Guidance for Local Jurisdictions to Develop or Review Tsunami Evacuation Plans for a Post-Earthquake, Local-Source Tsunami

Purpose: This document provides local jurisdictions with guidance for assessing hazards after a large local earthquake that could inhibit safe evacuation from tsunami hazard areas.

Background: California's coastal region has many large active faults and unstable submarine slopes capable of producing destructive tsunamis. Examples where local earthquakes generated tsunamis in California include:

- January 26, 1700 - A magnitude 9 earthquake along California's north coast generated a major tsunami locally.
- December 21, 1812 - A local earthquake triggered a tsunami near Santa Barbara that so alarmed people in coastal villages that they retreated several miles inland closer to the Santa Barbara Mission.
- November 4, 1927 - A magnitude 7.1 earthquake off the coast of northern Santa Barbara County caused a six-foot-high tsunami along portions of the central coast.

For anyone in tsunami evacuation zones, strong ground shaking from an earthquake is the natural warning that a tsunami might be coming. People on the beach or in harbor areas should evacuate for any felt earthquake and, if strong shaking lasts for 20 seconds or more, all people within evacuation areas should move inland or to higher ground. However, strong earthquake shaking can also cause additional hazards, such as landslides or downed power lines, which can inhibit or prevent safe evacuation. Without analysis to identify these potential hazards along evacuation routes, evacuees might be routed through areas where they could become injured while moving away from potential tsunami inundation areas.

The state tsunami program provides assistance to jurisdictions that request help preparing or reviewing evacuation plans to address local-source tsunamis. However, for local jurisdictions that would like to evaluate these potential evacuation hazards using their own resources, the following step-by-step guidance is provided:

Step 1: Determine the areas vulnerable to tsunami hazards from all potential local tsunami sources. The state tsunami program has evaluated potential tsunami sources through their statewide inundation mapping project, which covers almost all populated, low-lying coastal areas in California (www.tsunami.ca.gov). Local jurisdictions have used this information and other data to compile evacuation zones. Although they address the combined tsunami hazard from both local and distant sources, these evacuation zones are the best starting point for this evaluation of potential evacuation hazards during a local earthquake. Consult the state program if you would like more detailed information about the local tsunami sources affecting your jurisdiction.

Step 2: Select a team representing local emergency planners and responders, and local/regional earthquake and tsunami experts to identify local, collateral earthquake hazards. In addition to the group typically selected for evacuation plan preparation (primarily emergency managers), engineers, geologists, and Geographic Information Systems (GIS) personnel from the jurisdictions at risk should be consulted to determine what additional hazards exist and where they are located. Regional earthquake alliance or tsunami work groups will also have the needed breadth and expertise to oversee such efforts. This group should work with the state tsunami program in the hazard identification effort.

Step 3: **Using a GIS platform, identify and map out potential collateral hazards and obstacles, and consider any special needs of the communities in the tsunami hazard areas.** First determine if previous earthquake scenarios have been developed for the area, including HAZUS assessments. For areas with significant coastal hazards, detailed analyses to determine the severity of those hazards may be required. The first focus should be on areas of potential isolation. The following variables should be considered during the evaluation:

- **Areas of isolation:** islands, peninsulas, cliffs, and other natural/man-made areas of isolation.
- **Geologic hazards:** ground shaking intensity, liquefaction, lateral spreading, subsidence, landslides, fault rupture, and other types of ground failure hazards.
- **Utility hazards:** above ground power lines/poles/towers (pictured right), buried gas/oil pipelines, buried electric lines, electrical boxes and structures, and other utilities.
- **Man-made obstacles:** fences, locked/electronic gates, walls, buildings, bridges, overpasses, berms, vegetation, and other structures.
- **Population at risk:** number of people, age and mobility, and other factors affecting the personal egress of the population.

Step 4: **Visit each location identified as having potential collateral hazards during evacuation.** Determine the impact and severity of potential hazards on evacuation in each area, including the combined effects from multiple hazards (for example: fires sparked by downed power lines over disrupted, leaking gas pipelines). Evacuation should always be ON FOOT. Identify pedestrian paths of egress with the fewest hazards and walk those routes to determine if evacuation can be safely done within 10 minutes, the time it typically takes a tsunami from a local source to arrive on shore. Without obstacles, the average person should be able to walk approximately 2000 feet (600 meters) in 10 minutes, a rate of about three feet (one meter) per second. If obstacles exist or the evacuees have mobility problems, the distance they can travel will be less. If certain man-made hazards or obstacles cannot be overcome, address these issues with the land/utility owners and the resident evacuees. Vertical evacuation options should be considered in this case (for more information, see FEMA document P646, "Vertical Evacuation from Tsunamis: A Guide for Community Officials" http://www.fema.gov/library/viewRecord.do?id=3808). This is also a good opportunity to identify locations to place tsunami hazard signs; make sure signs represent evacuation for both local and distant tsunami events (visit http://www.dot.ca.gov/hq/traffops/signtech/signdel/tsunami.htm for sign specifications).

Step 5: **Develop evacuation plans based on the pathways with the fewest hazards and obstacles.** Consider using a GIS for digital representation of evacuation plans that can be overlain on different base maps, and can be readily updated as needed. Discuss potential utility and obstacle (fence/locked gate) hazard issues with utility/property owners and determine if evacuation problems can be mitigated. Some areas may have no reasonable evacuation solution; discuss what messaging to use for those areas. Consult with representatives from adjacent jurisdictions to develop consistent evacuation plans across jurisdictional boundaries.

Step 6: **Share evacuation plans with communities at risk.** Present the results of the evacuation plan at public meetings in each community. Educate the communities about both earthquake and tsunami hazards that might impact them. Recommend that the communities practice their evacuation plans through drills, perhaps during "Tsunami Awareness Week" (held in March each year). Discuss possible sign placement options with the community leaders to get their assistance and input. Gather feedback from the communities.

Step 7: **Make adjustments to the evacuation plans as needed.** Review the tsunami evacuation plan every several years in case significant changes occur to the community population or evacuation pathways. Integrate community inputs as needed. The state can help provide localized public outreach materials.