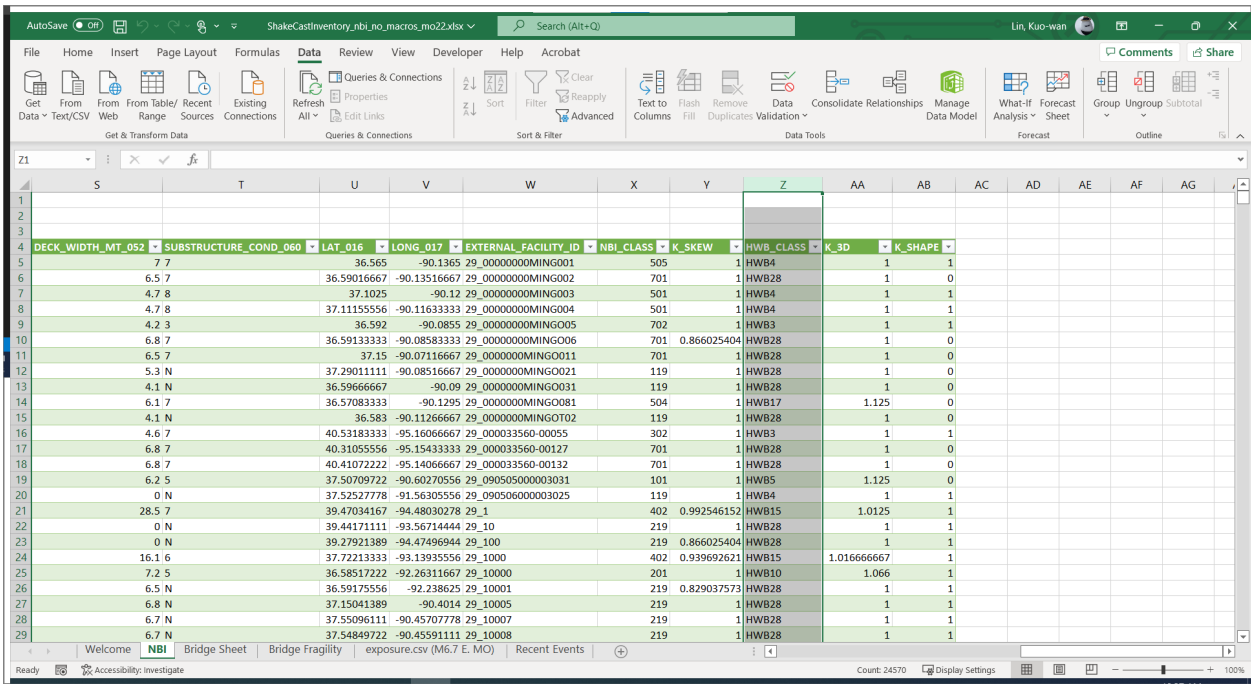
Figure E.2 The NBI data sheet of the ShakeCast Bridge Workbook. By selecting the Hazus bridge model (Conventional or California) and the seismic retrofit year, required parameters for NBI-to-HWB model mapping and fragility scaling factors will be computed in the same manner as the conversion script.

The NBI sheet extends the imported NBI data with additional columns required by the ShakeCast application:

- Decimal latitude in degrees (**LAT_016**)
- Decimal longitude in degrees (**LONG_017**)
- Default ShakeCast Facility ID (**EXTERNAL_FACILITY_ID**)

- NBI Class (**NBI_CLASS**)
- Bridge skew angle modifier (**K_SKEW**)
- Hazus Highway Bridge class (**HWB_CLASS**)
- Bridge 3D effect modifier (**K_3D**)
- Input ground motion spectrum shape modifier (**K_SHAPE**)

Based on the selected mapping scheme, the NBI sheet will update the *HWB_CLASS* column to reflect the selected model.



