



REPORT TO CONGRESS

The National Oceanic and Atmospheric Administration and Department of Homeland Security's Report on National Efforts that Support Rapid Response Following Near-Shore Tsunami Events

*Developed pursuant to: The Weather Research and Forecasting
Innovation Act, 2017 (P.L. 115-25)*

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THE WEATHER RESEARCH AND FORECASTING INNOVATION
ACT, 2017 (P.L. 115-25) INCLUDED THE FOLLOWING LANGUAGE

“... the Administrator and the Secretary of Homeland Security shall jointly, in coordination with the Director of the United States Geological Survey, Administrator of the Federal Emergency Management Agency, the Chief of the National Guard Bureau, and the heads of such other Federal agencies as the Administrator considers appropriate, submit to the appropriate committees of Congress a report on the national efforts in effect on the day before the date of the enactment of this Act that support and facilitate rapid emergency response following a domestic near-shore tsunami event to better understand domestic effects of earthquake derived tsunami on people, infrastructure, and communities in the United States.”

THIS REPORT RESPONDS TO THE COMMITTEE ON COMMERCE, SCIENCE, AND
TRANSPORTATION AND THE COMMITTEE ON HOMELAND SECURITY AND
GOVERNMENTAL AFFAIRS OF THE SENATE, THE COMMITTEE ON SCIENCE,
SPACE, AND TECHNOLOGY, THE COMMITTEE ON HOMELAND SECURITY, AND
THE COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE OF THE HOUSE
OF REPRESENTATIVES REQUEST.

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I. EXECUTIVE SUMMARY

The Department of Commerce’s National Oceanic and Atmospheric Administration (NOAA) prepared this report in coordination with the Department of Homeland Security’s Federal Emergency Management Agency and the United States Geological Survey in response to the following direction provided by the Weather Research and Forecasting Innovation Act of 2017 (PL 115-25). It has been reviewed and edited by the National Guard Bureau.

“... the Administrator and the Secretary of Homeland Security shall jointly, in coordination with the Director of the United States Geological Survey, Administrator of the Federal Emergency Management Agency, the Chief of the National Guard Bureau, and the heads of such other Federal agencies as the Administrator considers appropriate, submit to the appropriate committees of Congress a report on the national efforts in effect on the day before the date of the enactment of this Act that support and facilitate rapid emergency response following a domestic near-shore tsunami event to better understand domestic effects of earthquake derived tsunami on people, infrastructure, and communities in the United States.”

Certain areas of the United States, such as the Cascadia region of the Pacific Northwest (including Northern California), are particularly vulnerable to a near-shore tsunami event. Due to this concern, extensive research, assessment, and planning have been done by multiple Federal agencies and the states over the past three decades. The ability to quickly assess the effects of a domestic near-shore tsunami on people, infrastructure, and communities—and to facilitate rapid emergency response amid logistical and communication challenges unique to this type of event—must be considered within the existing emergency response framework of the United States.

The capacity for rapid emergency response to near-shore tsunamis relies upon the existence and maintenance of key observing networks (e.g., seismic and water-level networks) and continued improvement of tsunami modeling techniques. It also relies upon clear plans and robust operational and interoperable communications for efficient situation assessment. Disaster exercises are the primary means to assess the effectiveness of preparedness, mitigation, and response plans. Full-scale exercises test a system from end-to-end. This requires hazard response planning; observation and situational assessment capabilities; systems supporting communications among response personnel and key leaders; and active participation by state and local governments.

II. Report Requirements for Near-Shore Tsunami Events

This Report to Congress is in response to Section 509 of the Weather Research and Forecast Innovation Act (Act) signed into law on April 18, 2017. This Report addresses rapid response following near-shore tsunami events and is a cross-agency effort. The Report is segmented into the seven sections defined by the Act under Section 509 (b).

