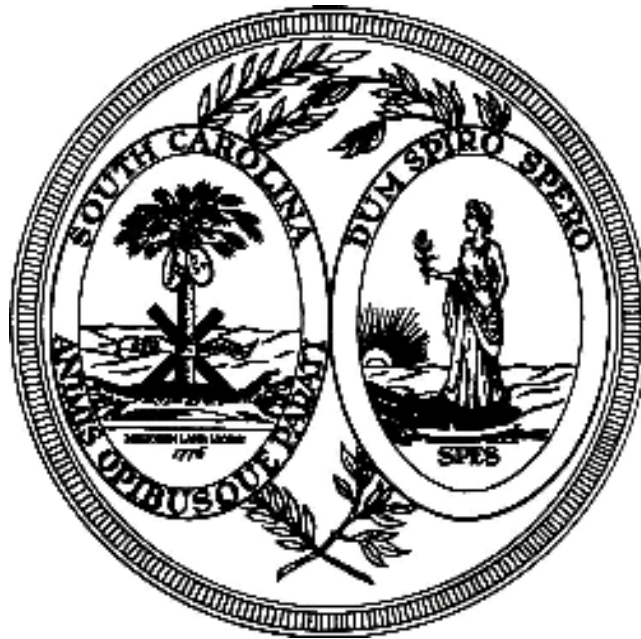


South Carolina Tsunami Response Plan

Appendix 11

South Carolina Emergency Operation
Plan



South Carolina
Emergency Management Division

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I. INTRODUCTION

- A. Tsunamis are ocean waves produced by earthquakes or underwater landslides. Tsunamis are often incorrectly referred to as tidal waves, but a tsunami is actually a series of waves that can travel at speeds averaging 450 (and up to 600) miles per hour in the open ocean. The National Tsunami Warning System was developed and implemented to help reduce the loss of life and property from a tsunami event. The National Oceanic and Atmospheric Administration (NOAA) monitors for earthquakes and subsequent tsunami events in both the Pacific and Atlantic Oceans. The Tsunami Warning Centers issue Tsunami Warnings, Watches, and Advisories in addition to Tsunami Information Bulletins for both the U.S. West and East Coasts. See Attachment A for Acronyms and Glossary.
- B. NOAA's National Weather Service (NWS) Offices promote the TsunamiReady Program. The TsunamiReady Program is designed to help states, counties, municipalities, universities and other population centers in coastal areas reduce the potential for deadly tsunami-related consequences. The program helps community leaders and emergency managers strengthen their local operations. TsunamiReady communities are better prepared to save lives through improved planning, education, and awareness. Communities have fewer fatalities and property damage if they effectively plan before a tsunami arrives. No community is tsunami proof, but the TsunamiReady Program can help minimize loss to vulnerable communities.

II. PURPOSE

To plan and coordinate the operational procedures that South Carolina will use and provide resources to assist local governments in preventing and minimizing injury or death to people resulting from a tsunami.

III. SITUATIONS AND ASSUMPTIONS

- A. Situation
1. The tsunami threat for South Carolina is relatively low, and any tsunamis would likely be small and inundate mostly the beaches. Although the risk is low, the consequences could be high. Tsunamis have been recorded on the U.S. Atlantic Coast in 1755, 1884, 1886 and in 1929. The majority of tsunamis in the Atlantic Ocean and Caribbean Sea were triggered by either earthquake activity or were the result of volcanic eruptions. The majority of these resulted in localized damage and death, but nothing on a regionally catastrophic scale outside of the Caribbean. The August 31, 1886, Charleston, SC, earthquake had an estimated magnitude of 7.3 with the epicenter estimated to be just onshore. In both South Carolina and

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Florida, the event produced a small, non-destructive tsunami. In South Carolina, the maximum run-ups for this event measured in the range of 0.5 to 20 inches. Tsunami run-up over three feet is dangerous to people and property.

2. There are two sources of tsunamis for coastal waters: a distant source and a local source.
 - a. Distant Source: The source of the tsunami more than 620 miles (1,000 km) away from the Tsunami Warning Center's Area Of Responsibility (AOR).
 - b. Local/Regional Source: Source of the tsunami within 620 miles of the AOR. A local or near-field tsunami has a very short travel time (30 minutes or less), and mid-field or regional tsunami waves have travel times on the order of 30 minutes to 2 hours.
 - c. Locally generated tsunamis generally cause more loss of life than distant tsunamis. Tsunamis generated from local sources are generally larger and arrive much sooner after the causative source event than tsunamis from distant sources.
3. See Attachment B for additional Tsunami Background Information

B. Assumptions

1. A tsunami may occur at any time, day, or night.
2. A locally generated tsunami of any significance affecting South Carolina is unlikely.
3. A Tsunami Watch or Warning will be transmitted by NWS forecast offices for all tsunamis that are forecast to impact South Carolina.
4. The NWS Forecast Offices might not activate the Emergency Alert System (EAS) for all Tsunamis forecast to affect South Carolina. Tsunamis forecast with minimal impacts (riptides for example) may not result in EAS activation.
5. The tsunami threat in South Carolina may be caused by a distant seismic source, and in this case would provide at least three to four hours lead time to warn the public and evacuate sensitive facilities followed by establishing temporary shelters, and securing the coastal area.

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6. Landslides on the outer continental shelf and slope along the Mid-Atlantic coast have the potential to trigger tsunamis that may affect populated coastal areas.
7. Communications and critical infrastructure services may be disrupted or destroyed.
8. The maximum possible tourist and workforce populations may be present in the affected areas.
9. Withdrawal of the sea may be a precursor to arrival of the wave.
10. The first wave may not be the largest. The largest wave usually occurs among the first three waves.
11. Damage will be widespread and will vary widely, i.e., there may be concentrations of significant damage in some areas with only slight damage in others.
12. Access to and from the damaged areas may be restricted and some low-lying areas may be inundated.
13. The Statewide Mutual Aid Agreement will be implemented.