DECK_WIDTH_MT_052	SUBSTRUCTURE_COND_060	LAT_016	LONG_017	EXTERNAL_FACILITY_ID	NBI_CLASS	K_SKEW	HWB_CLASS	K_3D	K_SHAPE
7	7	36.565	-90.1365	29_00000000MING001	505	1	HWB4	1	1
6.5	7	36.59016667	-90.13516667	29_00000000MING002	701	1	HWB28	1	0
4.7	8	37.1025	-90.12	29_00000000MING003	501	1	HWB4	1	1
4.7	8	37.11555556	-90.11633333	29_00000000MING004	501	1	HWB4	1	1
4.2	3	36.592	-90.0855	29_00000000MINGO05	702	1	HWB3	1	1
6.8	7	36.59133333	-90.08583333	29_00000000MINGO06	701	0.866025404	HWB28	1	0
6.5	7	37.15	-90.07116667	29_0000000MINGO011	701	1	HWB28	1	0
5.3	N	37.29011111	-90.08516667	29_0000000MINGO021	119	1	HWB28	1	0
4.1	N	36.59666667	-90.09	29_0000000MINGO031	119	1	HWB28	1	0
6.1	7	36.57083333	-90.1295	29_0000000MINGO081	504	1	HWB17	1.125	0
4.1	N	36.583	-90.11266667	29_0000000MINGOT02	119	1	HWB28	1	0
4.6	7	40.53183333	-95.16066667	29_000033560-00055	302	1	HWB3	1	1
6.8	7	40.31055556	-95.15433333	29_000033560-00127	701	1	HWB28	1	0
6.8	7	40.41072222	-95.14066667	29_000033560-00132	701	1	HWB28	1	0
6.2	5	37.50709722	-90.60270556	29_090505000003031	101	1	HWB5	1.125	0
0	N	37.52527778	-91.56305556	29_090506000003025	119	1	HWB4	1	1
28.5	7	39.47034167	-94.48030278	29_1	402	0.992546152	HWB15	1.0125	1
0	N	39.44171111	-93.56714444	29_10	219	1	HWB28	1	1
0	N	39.27921389	-94.47496944	29_100	219	0.866025404	HWB28	1	1
16.1	6	37.72213333	-93.13935556	29_1000	402	0.939692621	HWB15	1.016666667	1
7.2	5	36.58517222	-92.26311667	29_10000	201	1	HWB10	1.066	1
6.5	N	36.59175556	-92.238625	29_10001	219	0.829037573	HWB28	1	1
6.8	N	37.15041389	-90.4014	29_10005	219	1	HWB28	1	1
6.7	N	37.55096111	-90.45707778	29_10007	219	1	HWB28	1	1
6.7	N	37.54849722	-90.45591111	29_10008	219	1	HWB28	1	1

Figure E.3 The NBI data sheet of the ShakeCast Bridge Workbook showing the highlighted HWB model assignment based on the selected Hazus model.

In addition to the default NBI 2022 dataset that was used to develop the NBI Workbook, older NBI dataset (2012 and later) also has been verified.

- The source file of the NBI raw dataset can be reviewed via the "*Queries & Connections*" side panel.

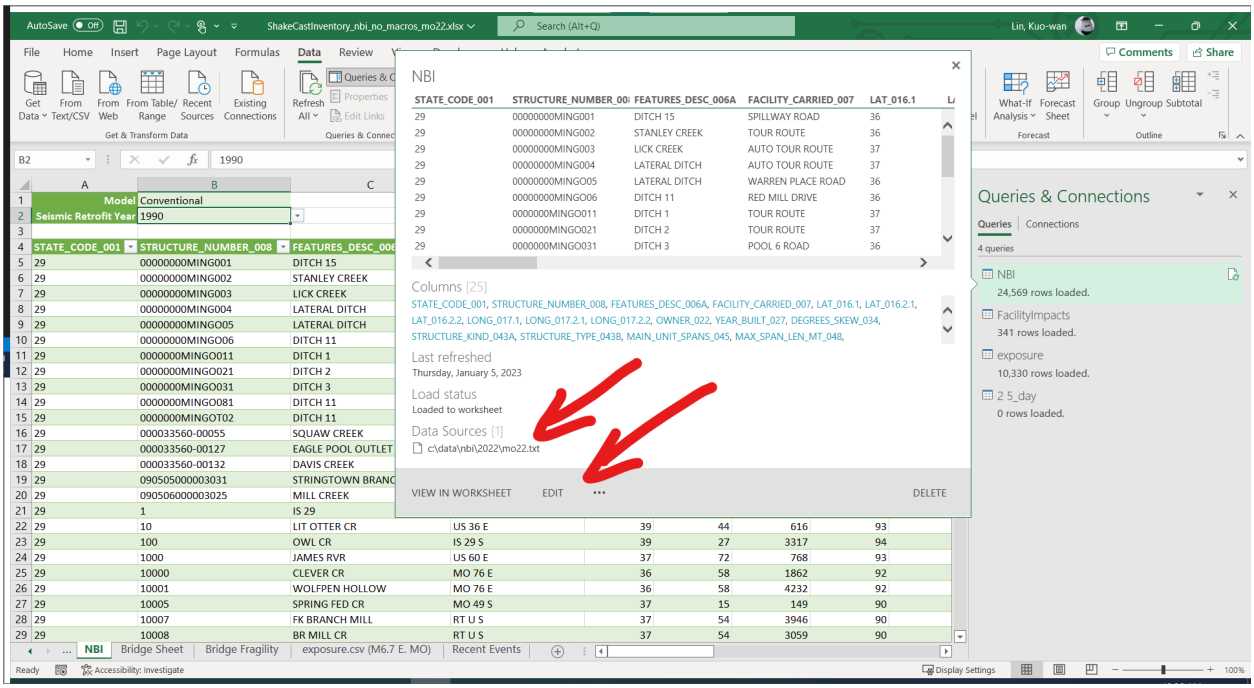


Figure E.4 The Data Query dialog for updating the raw NBI input data (csv data from FHWA).

- Via the "*Edit*" action, the user can specify a custom dataset (in NBI format) to be imported.