SEC. 509. REPORTS

(b) REPORT ON NATIONAL EFFORTS THAT SUPPORT RAPID RESPONSE FOLLOWING NEAR-SHORE TSUNAMI EVENTS. —

(1) IN GENERAL.—Not later than 1 year after the date of the enactment of this Act, the Administrator and the Secretary of Homeland Security shall jointly, in coordination with the Director of the United States Geological Survey, Administrator of the Federal Emergency Management Agency, the Chief of the National Guard Bureau, and the heads of such other Federal agencies as the Administrator considers appropriate, submit to the appropriate committees of Congress a report on the national efforts in effect on the day before the date of the enactment of this Act that support and facilitate rapid emergency response following a domestic near-shore tsunami event to better understand domestic effects of earthquake derived tsunami on people, infrastructure, and communities in the United States.

(2) ELEMENTS.—The report required by paragraph (1) shall include the following:

A. Measurements Collected Before Enactment of this Act

A description of scientific or other measurements collected on the day before the date of the enactment of this Act to quickly identify and quantify lost or degraded infrastructure or terrestrial formations.

Response: The Federal Emergency Management Agency (FEMA) coordinates the interagency and state emergency management information flow to develop situational awareness and understanding of an incident. Based on the National Response Framework and the whole of government approach, FEMA uses Emergency Support Functions (ESF) and relies upon the FEMA Regions to quickly identify and quantify lost or degraded infrastructure as the result of a tsunami incident. FEMA relies on resident organizations within the ESF structure to gather and measure information on infrastructure. FEMA uses the Web-based Emergency Operations Center, an incident management tool and traditional means of information exchange to develop situational awareness.

The United States Geological Survey (USGS) supports seismic networks of relevance that provide high-quality, real-time measurements needed to quickly characterize potentially tsunamigenic earthquakes in order to identify and quantify possible impacts. The Global Seismographic Network (GSN), supported jointly by the USGS and the National Science Foundation, consists of 150 globally distributed seismic stations. The GSN is designed to provide robust, uniform, high-quality, and high-dynamic-range recordings of earthquakes and other seismic events. The national network of the USGS Advanced National Seismic System

(ANSS) is a high-quality, real-time national network covering the United States. The GSN and ANSS form the core station set for large earthquake characterization and provide data to the NOAA Tsunami Warning Centers and the USGS National Earthquake Information Center. These resources are critical to the rapid detection, locating, and characterization of significant seismic events around the world that can impact infrastructure and terrestrial formations.

The USGS also collects—and collaborates with others to collect—coastal measurements before and after a tsunami to identify and quantify lost or degraded terrestrial formations. Lost or degraded terrestrial formations include changes in landscape and coastline, such as beach and dune erosion, barrier-island breaches, coastal landslides, and sedimentation in harbors following a tsunami and its originating earthquake. Measurements include satellite imagery, geodetic data, Light Detection and Ranging (LiDAR), oblique-aerial photographs, and bathymetric data in harbors and along coasts. There are also on-the-ground measurements of erosion, land-elevation change documenting coastal subsidence and uplift, and tsunami inundation. A critical expertise that the USGS provides is geologic interpretation of these coastal measurements.

NOAA supplements USGS seismic network density in Alaska, Hawaii, and Puerto Rico with additional seismic monitoring stations. NOAA also deploys Deep-ocean Assessment and Reporting of Tsunamis (DART) buoys and water-level gauges in oceans and on U.S. coastlines. These seismic, DART buoy, and water level observation stations collect data used by its Tsunami Warning Centers to refine tsunami forecasts. However, these additional sensing devices do not measure terrestrial formations or have the ability to detect degraded infrastructure, other than the sensors themselves being rendered nonoperational by being damaged by an earthquake or tsunami.

FEMA also collaborates and coordinates with NOAA's Tsunami Warning Centers and Pacific Marine Environmental Laboratory (PMEL) for tsunami model scenario development to enable exercises and response planning. In 2017, FEMA released the Hazus Tsunami loss estimation module to the public, providing a standardized model to the whole community for estimating the impacts of near-shore and distant tsunamis. Tsunami-inundation data for real-time forecasts and historical scenarios (developed by PMEL), the states, and academic partners—combined with the Hazus Tsunami loss-estimation module—provide a robust means for quickly identifying and quantifying infrastructure and other built-environment and economic impacts.

B. Measurements Necessary Going Forward

A description of scientific or other measurements that would be necessary to collect to quickly identify and quantify lost or degraded infrastructure or terrestrial formations.

