REPORT OF THE EXECUTIVE OFFICER
State Allocation Board Meeting, July 22, 2009

# THE COMPLEX AND MULTIFACETED NATURE OF SCHOOL CONSTRUCTION COSTS: FACTORS AFFECTING CALIFORNIA

## PURPOSE OF REPORT

To present a report prepared by University of California – Berkeley that addresses research findings of school construction costs and factors that affect California.

An electronic copy of this report is available on the OPSC website at: www.opsc.dgs.ca.gov.

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# STATUS OF EARTHQUAKE EARLY WARNING IN CALIFORNIA

## PURPOSE OF REPORT

To present, by Division of the State Architect (DSA), a report that provides an update and status of earthquake early warning in California.

## BACKGROUND

At the April 2009 State Allocation Board meeting, the Board requested that the DSA provide an update on the status of earthquake early warning in California.

## DESCRIPTION

The DSA requested the Seismic Safety Commission to look into this issue and provide some background material for the Board. In addressing this issue, the DSA focused on the world's most advanced warning system currently operating in Japan in order to allow discussion of a proposed federally supported early warning system for California. Additionally, the report includes a brief section that covers current private sector early warning efforts in California.

State of California
Alfred E. Alquist Seismic Safety Commission

# Memo

To: Commissioner David Thorman
State Architect

From: Richard McCarthy
Executive Director
Alfred E. Alquist Seismic Safety Commission
1755 Creekside Oaks Drive, Suite 100
Sacramento, CA 95833
(916) 263-5506 x 230

Date: June 15, 2009

Subject: Status of Earthquake Early Warning in California

**Background:**

At its April meeting, the State Allocation Board (Board) requested the Division of the State Architect to provide it with an update on the status of earthquake early warning in California. The State Architect requested the Seismic Safety Commission to look into this issue and provide some background material for the Board. To best address this question, I will focus on the world's most advanced warning system currently operating in Japan, and then discuss the status of a proposed federally supported early warning system for California. I will also briefly cover private sector early warning efforts in California to date.

Dr. Richard Allen from the U.C. Berkeley Seismological Laboratory and Dr. Egill Hauksson from the California Institute of Technology recently attended a conference in Kobe, Japan. The purpose of this conference was to demonstrate how the Japanese Earthquake Early Warning System operates and how the warnings are transmitted to the public. They are also familiar with the California Integrated Seismic Network (Network). I have included their input on these two subjects into this memo.

**The Early Warning Concept**

Earthquake early warning is based on the fact that all earthquakes produce a series of different types of shock waves, which travel at different speeds and carry different amounts of energy. The fastest wave and the first to arrive are called "Primary" (or P waves). These travel about twice as fast as the next fastest wave and rarely cause any damage. The next wave to arrive are called "Shear" waves (or S waves) followed by Love and Rayleigh waves, which cause most of the damage from earthquakes.

Since the P waves arrive first, they can provide an advance notice of the heavy shaking to follow. The warning time is about 1 second for every 5 miles of distance to the hypocenter of the earthquake. This amount of warning can give automated systems plenty of time to respond and, depending on the distance to the hypocenter, enough time for people to react.

## Earthquake Early Warning Outside the United States

Various government supported early warning systems have been deployed in foreign countries. These countries include: Japan, Mexico, Turkey, Taiwan, and Romania. Countries now developing some form of early warning system include Iceland, Switzerland, Italy, Greece, Egypt and India. No country or even statewide early warning system exists in the United States. California is considering developing a federal/state sponsored early warning system that would make use of its existing seismic monitoring networks. Commercial (private industry developed) stand alone early warning locations have been established at locations throughout the state.