IV. CONCEPT OF OPERATIONS

A. Warning System

1. NOAA operates the Tsunami Warning System. The goal of the Tsunami Warning System is to protect life and property from the tsunami hazard by providing timely, accurate, reliable, and effective tsunami warning to coastal populations and emergency management organizations within the AOR as well as by advancing other aspects of tsunami hazard mitigation. The primary operational objectives of a Tsunami Warning System are to rapidly locate, assess magnitude and extent, and otherwise characterize major earthquakes to determine their tsunamigenic potential, predict tsunami arrival times, predict coastal run-up when possible, and disseminate appropriate warning and informational products based on this information.
2. The Tsunami Warning Center at Palmer, Alaska, also known as the West Coast/Alaska Tsunami Warning Center (WC/ATWC), is responsible for the preparation and dissemination of Tsunami Warning, Watch, Advisory, and Information products for the coastal regions of Canada and all States except Hawaii. These regions are defined as the WC/ATWC's AOR. The

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WC/ATWC has the primary responsibility for the detection and parameterization of potentially tsunamigenic earthquakes occurring within or immediately adjacent to its AOR and events within the Atlantic Basin north of the Tropic of Cancer.

3. The Tsunami Warning Center uses earthquake information, tide gauges, and DART (Deep-ocean Assessment and Reporting of Tsunamis) buoys. DART buoys are located in the Atlantic Ocean, the Gulf of Mexico, and the Caribbean Sea. In addition NOAA plans to deploy tsunameter buoys in the Atlantic. The DARTs (or tsunameters) have been strategically deployed near regions to ensure accurate measurement of the waves as they propagate towards threatened U.S. coastal communities. The data captured by DART buoys are critical to monitoring tsunami waves and predicting the timing and magnitude of the waves as they approach and impact the coast of South Carolina.
4. The following products are issued by NOAA's Tsunami Warning Centers. Each had a distinct meaning relating to local emergency response. In summary:

Information Statement	Minor waves at most	No action suggested
Watch	Danger level not yet known	Stay alert for more info
Advisory	Strong currents likely	Stay away from the shore
Warning	Inundating wave possible	Full evacuation suggested

- a. **Tsunami Information Statement** - a tsunami information statement is issued to inform emergency management officials and the public that an earthquake has occurred, or that a tsunami warning, watch or advisory has been issued for another section of the ocean. In most cases, information statements are issued to indicate there is no threat of a destructive tsunami and to prevent unnecessary evacuations as the earthquake may have been felt in coastal areas. An information statement may, in appropriate situations, caution about the possibility of destructive local tsunamis. Information statements may be re-issued with additional information, though normally these messages are not updated. However, a watch, advisory or warning may be issued for the area,

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if necessary, after analysis and/or updated information becomes available.

- b. **Tsunami Watch** - a tsunami watch is issued to alert emergency management officials and the public of an event which may later impact the watch area. The watch area may be upgraded to a warning or advisory - or canceled - based on updated information and analysis. Therefore, emergency management officials and the public should prepare to take action. Watches are normally issued based on seismic information without confirmation that a destructive tsunami is underway.
 - c. **Tsunami Advisory** - a tsunami advisory is issued due to the threat of a potential tsunami which may produce strong currents or waves dangerous to those in or near the water. Coastal regions historically prone to damage due to strong currents induced by tsunamis are at the greatest risk. The threat may continue for several hours after the arrival of the initial wave, but significant widespread inundation is not expected for areas under an advisory. Appropriate actions to be taken by local officials may include closing beaches, evacuating harbors and marinas, and the repositioning of ships to deep waters when there is time to safely do so. Advisories are normally updated to continue the advisory, expand/contract affected areas, upgrade to a warning, or cancel the advisory.
 - d. **Tsunami Warning** - a tsunami warning is issued when a potential tsunami with significant widespread inundation is imminent or expected. Warnings alert the public that widespread, dangerous coastal flooding accompanied by powerful currents is possible and may continue for several hours after arrival of the initial wave. Warnings also alert emergency management officials to take action for the entire tsunami hazard zone. Appropriate actions to be taken by local officials may include the evacuation of low-lying coastal areas, and the repositioning of ships to deep waters when there is time to safely do so. Warnings may be updated, adjusted geographically, downgraded, or canceled. To provide the earliest possible alert, initial warnings are normally based only on seismic information.
- 5. All Tsunami products will be plotted on the NWS hazards maps.
 - 6. When a potential tsunami-producing earthquake greater than threshold magnitude of 6.75 occurs in the Atlantic Tsunami Center's AOR, all

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tsunami products for South Carolina are issued by West Coast Alaska Tsunami Warning Center (WC/ATWC). Tsunami products also may be issued when potential tsunami-producing earthquakes greater than magnitude 7.5 occur outside the Atlantic AOR and are likely to impact the AOR.

6. The geographic extent of a tsunami product is based on the size of the earthquake, the tsunami travel times throughout the AOR, and expected impact zones.
7. Tsunami Warnings are generally issued within 10 minutes after earthquake occurrence.
8. Below is the U.S. East Coast criterion:

Magnitude	Area	Product
4.0-4.9	Within 50km of coast	Tsunami Seismic Information Statement
5.0-5.9	Within 500 km of coast	Tsunami Seismic Information Statement
6.0-6.75	Within approximately 500km of coast	Tsunami Information Statement
6.0+	Inland	Tsunami Information Statement
6.8-7.5	Atlantic coast	Fixed warning (350km)*
7.6-7.8	Atlantic coast	Fixed warning (1000km)*
>7.8	Atlantic coast	3 hour watch/3 hour warning**

B. Notification

1. In the event of a Tsunami Warning, Watch, Advisory, or Information Statement, the West Coast/Alaska Tsunami Warning Center (WC/ATWC) issues the tsunami message to the National Weather Service Forecast

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Offices (NWS) in the affected states. The local NWS forecast offices have the primary responsibility to process the information and rebroadcast the tsunami message or product through the civil emergency system which activates EAS.