Response: FEMA, through the use of ESFs and the FEMA Regions, relies on resident organizations within the ESF structure to quickly identify and quantify lost or degraded infrastructure as the result of a tsunami incident. Information provided to FEMA by partners, such as the USGS, allows FEMA to estimate impacts and identify locations sustaining infrastructure damage or loss.

Accurate pre-event modeling simulations and information from partners regarding the types of tsunamis could occur in given locations, the areas would be flooded by those tsunamis, and the hydrodynamic impacts on structures and infrastructure will assist in identifying risk and build upon information for deliberate response and mitigation plans.

Post-event, the Federal Government's ability to utilize modeling and spatial visualization of model outputs of the tsunami—and compare them against geospatial datasets of the built environment—helps bridge the information gap before reliable field observations, satellite photos, and other visual data become available. Use of model output to guide response until reliable observation data is available is consistent with the approach used for other types of flooding, including riverine flooding and coastal storm-surge flooding.

Ensuring a high degree of accuracy in models and visualizations available to FEMA will improve situational awareness and facilitate their ability to readily project infrastructure loss. FEMA partners coordinate actively with NOAA's PMEL for tsunami-model forecast and scenario development, which relies extensively on digital elevation models that account for ground deformation estimated for seismic events. Further, FEMA partners actively work with the National Aeronautics and Space Administration's Jet Propulsion Laboratory for remote sensing-based observations of ground deformation which—in both pre-event planning and post-event response—are necessary for accurately modeling both tsunami flooding and rapid damage assessments.

While global and national earthquakes are quickly and well characterized by existing seismic networks, these networks must be maintained to ensure that capabilities do not erode. Both the accuracy and timeliness of tsunami warnings and post-tsunami damage assessments could be improved and made more timely by: 1) integrating real-time displacement monitoring data (such as Global Navigation Satellite System (GNSS) data) into large earthquake characterization, especially in subduction zone tectonic environments; 2) integrating regional seismic network data into tsunami warning and event characterization systems; and 3) improving data sets of the built environment in coastal regions to improve the accuracy of post-earthquake and post-tsunami damage assessments.

The post-tsunami measurements needed to quickly identify and quantify lost or degraded terrestrial formations include satellite imagery, geodetic data, LiDAR, oblique-aerial photographs, bathymetric data in harbors, and on-the-ground measurements. Baseline elevation data of sufficient resolution and accuracy for comparison with post-tsunami measurements exist for a majority of the open coast of Washington, Oregon, California, Hawaii, and U.S. territories in the Caribbean. However, data coverage is incomplete for much of Alaska and the U.S. territories in the Pacific.

High-resolution elevation data and imagery do not extend inland sufficient distances to capture all tsunami and earthquake-induced landform changes in all regions. Similarly, baseline oblique-aerial photography coverage is incomplete for the United States and its territories. In addition, to comprehensively capture loss and degradation of landforms in coastal areas, both pre-tsunami baseline and post-tsunami near-shore bathymetric data are needed. Improved agency

coordination would enhance the government’s ability to provide information on lost or degraded coastal landforms in a rapid fashion and for large areas.

C. Identification of First Responder Capabilities Before Enactment of the Act

Identification and evaluation of Federal, State, local, tribal, territorial, and military first responder and search and rescue operation centers, bases, and other facilities as well as other critical response assets and infrastructure, including search and rescue aircraft, located within near-shore and distant tsunami inundation areas on the day before the date of the enactment of this Act.

Response: FEMA identifies potential Federal capability and capacity needed to respond to tsunami impacts through catastrophic planning efforts. FEMA conducts annual exercises nationally and regionally that allow Federal, state, local, tribal, territorial, military (Title 10 and 32), and other essential first responders to assess their capacity and capabilities. No tsunami exercises were conducted by FEMA in 2017.

D. Evaluation of Response Plans

An evaluation of near-shore tsunami response plans in areas described in subparagraph (C) in effect on the day before the date of the enactment of this Act, and how those response plans would be affected by the loss of search and rescue and first responder infrastructure described in such subparagraph.