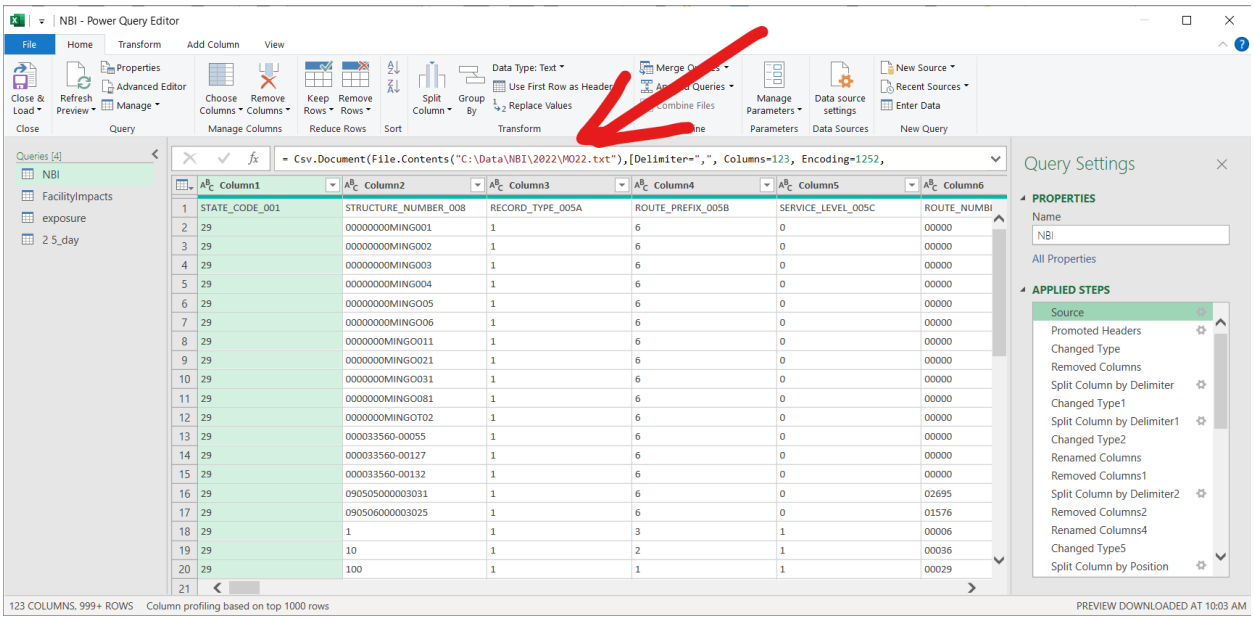
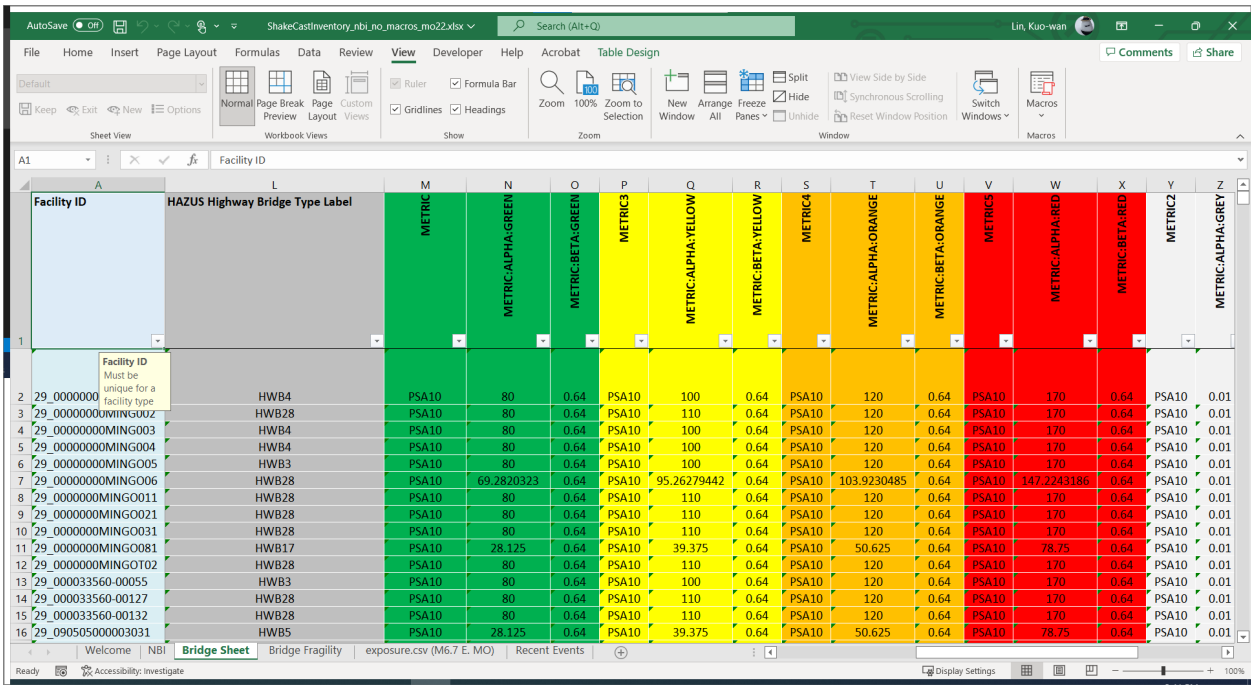


Figure E.5 The alternative method to update the source NBI input data (csv data from FHWA) via Microsoft's Power Query.