2. The decision to activate EAS for a tsunami product is the sole responsibility of the local NWS Forecast Offices. The issuance of a Tsunami Warning or Watch may prompt NWS to activate EAS with a Civil Emergency Message. However, with the issuance of a Tsunami Advisory and Information Statement neither of these will prompt EAS activation. If NWS activates EAS, state and local officials can follow-up with another activation of EAS to warn the public and/or issue safety messages.
3. Upon SCEMD receipt of a Tsunami Warning, Watch, Advisory, or Information Statement, the State Warning Point will confirm receipt of the tsunami message with the WC/ATWC and relay to coastal counties. For redundancy, the SC Warning Point has several communications systems to receive tsunami messages when issued by NOAA:
 - a. The Emergency Management Weather Information System (EMWIN) which is a NOAA satellite-based system;
 - b. State Law Enforcement Division (SLED) teletype system;
 - c. Internet; and
 - d. NOAA All Hazards Weather Radio.
4. During business hours a copy of the tsunami message is given to SCEMD officials by the State Warning Point and faxed to the coastal emergency management offices. The State Warning Point will call to confirm receipt of the message.
5. After business hours, it is faxed to coastal emergency management warning centers which notify the county emergency management director. The State Warning Point will also confirm the receipt of the message telephonically with the warning centers. The message will be texted to SCEMD officials.
6. The State Warning Point participates monthly in an unannounced tsunami message test drill. The procedures for notification of a tsunami message are exercised during this monthly test drill.

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7. The coastal county warning centers also receive Tsunami Warning and/or Watch information independent of the State Warning Point through NOAA All Hazards Weather Radio and other systems that receive NOAA Weather warnings.
8. Upon receipt of any of the tsunami products, the SCEMD Director (or his designee) will confer with the NWS State Liaison (and if not available, a coastal NWS Forecast representative) to confirm threat and discuss potential consequences.
9. In the event a Tsunami Warning is issued for South Carolina coast by the West Coast/Alaska Tsunami Warning Center (WC/ATWC), the State Emergency Operations Center (SEOC) will activate at OPCON 1 and staffed accordingly.
10. In the event a Watch, Advisory or Information Statement is issued for South Carolina coast by the WC/ATWC, the SEOC will activate at OPCON 3 and staffed accordingly.

C. Evacuation

1. High-speed communications systems are used by the Tsunami Warning Centers, and distant tsunamis can often be announced by the Warning Centers with lead time to evacuate. A tsunami produced from a distant-source may allow three or four hours to evacuate.
2. Current tsunami inundation modeling is still in its infancy for the U.S. East Coast, there is some modeling work being done by NOAA. Until tsunami inundation maps are developed for coastal South Carolina, the State's Tsunami Evacuation Zone will use the recommended NWS Forecast Zone which is the evacuation one (1) mile inland away from river or approximately the third floor of a high rise building in the event of a Tsunami Warning.
3. Inland evacuation is the preferred method to evacuate low-lying coastal areas in advance of the initial tsunami wave. However, if lead time is insufficient to effect an inland mass evacuation, citizens should evacuate to high rise buildings at least to the third floor to implement vertical evacuation procedures. Vertical evacuation is the act of moving to the highest floor in a multiple-story building in order to avoid the tsunami wave. It is the local government responsibility to recommend the most prudent evacuation method for its threatened areas.
4. Upon receipt of a Tsunami Warning, local government officials are responsible for issuing an evacuation order to the threatened area.

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Simultaneously or not long afterwards, SCEMD will request the Governor to activate the SCEOP and may declare a mandatory evacuation of specific coastal areas based on local authority to evacuate. See Attachment C for Sample Evacuation Order.

5. The evacuation message will be broadcast to television and radio stations through the activation of EAS and other communications systems. See Public Information Section IV.D.2.
6. SCEMD and the local emergency manager will maintain communication with the NWS State Liaison and the local NWS Forecast offices on all notification and evacuation decisions. Telephone numbers of the NWS Forecast offices are maintained in SCEMD and the county emergency managers' telephone directories.
7. If there is observation of severe water drawback of the sea from South Carolina coasts and it is authenticated by reliable sources, local officials will order an evacuation of the beach via whatever communications methods are available at the time (route alerting, loud speaker, etc). The county emergency manager will request the local NWS Forecast Office to issue a civil emergency message (which includes activation of EAS) to broadcast the tsunami warning and for persons to evacuate the beach immediately. County emergency managers will inform SCEMD of the evacuation order and the SCEMD Director (or his designee) will request the NWS State Liaison to confirm threat and will follow the same procedures as outlined above in C. 2 through 6.
8. An evacuation order for a Tsunami Watch will be dependent upon the situation. The decision to evacuate will be made by representatives of the State Emergency Response Team (SERT), NWS forecast officials, and affected local emergency management officials.
9. After the arrival of the first wave, additional waves may continue at varying intervals for several hours.
10. Assembly areas for those without transportation will be designated in the tsunami risk areas by county emergency managers.
11. Shelters for persons needing accommodations will be identified outside the tsunami risk areas.
12. If required or requested, Traffic Control Points (TCPs) will be identified for the areas and will be implemented by local law enforcement with assisted by ESF-16 if necessary.

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13. Identifying evacuation routes are not necessary due to the limited inundation area; however, if the need arises to implement evacuation routes, the routes currently identified for hurricane evacuation will be implemented along with the traffic management operations. Local officials will be responsible for coordinating the local evacuation effort and requesting implementation of the hurricane traffic management operations.
14. The following actions will occur following an evacuation order:
 - a. Advise jurisdictions to maintain full evacuation until the evacuation order has been rescinded. The evacuation order being rescinded will be based upon an ALL-CLEAR signal which is a minimum of two hours after arrival of the last wave.
 - b. An ALL CLEAR determination is the responsibility of the local officials in consultation with NWS Forecast Offices and SERT officials. An ALL CLEAR message will be issued no earlier than two hours after the last damaging wave. Before the ALL CLEAR determination is made, officials must be able to observe the waves from a safe distance/height.
 - c. No persons are to enter the evacuated areas until the evacuation order has been rescinded after the ALL CLEAR signal. Re-entry is the responsibility of local officials.
 - d. Consider declaration of emergency or disaster based on damage.
 - e. Disseminate public information about the event.
 - f. Resource allocation and coordination preceding the tsunami wave will take into consideration the following areas of special concern:
 - 1) Evacuation of education and childcare facilities and nursing homes located within the Tsunami Evacuation Zone.
 - 2) Evacuation of disabled persons and those needing special medical assistance within the Tsunami Evacuation Zone.
 - g. Request jurisdictions to initiate preparation for damage assessments to compile information and report information to SEOC.
 - h. SCEMD will request State Damage Assessment Teams to begin preparation to assist local governments in the assessment.