Response: Federal tsunami response and recovery support actions are addressed through FEMA national and regional operational planning efforts.

All 10 FEMA Regions¹ have all-hazards plans that address common and generic response and recovery consequence management actions. Regions I, II, III, IV, IX, and X address response actions specific to geophysical and meteorological hazards such as tsunamis and hurricanes. Specific to tsunamis, Region IX developed plans addressing the tsunami threats to Hawaii (2015) and Guam/Commonwealth of Northern Mariana Islands (2017). Region X has earthquake-specific hazard annexes (Alaska, 2015; Cascadia Subduction Zone, 2014) that address earthquake-induced tsunami threats. All plans were developed in partnership with the state or territory, FEMA’s hazard mitigation programs, and the interagency response community. The FEMA response and recovery plans support the state, territory, or commonwealth emergency operations plans.

The state or territory National Guard plans are in support of the state or territory civil emergency response plans. This support is coordinated through the Joint Force Headquarters State (JFHQ-State) with additional support and coordination from the National Guard Bureau (NGB) through the National Guard Coordination Center (NGCC). Tsunami-response plans (when applicable) in the National Guard are either scenario-specific—as in the case of the Washington and Oregon

¹ Graphical depiction of the 10 FEMA regions available from: <https://www.fema.gov/fema-regional-contacts>

Cascadia Subduction Zone (CSZ) response plans—or through the 54 state or territory All-Hazards Response Plans. Individual state or territory National Guard forces mitigate catastrophic effects through Continuity of Operations Planning. When capabilities are lost or the need for additional National Guard capabilities is requested, support between states and territories is through the use of mutual-assistance agreements or Emergency Management Assistance Compacts (EMAC). NGB assists in the coordination between states and territories and helps to identify needed capabilities and recommend sourcing solutions when not specifically addressed in the state or territory National Guard plans. The NGB utilizes the NGB All-Hazards Support Plan as guidance to the states and territories on support to a complex catastrophe. Support appendices specific to CSZ and for tsunamis in general are under development and expected to be completed in FY 2019.

The FEMA National Urban Search and Rescue (US&R) Response System has formal plans and procedures in place for the deployment of the closest resources in a sudden-onset incident. If the closest Federal US&R resources were unable to respond, the next geographically closest task forces/resources would be activated and deployed, effectively re-locating like-type resources from non-impacted areas. The Federal US&R mission would be backfilled by identical resources (National Incident Management System-typed). (Each of the 28 task forces in the National US&R Response System has standardized equipment, training, personnel depth, and operational procedures.) The 28 US&R sponsoring agencies all have two equipment caches, and they are capable of simultaneously deploying a second task force, which ensures interoperability and resilience. In addition to the Federal capabilities, the first-responder mission would also be backfilled by similar resources via existing mutual-aid agreements and/or EMAC.

E. Description of Redevelopment Plans and Reports Before Enactment of the Act

A description of redevelopment plans and reports in effect on the day before the date of the enactment of this Act for communities in areas that are at high-risk for near-shore tsunami, as well as identification of States or communities that do not have redevelopment plans.

Response: FEMA response and recovery plans address the consequence-management actions needed for life-safety, infrastructure, and community protection. Each operational plan addresses the response and recovery actions based on the National Response and Recovery core capabilities needed to save lives, protect property and infrastructure, and support the consequence management of the whole community.

F. Recommendations to Enhance Preparedness and Response Plans

Recommendations to enhance near-shore tsunami preparedness and response plans, including recommended responder exercises, pre-disaster planning, and mitigation needs.

Response: NOAA's National Weather Service provides support to state, local, tribal, and territorial governments in order to enhance near-shore tsunami preparedness, mitigation, exercises, and response plans. NOAA recognizes that there are certain geographic areas where there is a limited means of evacuating at-risk populations, particularly in response to a near-shore tsunami event. NOAA supports the efforts of state, local, tribal, and territorial governments to

address these issues through various means of improving public safety for a tsunami, such as pedestrian evacuation analyses, hardening of infrastructure, vertical evacuation structures, and other mitigation alternatives.