E.2 ShakeCast Bridge Sheet

The ShakeCast Bridge sheet replicates the "*Facility XML*" sheet of the macros-enabled ShakeCast Inventory Workbook. The table contains bridge parameters to be uploaded into the ShakeCast database and is synchronized with the NBI sheet automatically. The scope of retrieved data includes raw NBI data fields (attributes), converted data fields, and derived/mapped data fields. The list of bridge attributes covers most parameters based on user requests and is expandable to meet specific needs.

When reviewing and overriding the assigned bridge fragilities and other derived fields, though not required, it is advised to update the source data in the NBI sheet instead of the ShakeCast bridge sheet. Editing the bridge entry in the ShakeCast bridge sheet may prevent automatic updating triggered by the changes to the NBI sheet.



Facility ID	HAZUS Highway Bridge Type Label	METRIC	METRIC:ALPHA:GREEN	METRIC:BETA:GREEN	METRIC3	METRIC:ALPHA:YELLOW	METRIC:BETA:YELLOW	METRIC4	METRIC:ALPHA:ORANGE	METRIC:BETA:ORANGE	METRIC5	METRIC:ALPHA:RED	METRIC:BETA:RED	METRIC2	METRIC:ALPHA:GREY
29_0000000	HWB4	PSA10	80	0.64	PSA10	100	0.64	PSA10	120	0.64	PSA10	170	0.64	PSA10	0.01
29_0000000MINGO02	HWB28	PSA10	80	0.64	PSA10	110	0.64	PSA10	120	0.64	PSA10	170	0.64	PSA10	0.01
29_00000000MING003	HWB4	PSA10	80	0.64	PSA10	100	0.64	PSA10	120	0.64	PSA10	170	0.64	PSA10	0.01
29_00000000MING004	HWB4	PSA10	80	0.64	PSA10	100	0.64	PSA10	120	0.64	PSA10	170	0.64	PSA10	0.01
29_00000000MINGO05	HWB3	PSA10	80	0.64	PSA10	100	0.64	PSA10	120	0.64	PSA10	170	0.64	PSA10	0.01
29_00000000MINGO06	HWB28	PSA10	69.2820323	0.64	PSA10	95.26279442	0.64	PSA10	103.9230485	0.64	PSA10	147.2243186	0.64	PSA10	0.01
29_0000000MINGO011	HWB28	PSA10	80	0.64	PSA10	110	0.64	PSA10	120	0.64	PSA10	170	0.64	PSA10	0.01
29_0000000MINGO021	HWB28	PSA10	80	0.64	PSA10	110	0.64	PSA10	120	0.64	PSA10	170	0.64	PSA10	0.01
29_0000000MINGO031	HWB28	PSA10	80	0.64	PSA10	110	0.64	PSA10	120	0.64	PSA10	170	0.64	PSA10	0.01
29_0000000MINGO081	HWB17	PSA10	28.125	0.64	PSA10	39.375	0.64	PSA10	50.625	0.64	PSA10	78.75	0.64	PSA10	0.01
29_0000000MINGOT02	HWB28	PSA10	80	0.64	PSA10	110	0.64	PSA10	120	0.64	PSA10	170	0.64	PSA10	0.01
29_000033560-00055	HWB3	PSA10	80	0.64	PSA10	100	0.64	PSA10	120	0.64	PSA10	170	0.64	PSA10	0.01
29_000033560-00127	HWB28	PSA10	80	0.64	PSA10	110	0.64	PSA10	120	0.64	PSA10	170	0.64	PSA10	0.01
29_000033560-00132	HWB28	PSA10	80	0.64	PSA10	110	0.64	PSA10	120	0.64	PSA10	170	0.64	PSA10	0.01
29_090505000003031	HWB5	PSA10	28.125	0.64	PSA10	39.375	0.64	PSA10	50.625	0.64	PSA10	78.75	0.64	PSA10	0.01

Figure E.6 The Bridge Data sheet of the ShakeCast NBI Workbook. Its functionality mimics the Facility XML sheet of the standard ShakeCast Inventory Workbook.

E.3 Bridge Fragility Sheet

The "**Bridge Fragility**" sheet integrates information from both the ShakeCast bridge model sheet and optionally ShakeCast impact notifications (in either CSV or JSON format) from processed ShakeMap. It allows advanced users to investigate both the assigned fragilities and assessed damage state probabilities on a bridge-by-bridge basis.