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E. Recovery

1. SCEMD will implement its Recovery Plan to facilitate recovery in the disaster area after the evacuation order has been rescinded and the ALL CLEAR Signal has been given.
2. A focus will be placed on health inspections to prevent the spreading of communicable diseases, contamination of food, and water supplies.

V. RESPONSIBILITIES

A. SC Emergency Management Division (SCEMD)

1. Update and review annually this Annex and coordinate plan review with applicable state agencies, local NWS Weather Forecast Offices, and county emergency management offices.
2. Provide assistance to county emergency management offices in support of tsunami planning and TsunamiReady Program. See Attachment I – Map of Tsunami Ready Counties and Communities.
3. Coordinate with local emergency management offices and local NWS Weather Forecast Offices to review procedures for disseminating tsunami products to local jurisdictions.
4. Coordinate and implement procedures to relay and/or verify receipt of tsunami products notifications to affected counties.
5. Coordinate with local NWS Weather Forecast Offices and local emergency management offices to determine tsunami inundation areas within the State and develop tsunami inundation maps.
6. In conjunction with county emergency management offices and local National Weather Service Forecast Offices develop public education tools for tsunami public education program.
7. Coordinate with local NWS Weather Forecast Offices to prepare EAS tsunami messages to include ALL CLEAR messages in English and in Spanish.
8. Coordinate with local NWS State Liaison Office to participate in the monthly EAS test and provide information to coastal counties.
9. In coordination with SC DHEC, identify Special Medical Needs population in the tsunami inundation zone and the requirements to evacuate.

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B. American Red Cross (ARC)

1. In coordination with the local emergency managers and SCDSS identify shelters to support evacuations from tsunami risk areas. Shelters identification should be outside the tsunami risk areas.
2. In coordination with SCDSS, the Salvation Army and local emergency managers be prepared to feed evacuated persons from the tsunami threatened areas to include groups of special needs such as nursing homes, health care facilities, Foster Care Group homes, vulnerable adult population groups.
3. Support the local governments TsunamiReady Program.

C. Clemson University Livestock-Poultry Health

1. Consult with SC Association of Veterinarians (SCAV) and SC Department of Environmental Health (SCDHEC) concerning animal diseases and public health concerns related to a tsunami hazard, and assist with dissemination of this information to the public.
2. In coordination with local emergency managers and ESF-17 support agencies, identify emergency animal shelters outside the tsunami risk areas.

D. SC Department of Health and Environmental Control (SCDHEC)

1. Review all aspects of possible health concerns that may affect the public following a tsunami and develop procedures to prevent the spreading of communicable diseases and contamination of food and water supplies.
2. Identify Special Medical Needs population in the tsunami inundation zone and the requirements to evacuate.

E. SC Department of Natural Resources

In coordination with SCDOT and SCDPS, develop plans and procedures to evacuate persons using boats and other water craft and respond to other requests for assistance.

F. SC Department of Public Safety (SCDPS)

1. In conjunction with county law enforcement authorities, develop and coordinate traffic management plans to ensure timely evacuation to include establishing local traffic control points/road blocks and implementation of the hurricane traffic management planning if necessary.

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2. Support local government tsunami planning.

G. SC Department of Social Services (SCDSS)

1. In coordination with the ARC and local emergency managers identify shelters to support evacuations from tsunami risk areas. Shelters identification should be outside the tsunami risk areas.

2. In coordination with Salvation Army and American Red Cross (ARC) be prepared to feed evacuated persons from the tsunami threatened areas to include groups of special concern such as nursing homes, health care facilities, Foster Care Group homes, vulnerable adult population groups.

H. SC Department of Transportation (SCDOT)

Review plans and procedures to transport evacuated persons from the tsunami threatened areas and if necessary, be prepared to implement transportation plans.

I. SC Lieutenant Governor's Office on Aging

1. Identify the vulnerable senior population groups in the inundation areas and the requirements to evacuate.

2. Coordinate and implement procedures to relay Tsunami Warning and Watch notifications to facilities serving senior population groups in inundation areas.

J. Salvation Army

In coordination with Department of Social Services and American Red Cross (ARC) be prepared to feed evacuated persons from the tsunami threatened areas to include groups of special needs such as nursing homes, health care facilities, Foster Care Group homes, vulnerable adult population groups.

K. Coastal County Emergency Management Offices

1. Participate in TsunamiReady Program and tsunami planning.

2. In conjunction with SCEMD and local National Weather Service Forecast Offices assist in the development of tsunami inundation maps.

3. Develop plans to reissue EAS messages upon receipt of a Tsunami Warning.

4. In conjunction with SCEMD, local National Weather Service Forecast Offices, SCDPS, SCDOT, and local law enforcement offices, assist in the development and coordination of traffic management plans to ensure

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effective evacuation to include establishing local traffic control points/road blocks and implementing of the hurricane traffic management planning if necessary.

5. Review and identify the best methods to evacuate threatened areas. For vertical evacuations, local planning for use of multi-story, high capacity, structurally sound buildings is needed. Additionally, identification of and routing to/from these structures must be considered.
6. In coordination with SCDHEC, identify populations with special transportation needs including day care facilities, schools, nursing homes, health care facilities, Foster Care Group homes, vulnerable adult population groups, and those without transportation.
7. In conjunction with ARC and SCDS, identify shelters to support displaced tourists and county population. Shelters identification should be outside the tsunami risk area.
8. In conjunction with local NWS Forecast Offices develop public education tools for tsunami public education and information program. Utilize materials from TsunamiReady Program.
9. Identify assembly areas for those without transportation to take to shelters.
10. In coordination with SCEMD and local NWS Forecast Offices develop plans to issue ALL-CLEAR signal and initiate re-entry policies.