FEMA plans address the Federal consequence management actions for response and recovery. Operational plans address the response and recovery actions based on the National Response and Recovery core capabilities needed to save lives, protect property and infrastructure, and support the consequence management of the whole community. FEMA works with state, local, tribal, and territorial communities to develop hazard mitigation plans that address vulnerability reduction and increasing resilience at the community level as part of the Hazard Mitigation Act of 2000.

To continue enhancing near-shore tsunami preparedness and response plans, FEMA and NOAA should continue relationship-building activities supporting tsunami modeling and mapping activities. In 2017, FEMA released the Hazus Tsunami loss-estimation module, providing emergency-management partners with a standardized capability to estimate potential damage for various tsunami-inundation scenarios. The Hazus Tsunami module was developed around the use of NOAA tsunami-model data for estimation of impacts and other requirements for preparedness and response planning. Additional research can refine current models and to improve sensor readings to continue to enhance the Federal Government's ability to plan for, to mitigate against, and to respond to tsunami threats.

The continued utilization of integrated planning with Federal, State and local partners that is synchronized with national planning scenarios is the best means for tsunami consequence management, mitigation, and recovery. Plan development and integration is a continuous process and the regular concentration of planning resources on specific catastrophic response scenarios assists the whole of government and interorganizational response to save lives, prevent suffering, and mitigate the damage from a tsunami event. Where applicable, tsunami effects should be exercised as part of the national planning scenarios and should be regularly scheduled as part of our national preparedness objectives. Lessons learned should be shared and integrated into tsunami planning across organizations and geographic areas.

G. Other Appropriate Data and Analysis

Such other data and analysis information as the Administrator and the Secretary of Homeland Security consider appropriate.

Response: The Cascadia Rising national-level exercise to test response plans was conducted in 2016. Results of that exercise are being addressed and implemented by Federal agencies and the states. FEMA's Joint Multi-State After-Action Report² (September 6, 2016) indicated a number of strategic findings and areas for improvement (e.g., operational communication and situational assessment). In addition to the summary and recommendations from the Cascadia Rising report,

² Report available from: https://www.fema.gov/media-library-data/1484078710188-2e6b753f3f9c6037dd22922cde32e3dd/CR16_AAR_508.pdf

FEMA's Hazus Tsunami loss-estimation module relies heavily on the NOAA Short-term Inundation Forecast for Tsunami database for conducting damage assessments for preparedness and response planning. FEMA strongly supports opportunities to improve and facilitate data sharing with NOAA to enhance damage and loss-estimation techniques for near-shore tsunami inundation scenarios and events.

In a post-event environment, FEMA would also rely on the USGS for perishable tsunami flood data collection, including analysis of water-level information (from instrumentation and field surveys) to refine forecast-model estimates, rapid damage assessment techniques, and guidance for long-term recovery and potential mitigation strategies. FEMA and USGS should continue relationship-building activities that enhance transfer of information after a tsunami.

III. Summary and Recommendation

Rapid emergency response following a domestic near-shore tsunami event is a critical concern and has been researched, studied, and exercised since the 1980s.

In this time, the Nation has seen vast improvements in seismic safety building codes and construction. While historically focused on life safety, outreach and education for the public about both self-protection and home/business mitigation actions to reduce earthquake and tsunami loss have been extensive. Through investments implemented by NTHMP states, 100 percent of the known areas at risk for tsunami inundation on the West Coast have been mapped, and subsequent preparedness and mitigation activities to protect life and property are routinely conducted to engage the public on an ongoing basis. Public participation in all of these activities is key to the adoption of safety behaviors and development of a culture of preparedness and community resilience.

Disaster exercises help to better understand the effects of an earthquake-induced tsunami on people, infrastructure, and communities in the United States and are a critical component of preparedness.

Results of the Cascadia Rising exercise are being addressed and implemented by Federal agencies and the states. We recommend that ongoing support be provided to assist states in executing the *Strategic Findings and Areas for Improvement* in FEMA's Joint Multi-State After-Action Report (Section G). While the scenario at the center of this exercise represents the single biggest near-shore tsunami threat to the United States, the recommendations in this report are transferable to other geographic areas.