- **Bridge fragility model**: Select/enter the bridge facility ID from the "*Facility ID*" pulldown menu to load the bridge fragility model shown in the ShakeCast Bridge Sheet. The peak ground acceleration at 1.0 sec (PSA1.0) that intersects the 50% probability for each fragility curve represents the notification threshold in addition to the notification triggering floor, defaults at 10%g.

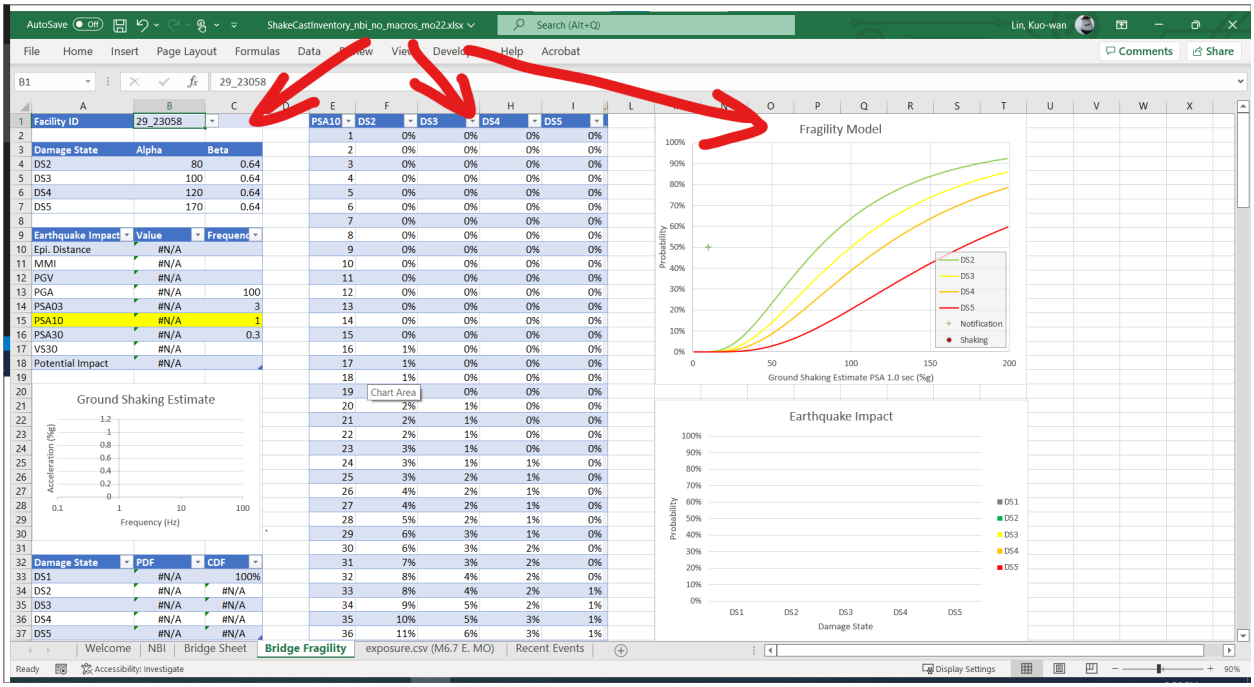


Figure E.7 The Bridge Fragility sheet of the ShakeCast NBI Workbook. This sheet aggregates defined bridge fragility from the selected bridge with the shaking estimates from ShakeCast output to allow engineers to review bridge performance for the earthquake. The highlighted components represent the bridge fragility model.

- **Bridge performance**: If the selected bridge has been analyzed in the ShakeCast Exposure Notification Sheet, bridge performance tables and charts will be enabled for
  - Shaking estimates (table and chart) at bridge site
  - Notified estimate of impact potential (metric and model)
  - Estimates of damage probabilities for each damage state (table and chart)