The most advanced earthquake early warning system deployed to date is located in Japan. Today, every citizen in Japan can receive an advanced alert of earthquake ground shaking from the Japan Meteorological Agency. A network of 1000 seismic instruments rapidly detects earthquakes and predicts the intensity of ground shaking that will result. Alerts are transmitted via the internet, satellite, and the wireless networks to cell phone users, to desktop computers, and to automated control systems that stop trains, place sensitive equipment in a safe mode and isolate hazards while the public takes cover. Warning times range from seconds to tens of seconds. Not everyone gets a warning for all earthquakes, but many people get warnings for most earthquakes.

Attachments A, B, C and D are examples of how the Japanese government explains the operational aspects of the earthquake early warning system and what to do when a warning is issued to their citizens.

Implementation of the publically operated system in Japan has led to rapid growth of private enterprise providing enhancements to the system for specific users. These include consulting firms advising on effective use of the information, companies selling devices to receive the alert and warn the public, and companies developing systems to both transmit the public warning and enhance it by making the warning faster and more accurate. The investment in the public Network will therefore also stimulate the private sector and provide yet more jobs while improving public safety.

## Status of Earthquake Early Warning in California

In 2001 state, federal, and university partners came together to form the Network to provide statewide coordinated real-time earthquake information. The Network has become a very successful collaboration of public and private institutions that leverages financial support from multiple sources to operate seismic networks across the State (www.CISN.org). These include Caltech, UC Berkeley, CalEMA, the California Geological Survey (CGS) and the US Geological Survey (USGS). In addition, more than 15 other entities contribute data to the network. The Network currently operates more than 381 real-time seismic stations throughout the State (Attachment E).

For decades, the Network and its predecessors have harnessed the intellectual capital of seismologists and engineers across the State to provide a real-time earthquake information system including rapid earthquake locations, magnitudes and maps showing the distribution of ground shaking ("ShakeMaps"). In addition, the Network provides all data to the research community, stimulating development of new earthquake information products, including earthquake early warning, as well as providing for state-of-the-art understanding of the impacts of earthquakes and predictability of earthquakes.

With appropriate additional funding, the State will have a state-of-the-art public earthquake early warning information system that will include the complete range of time sensitive products:

(1) Earthquake Early Warning alerts for users, who will protect themselves just before onset of strong shaking
(2) Accurate earthquake notifications, including location and magnitude, to alert emergency responders
(3) Maps of measured ground shaking (ShakeMap), for impact assessment, response, and State/Federal resource needs
(4) Configuration of the fault that broke in the earthquake, to identify the fault that caused the quake
(5) Notifications of aftershocks and likelihood of major damaging aftershocks, to aid in the response and recovery effort
(6) Forecasts of significant ground motions in the next 24 hours, to protect search and rescue crews
(7) Long-term seismicity monitoring and notification, to assess the long term earthquake hazard
(8) Accurate measurements of ground shaking for both earthquake engineering and seismological research, to facilitate more cost-effective engineering, and studies of earthquake effects and predictability

Over the last three years methodologies for providing earthquake early warning have been tested by the Network. They have successfully detected earthquakes and predicted the ground-shaking intensity before it was felt. Leveraging federal support through the USGS, the Network is now poised to add an earthquake early warning component to its capabilities. This component will serve the safety and mitigation needs of the proposed high-speed rail system and help improve safety in schools, hospitals as well as multiple other communities statewide.

Typically, warning times will be a few to a few tens of seconds prior to peak ground shaking. While likely to be "worst-case" scenarios in their effects on major metropolitan areas, the “best-case” earthquakes for a warning in California are a southward rupture on the northern San Andreas fault initiating near the Mendocino Triple Junction and propagating through the San Francisco Bay Area, or a northward propagating rupture on the southern San Andreas initiating near the Salton Trough and propagating past the Los Angeles Metropolitan Region. These scenarios represent two of the most damaging earthquakes due to size and directivity towards metropolitan areas. In each of these cases warnings of up to one minute might be available before shaking starts in the metropolitan areas. Warning times will always be a minimum at the epicenter and increase with distance from the epicenter. As a matter of principle, warning systems that use networks of instruments will have a “blind-zone” around the epicenter where no warning is available after peak shaking has occurred. The single station detection and alert approach, referred to as the “on-site” method, can achieve a significant reduction of the blind zone radius