VI. FEDERAL ASSISTANCE

The principal federal agencies that provide assistance in the event of a tsunami disaster are National Oceanic & Atmospheric Administration (NOAA) to include the National Weather Service (NWS) Weather Forecast Offices (NWS), the NOAA Center for Tsunami Research (NCTR), and the National Geophysical Data Center (NGDC). The Department of Homeland Security and the Federal Emergency Management Agency (FEMA) will implement the National Response Framework (NRF) to provide assistance. Earthquake monitoring and analysis support is provided by the United States Geological Survey (USGS). Other federal agencies that have collateral or coordinating responsibilities are identified in the Basic Plan of the SC Emergency Operations Plan (SCEOP).

VII. ATTACHMENTS

ATTACHMENT A - Acronyms and Glossary

ATTACHMENT B – Tsunami Background Information

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ATTACHMENT C - Sample Evacuation Order

ATTACHMENT D- Tsunami Warning Checklist

ATTACHMENT E - Tsunami Watch Checklist

ATTACHMENT F - Tsunami ALL-CLEAR Checklist

ATTACHMENT G - Sample Emergency Alert System (EAS) Messages for Tsunami Hazard

ATTACHMENT H - Sample News Release

ATTACHMENT I - Map of TsunamiReady Counties and Communities

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ATTACHMENT A - Acronyms and Glossary

Amplitude: The rise above or drop below the ambient water level as read on a tide gauge.

AOR: Area of Responsibility. Each Tsunami Warning Center is given an area of responsibility to provide tsunami information and warning messages to its area-of-responsibility (AOR).

Arrival Time: Time of arrival, usually of the first wave of the tsunami, at a particular location.

Crest: The high-point, peak or top of a wave.

Earthquake: The sudden, sometimes violent movement of the earth's surface (and ocean floor) from the release of energy in the earth's crust. Earthquakes are often caused by slip along a sloping fault where the rock above the fault moves downward relative to the rock below. The most common type of earthquake source of damaging tsunamis is the 'thrust' earthquake, caused by slip along a gently sloping fault where the rock above the fault is pushed upward relative to the rock below.

Inundation: The depth, relative to a stated reference level, to which a particular location is covered by water.

Inundation Area: An area that is flooded with water.

NOAA: National Oceanic and Atmospheric Administration, a line office of the Department of Commerce and parent agency of the National Weather Service.

Period: The length of time between two successive peaks or troughs. Tsunami periods generally range from 5 to 60 minutes.

Run-up: Maximum height of the water onshore observed above a reference sea level. Usually measured at the horizontal inundation limit.

Subduction Zone: A subduction zone is the place where two plates come together, one riding over the other. Tsunamis can be generated when the sea floor abruptly deforms and vertically displaces the overlying water.

Tidal Wave: Common term for tsunami used in older literature, historical descriptions, and popular accounts. Tides, caused by the gravitational attractions of the sun and moon, may increase or decrease the impact of a tsunami, but have nothing to do with their formation or movement. However, most tsunamis (initially) give the appearance of a fast-rising or fast-ebbing tide as they approach shore, and only rarely appear as a near-vertical wall of water.

Travel Time: Time (usually measured in hours and tenths of hours) that it took the tsunami to travel from the source to a particular location.

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Trough: The low-point, or bottom of a wave. The depression between wave crests.

Vertical Evacuation: Evacuation from one floor(s) to the floor(s) below or above. In the case of a tsunami threat this shelter-in-place option would involve evacuating persons to the upper floors of a substantial structure.

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ATTACHMENT B – Tsunami Background Information

- A. Tsunamis are infrequent, high impact events that can cause a considerable number of fatalities, inflict major damage, and cause significant economic loss to large sections of the U.S. coastlines.
- B. Tsunamis cause extensive damage and loss of life within a span of minutes near their source, and within hours across an entire ocean basin. The devastating tsunami in the Indian Ocean, that occurred on December 26, 2004, killed more people than any other tsunami in recorded history. Because of this earthquake-induced tsunami more than 297,248 people were either killed or listed as missing and presumed dead, and 1,126,900 were displaced by the tsunami. Estimated economic losses exceeded \$10 billion.
- C. The shape and characteristics of a tsunami are similar to wind-driven waves, but the potential impact of a tsunami is devastating. As the tsunami crosses the deep ocean, its length from crest (top of the wave) to crest may be a hundred miles or more, and its height from crest to trough (bottom of the wave) will only be a few feet or less. They cannot be felt aboard ships nor can they be seen from the air in the open ocean. In the deepest oceans, the waves will reach speeds exceeding 600 miles per hour. When the tsunami enters the shallow water of coastlines in its path, the velocity of its waves diminishes and the wave height increases. It is in these shallow waters that a large tsunami can rapidly rise to heights exceeding 100 feet and strike with overwhelming force.
- D. Depending on the distance from the point of origin and various other factors, a tsunami may only appear as a brief, discrete elevation increase of the water level, noted primarily by tide gauges. Or, on the end of the spectrum is the ‘mega-tsunami,’ which can reach heights of several hundred feet.
- E. A tsunami striking a coastal area is influenced by the tide level at the time of impact, i.e., a high tide will exacerbate inundation effects. Tsunamis are not ‘tidal waves’ since they are the result of earthquakes, and less commonly caused by landslides, volcanic eruptions and, in rare cases, a large meteorite impacting the ocean. Tsunamis are not generated by tides.
- F. The first wave is almost never the largest; successive waves may be spaced tens of minutes apart and continue arriving for many hours. The speed of the tsunami waves increases with the depth of the water. In deep water (greater than 600 feet), tsunamis are rarely over three feet, and will not be noticed by ships due to their long period (time between crests). As tsunamis propagate into shallow water, the wave height can increase by a factor of ten or more. The wave heights vary greatly along the affected coastline and can be amplified by shoreline and bathymetric (sea floor) features. A large tsunami can flood low-lying coastal land over a mile from the coast.