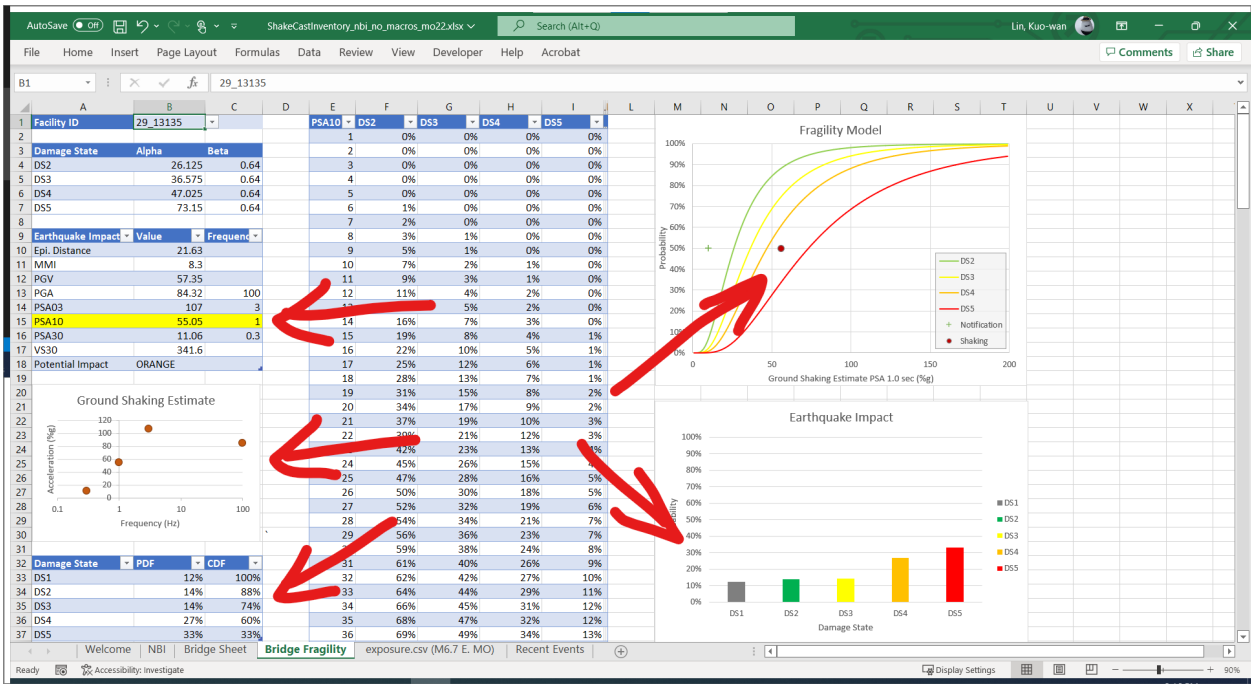


Figure E.8 The Bridge Fragility sheet of the ShakeCast NBI Workbook. The highlighted components represent results of fragility analysis for the selected bridge using the assessed earthquake shaking information.

E.4 ShakeCast Exposure Notification Sheet

The ShakeCast Exposure Notification sheet works very similarly to the NBI sheet except that the source data file comes from the ShakeCast application. Currently it supports two variants of the CSV format for both the V3/V4 default (*exposure.csv*) product and the InfoBridge export (*FacilityImpacts.csv*).

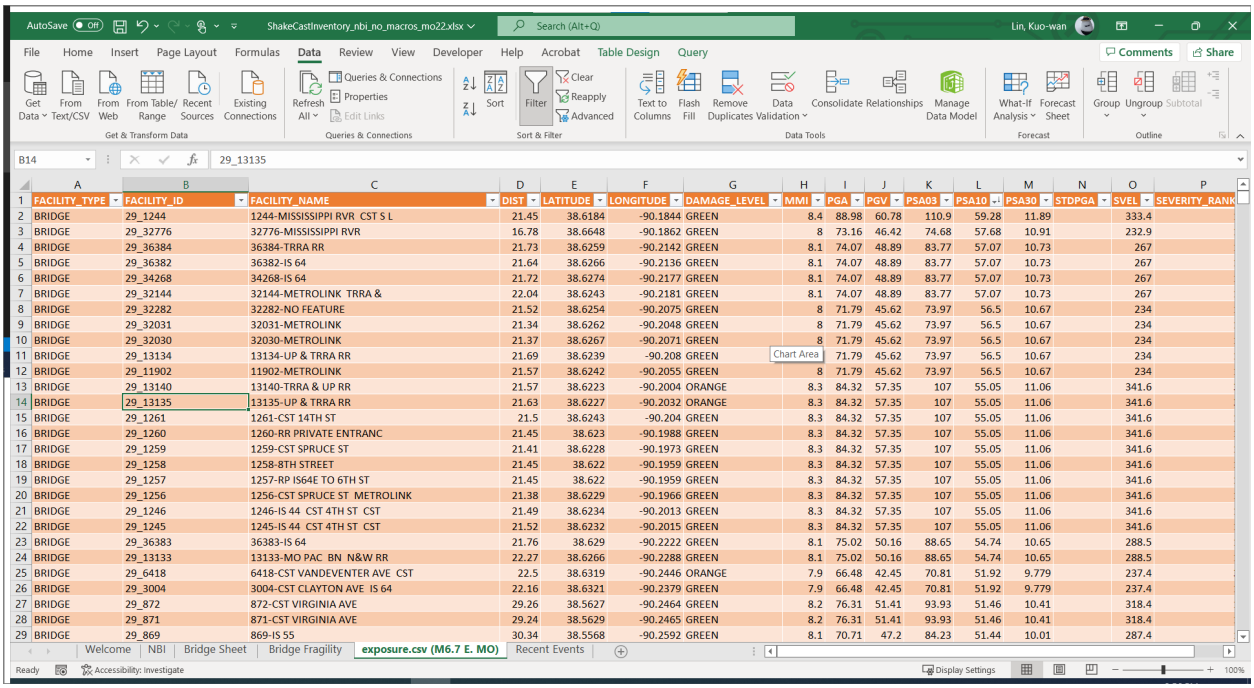


Figure E.8 The exposure.csv sheet of the ShakeCast NBI Workbook. This sheet contains the imported data from the ShakeCast csv product user typically receives from the email notifications.