SOUTH CAROLINA TSUNAMI RESPONSE PLAN

APPENDIX 11 ATTACHMENT B

- G. There are three direct factors that determine the destruction from tsunamis: inundation; wave impact on structures; and erosion.
- H. Flooding due to tsunami waves can extend up to one mile inland from the coast.
- Once a tsunami impacts the shoreline, it behaves very much like a flash flood, tearing through large buildings, carrying other buildings away, sweeping automobiles and people away, and battering them with debris that the flood has picked up. Being in front of a tsunami is not much different than being in the path of a dam that has broken - a person can be struck by a wall of water carrying trees, rocks, automobiles, boats, and construction debris. Floating debris, including boats, causes considerable damage. Cars can become dangerous projectiles that may crash into buildings, break power lines, and could start fires. Fires from damaged ships in ports or from ruptured coastal oil storage tanks and refinery facilities can cause greater damage than that inflicted directly by the tsunami.
- I. Access to the coast could be greatly impeded by changed shorelines, washed out roads, debris, and isolated islands created by erosion channels as water runs off the land. Of increasing concern is the potential effect of tsunami draw down, when receding waters uncover cooling water intakes of nuclear power plants.
- J. Survivability for victims caught in a tsunami is quite low. Many victims often are beaten and battered by the debris, and then drown. Those who survive do so by: climbing high enough to avoid the main thrust of the current; being deposited by the wave on higher ground; or by grabbing branches and buildings and pulling themselves from the water. Bystanders have rescued some victims, but this a rare occurrence because of the forces involved and the event.

SOUTH CAROLINA TSUNAMI RESPONSE PLAN

APPENDIX 11 ATTACHMENT C

ATTACHMENT C – Sample Evacuation Order

State of South Carolina

Executive Department



Office of the Governor

EXECUTIVE ORDER NO. _____

WHEREAS, coastline of the State of South Carolina has been placed under a Tsunami Warning by the National Oceanic and Atmospheric Administration (NOAA) West Coast/Alaska Tsunami Warning Center (WC/ATWC). It was estimated that the wave will arrive here at approximately _____; and

WHEREAS, tsunamis—like hurricanes—are potentially dangerous even though they may not strike each coastline or do damage when they strike, the effects of this event have the potential to generate great damage to our State;

WHEREAS, effective at _____ today, I have declared that a State of Emergency exists within the State; and

WHEREAS, I hereby declare that all state and local government agencies perform all emergency functions as assigned in the Emergency Operations Plan or as directed by the Director, South Carolina Emergency Management Division during this State of Emergency.

NOW THEREFORE, by the virtue of the power and authority vested in me as Governor pursuant to the Constitution and the laws of South Carolina, I hereby order a mandatory evacuation of the following areas:

1. _____
2. _____
3. _____
4. _____
5. _____

SOUTH CAROLINA TSUNAMI RESPONSE PLAN

APPENDIX 11 ATTACHMENT C

This mandatory evacuation order is effective at _____ today. The scope of this Order may be expanded to include such areas as are identified on a county-by-county basis by local emergency management officials for people who are deemed to be in immediate danger.

GIVEN UNDER MY HAND AND THE
GREAT SEAL OF THE STATE OF
SOUTH CAROLINA, THIS ____ DAY OF
MONTH, YEAR.

GOVERNOR

ATTEST:

SECRETARY OF STATE

SOUTH CAROLINA TSUNAMI RESPONSE PLAN

APPENDIX 11 ATTACHMENT D

ATTACHMENT D - TSUNAMI CHECKLIST – ADVISORY/WARNING

Tsunami Warning is issued when a potential tsunami with significant widespread inundation is imminent or expected. Warnings alert the public that widespread, dangerous coastal flooding accompanied by powerful currents is possible and may continue for several hours after arrival of the initial wave. Warnings may be updated, adjusted geographically, downgraded, or canceled. To provide the earliest possible alert, initial warnings are normally based only on seismic information.

- _____ Confirm that coastal communities and key agencies have received Tsunami Warning Information
- _____ Determine time remaining to estimated first wave arrival
- _____ Discuss with counties their response actions and their resource needs.
- _____ Review status of communication systems in the evacuation area
- _____ Discuss with counties their decision to evacuate.
- _____ Activate SEOC at OPCON 1
- _____ Review maps of threatened areas to determine locations of critical facilities within or outside of the evacuation zones.
- _____ Discuss with local governments their areas of evacuation.
- _____ Request Executive Order and activate SCEOP
- _____ Obtain information on weather/road condition
- _____ Obtain tourist count in the threatened area
- _____ Request Governor to declare a mandatory evacuation based on local authority to evacuate.
- _____ Coordinate with local governments the need to implement evacuation routes and request local governments to identify assembly points
- _____ Request ESFs to activate response procedures to include:
 - Implement evacuation procedures
 - Coordinate and establish TCPs
 - open shelters
 - stage emergency equipment outside of inundation area
 - repositioning of ships to deeper waters
 - search and rescue missions if necessary
 - lake and/or intercoastal waterways clearings
 - Moving search and rescue equipment to staging area outside risk area
 - Consider securing or closing of:
 - ports
 - boat landings
- _____ Disseminate Executive Order for Evacuation
- _____ Situation dependent, implement Operational Area Concept for response and recovery
- _____ Deploy first responders to assembly sites

SOUTH CAROLINA TSUNAMI RESPONSE PLAN

APPENDIX 11 ATTACHMENT D

- _____ Resource allocation will take into consideration the following areas of special concern:
 - Evacuation of education and childcare facilities and nursing homes
 - Evacuation of disabled persons and those needing special medical assistance
- _____ Activate State's Mutual Aid System as necessary
- _____ Notify adjacent States and FEMA of activation
- _____ Issue Public Information Statements and provide counties of Governor's declaration.
- _____ Monitor evacuations and provide assistance to jurisdictions as required. Advise jurisdictions and agencies that evacuations should be maintained until a minimum of two hours after the last wave has arrived
- _____ Monitor tide gauges via Weather Alert system
- _____ Relay to the counties and agencies the course of actions of the State

UPDATE JURISDICTIONS AT 30 MINUTE INTERVALS OR IMMEDIATELY UPON RECEIPT OF TIME SENSITIVE INFORMATION

SOUTH CAROLINA TSUNAMI RESPONSE PLAN

APPENDIX 11 ATTACHMENT E

ATTACHMENT E –TSUNAMI CHECKLIST - WATCH

A **Tsunami Watch** is issued to alert emergency management officials and the public of an event which may later impact the watch area. The watch area may be upgraded to a warning or advisory - or canceled - based on updated information and analysis.

- _____ Confirm with counties receipt of Watch message.
- _____ Discuss with counties their response actions and their resource needs.
- _____ Discuss with counties their decision to evacuate.
- _____ Assemble available information on status of the Tsunami Watch. Sources of information:
 - Local NWS Forecast Office
 - WC/ATWC
 - College of Charleston, SCEEP
 - FEMA, NOAA
- _____ Activate SEOC at OPCON 3
- _____ Facilitate a conference call with the primary ESF agencies: 1, 2, 6, 8, 9, 10, 13, 16, and 19 to discuss local actions and to be prepared to report to SEOC for possible activation.
- _____ Review maps of threatened areas to determine locations of critical facilities within or outside of the evacuation zones.
- _____ Request NWS offices to monitor tide gauges to determine the potential
- _____ Determine time remaining to estimated first wave arrival
- _____ Activate ESF-15 and issue public information statements on the Tsunami Watch and state's actions
- _____ Review status of communication systems in the evacuation area
- _____ In the event, prepare Executive Order for Evacuation.
- _____ Obtain information on weather/road condition
- _____ Obtain tourist count in the threatened area
- _____ Coordinate with local governments the evacuation routes and request local governments to identify assembly points if needed
- _____ Coordinate with ESF-6 to identify shelters and the need to place on standby notice
- _____ Consider if no action is needed until a Tsunami Warning is issued.
- _____ If not, consider:
 - Moving search and rescue equipment to staging area outside risk area
 - Determining if a voluntary evacuation of tourists is needed
 - Determine if critical facilities need evacuation assistance.
 - Consider securing or closing of:
 - ports
 - boat landings
- _____ Discuss state response actions with NWS offices, local county officials, adjacent states, and EFSSs.

SOUTH CAROLINA TSUNAMI RESPONSE PLAN

APPENDIX 11 ATTACHMENT E

- **UPDATE JURISDICTIONS AT 30 MINUTE INTERVALS OR IMMEDIATELY UPON RECEIPT OF TIME SENSITIVE INFORMATION**

SOUTH CAROLINA TSUNAMI RESPONSE PLAN

APPENDIX 11 ATTACHMENT F

ATTACHMENT F -TSUNAMI CHECKLIST - ALL CLEAR

All Clear determination will be the responsibility of the local officials. The evacuation areas should remain closed to the public until the evacuation order has been lifted and the ALL CLEAR decision is issued by local officials a minimum of two hours after arrival of last wave. Before the ALL CLEAR determination is made, officials must be able to observe the waves from a safe distance/height.

- _____ Advise jurisdictions to maintain full evacuation until the evacuation order being rescinded and a minimum of two hours after arrival of last wave a upon. Additional waves may occur.
- _____ Evacuated areas should remain closed to the public until after the threat of tsunami no longer exists
- _____ The decision to allow re-entry is a local decision and will be made based on the advice of consensus of the NWS Forecast Office and State authorities
- _____ All traffic control points will be maintained until the order to remove traffic control points is issued
- _____ Residents should enter through control points to ensure that safety and sanitary precautions are provided
- _____ Request jurisdictions initiate windshield damage assessment. Compile area wide
- _____ Activate State's Damage Assessment Team to assist local jurisdictions
- _____ Request aerial reconnaissance of damaged areas
- _____ Prepare for major PIO effort to disseminate information to public about event
- _____ Request Department of Health and Environmental Control to inspect damaged areas to ensure they are safe for residents
- _____ Request building inspectors to inspect damaged areas
- _____ Based on damage, consider a Governor's and Presidential Declaration of Emergency
- _____ Establish response priorities and mutual aid requirements
- _____ Based on the damage incurred, the following actions and issues may be considered:
 - Curfew
 - Quarantine (both human and animal)

SOUTH CAROLINA TSUNAMI RESPONSE PLAN

APPENDIX 11 ATTACHMENT F

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SOUTH CAROLINA TSUNAMI RESPONSE PLAN

APPENDIX 11 ATTACHMENT G

**ATTACHMENT G - THIS MESSAGE IS FOR TEST PURPOSES TO SHOW AN
EXAMPLE EAS MESSAGE FOR TSUNAMI**

Bulletin

Public tsunami message number 1

NWS West Coast/Alaska Tsunami Warning Center Palmer AK

...a test tsunami warning is in effect which includes the (*states/coastal areas in the threatened areas*)

A tsunami warning means... All coastal residents in the warning area who are near the beach or in low-lying regions should move immediately inland to higher ground and away from all harbors and inlets including those sheltered directly from the sea. Those feeling the earth shake... Seeing unusual wave action... Or the water level rising or receding may have only a few minutes before the tsunami arrival and should evacuate immediately. Homes and small buildings are not designed to withstand tsunami impacts. Do not stay in these structures.

All residents within the warned area should be alert for instructions broadcast from their local civil authorities. This tsunami warning is based solely on earthquake information – the tsunami has not yet been confirmed.

At _____ eastern daylight time on _____ an earthquake with preliminary magnitude _____ occurred _____. This earthquake may have generated a tsunami. If a tsunami has been generated the waves will first reach _____ at am/pm EST on _____. Estimated tsunami arrival times and maps along with safety rules. And other information can be found on the web site wcatwc.arh.noaa.gov.

Tsunamis can be dangerous waves that are not survivable. Wave heights are amplified by irregular shoreline and are difficult to predict. Tsunamis often appear as a strong surge and may be preceded by a receding water level. Mariners in water deeper than 600 feet should not be affected by a tsunami. Wave heights will increase rapidly as water shallows. Tsunamis are a series of ocean waves which can be dangerous for several hours after the initial wave arrival. Do not return to evacuated areas until an all clear is given by local civil authorities.