- The source file of the ShakeCast bridge impact input can be reviewed via the "*Queries & Connections*" side panel. Impact notifications from both actual and scenario ShakeMaps can be imported into this sheet.

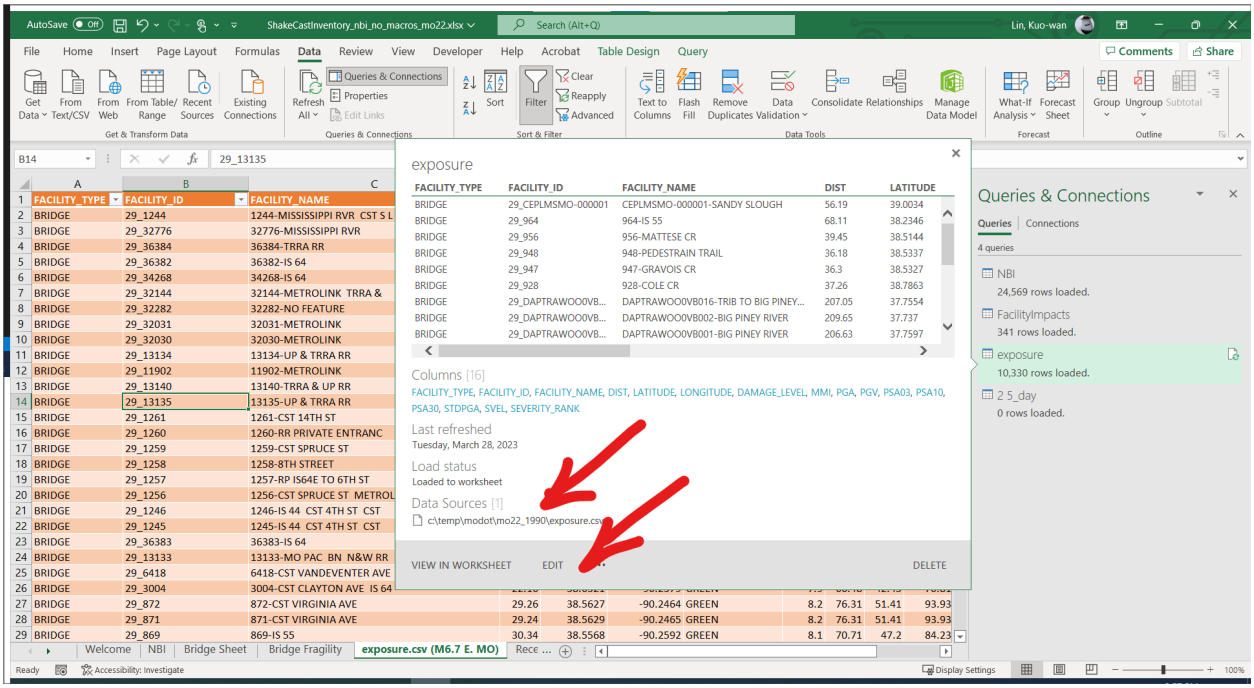


Figure E.9 The Data Query dialog for import exposure.csv sheet into the ShakeCast NBI Workbook.

- Via the "*Edit*" action, the user can specify a new dataset (in ShakeCast exposure format) to be imported.