Additional messages will be issued every half hour or sooner if conditions warrant. This tsunami warning and watch will remain in effect until further notice. For further information stay tuned to NOAA All Hazards Weather Radio... Your local TV or radio stations... Or see the web site wcatwc.arh.noaa.gov.

SOUTH CAROLINA TSUNAMI RESPONSE PLAN

APPENDIX 11 ATTACHMENT G

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SOUTH CAROLINA TSUNAMI RESPONSE PLAN

APPENDIX 11 ATTACHMENT H

ATTACHMENT H – *SAMPLE NEWS RELEASE*

NEWS RELEASE

For Immediate Release
South Carolina Emergency Management Division
2779 Fish Hatchery Road, West Columbia, SC 29172

FOR FURTHER INFORMATION CONTACT STATE PIO:

Telephone Number: _____ Fax: _____

Date: _____

S.C. NEWS RELEASE NO. _____

Time of news release: _____

POTENTIAL TSUNAMI FOR FOLLOWING SC COASTAL AREA:

_____, _____, _____, _____

COLUMBIA, S.C. – According to the (West Coast/Alaska-Pacific) Tsunami Warning Center, a severe earthquake has been generated at (location) at (time). The earthquake was measured at (Magnitude. It is (known/not known) at this time (that/if) a tsunami has been generated. However, the SC National Weather Service Forecast Offices have issued a Tsunami (Warning, Watch, Advisory, Information Statement). A Tsunami (Warning, Watch, Advisory, or Information Statement) means...

If a tsunami has, in fact, been generated, the wave heights cannot be accurately predicted; however, the tsunami waves could cause great damage to coastal cities and communities.

Residents of affected areas are urged to keep tuned to your local Emergency Alert System station (_____) for further information. People should stay away from low lying coastal areas until further notice. A tsunami is a series of waves and may be dangerous for several hours after the initial wave arrives at any particular point.

-END-

SOUTH CAROLINA TSUNAMI RESPONSE PLAN

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SOUTH CAROLINA TSUNAMI RESPONSE PLAN

APPENDIX 11 ATTACHMENT I

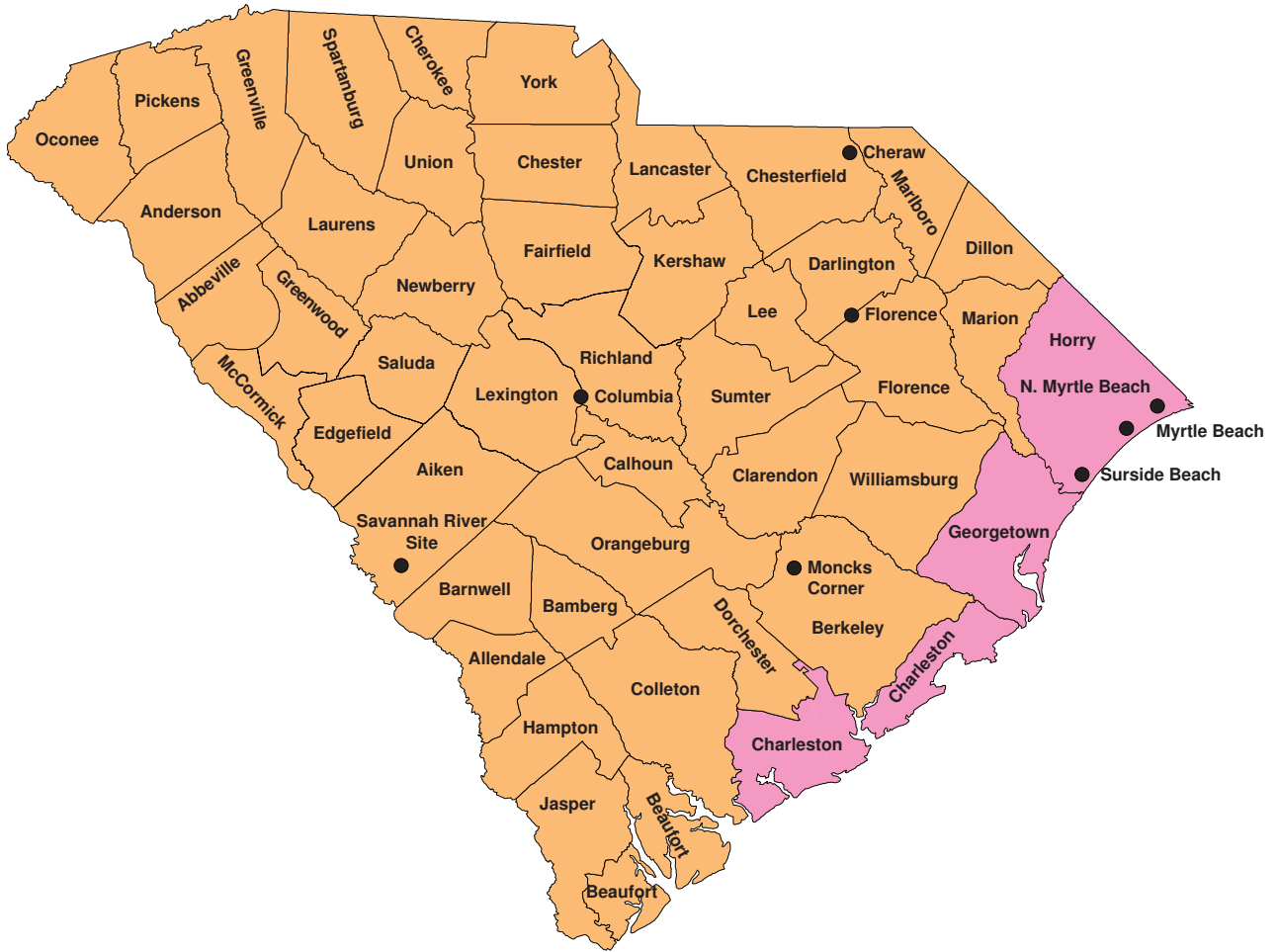
SC Tsunami Ready Counties and Communities

Counties

Charleston
Georgetown
Horry

Communities

Myrtle Beach
N. Myrtle Beach
Surfside Beach



SOUTH CAROLINA TSUNAMI RESPONSE PLAN

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