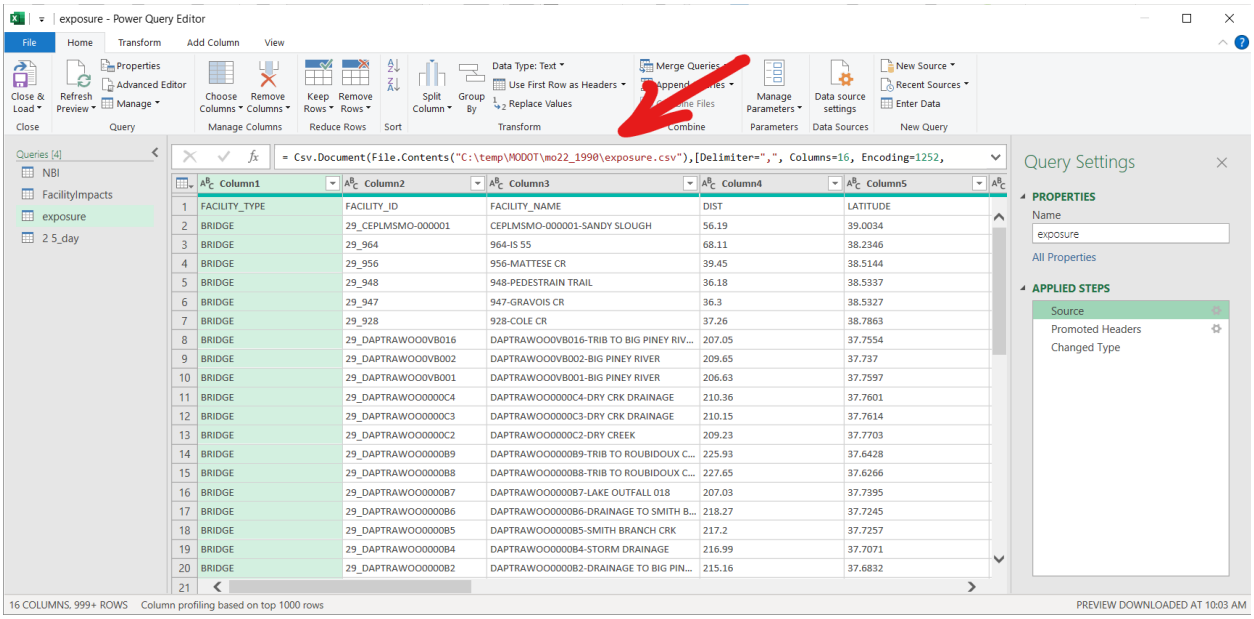


Figure E.10 The alternative method to specify the input data for the exposure.csv sheet using Microsoft's Power Query method.

E.5 USGS Near-Real-Time Earthquake Data Feed Sheet

This data sheet follows the USGS M2.5+ Earthquake Daily Feed in GeoJSON format for the last 24-hour period. While not directly related to the other bridge sheets, it provides situational awareness of earthquake activities in the region in near real-time.

The converted table filters the list of global earthquakes to the region enclosing the designated State and bordering areas. Content of the feed needs to be manually refreshed (automatic refresh can be enabled in the *Data Connection* properties).

To customize the Recent Events sheet, the user need to revise the Power Query for the data connection "*2.5_day*" that includes the source of data feed and region filters. Details of the USGS GeoJSON feed format can be found on the USGS web site.

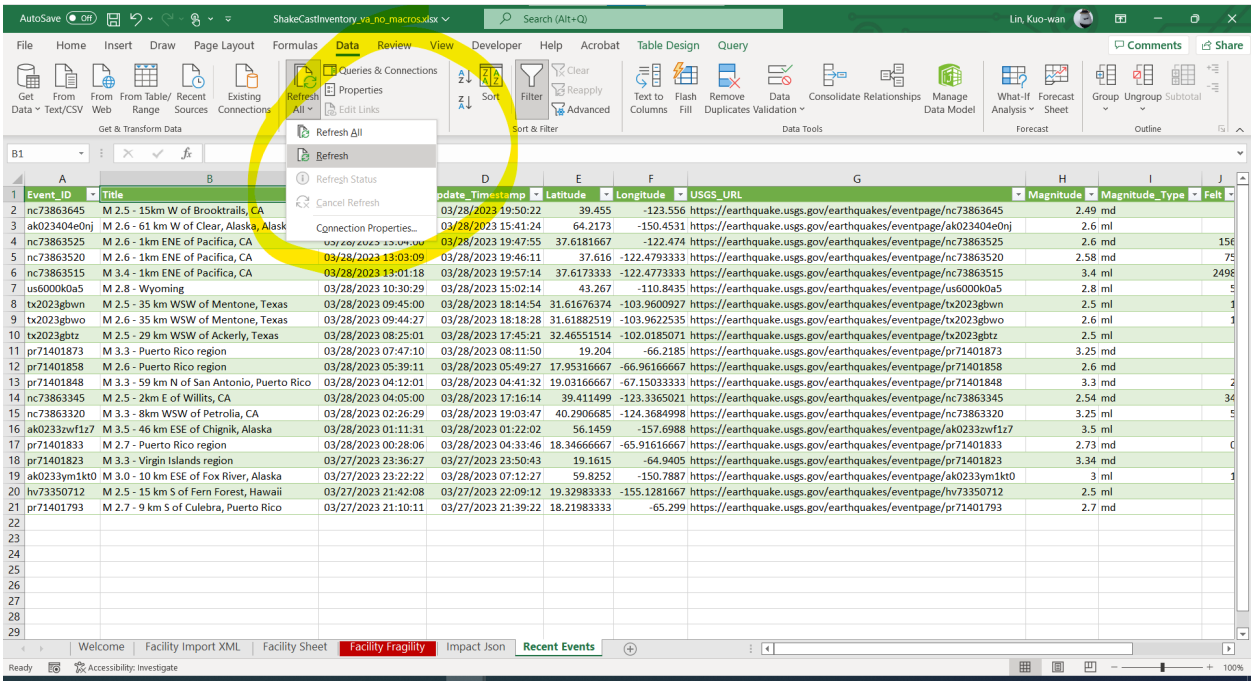


Figure E.11 The USGS earthquake data sheet of the ShakeCast NBI Workbook. This sheet contains the list of recent earthquakes (filtered by the bounding box of the DOT monitoring region). The highlighted dialog shows the refresh action.