Private sector companies have developed and deployed stand alone or “on site” earthquake early warning instruments in California for as long as ten years... These instruments have been utilized by users/clients and are designed to meet a specific need (shut down or activate equipment, provide an audible alert) at a specific location. Some examples of California users who have already deployed or are in the process of installing private sector early warning technology include:

Fire Stations
A Hospital
Two Private Schools
A National Laboratory
Worldwide Headquarters of a Major Corporation
A Local Government
A Transit Agency
A Regional Airport Authority

**Earthquake Early Warning Legislation in California**

AB 928 (Blakeslee) is a two year bill that would require the High-Speed Rail Authority to develop an earthquake early warning system and coordinate development of that system with the California Emergency Management Agency, the Department of Education, and the Public Utilities Commission. The bill would require the earthquake early warning system to be designed to protect the lives of high-speed train passengers and schoolchildren, and protect critical infrastructure in this state by providing advanced earthquake warning and by enabling recipients time to take preventive measure seconds before strong earthquake shaking arrives.

Due to the State's current fiscal crisis, this bill will most likely be reconsidered next January.

**Earthquake Early Warning and the American Recovery and Reinvestment Act of 2009**

The Seismic Safety Commission staff has been working with the representatives of Network and the Governor's California Federal Economic Stimulus Task Force members to develop a draft concept proposal to apply for federal stimulus funds to develop an Earthquake Early Warning System for California. A partnership consisting of federal and state government, California universities, and private industry would use the stimulus dollars to develop a "state of the art" warning system and create many jobs in the private sector. The Japanese early warning model has already demonstrated its value by improving public safety and stimulating the private sector by creating much needed small business jobs throughout the entire country.

California has already invested millions of dollars in the development and maintenance of CISN. The time is right to leverage these dollars to gain federal support to develop a "state of the art" Earthquake Early Warning System that will reduce the earthquake risk to the people and property for all those who live in California.

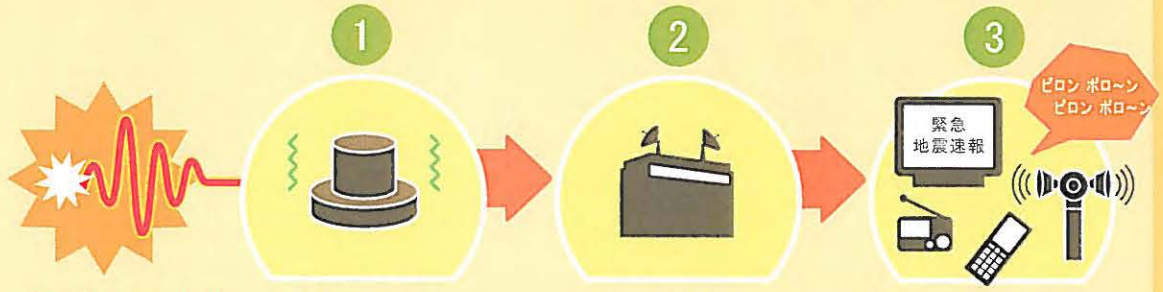
Attachment A

# Earthquake Early Warnings

"緊急地震速報 (Kinkyu Jishin Sokuhou)" in Japanese

**Forecasts of strong ground motion caused by earthquakes**

## Flow of an Earthquake Early Warning




**Earthquake!**

**Seismometer**
Detection of primary seismic wave by a seismometer

**JMA**
Issuance of EEW by JMA

**TV,radio,etc**
Provision to the public through broadcast media

Please note that strong tremors may arrive at the same time as the Earthquake Early Warning in areas that are close to the focus of the earthquake.

Ministry of Land, Infrastructure, Transport and Tourism

**Japan Meteorological Agency**

Attachment B

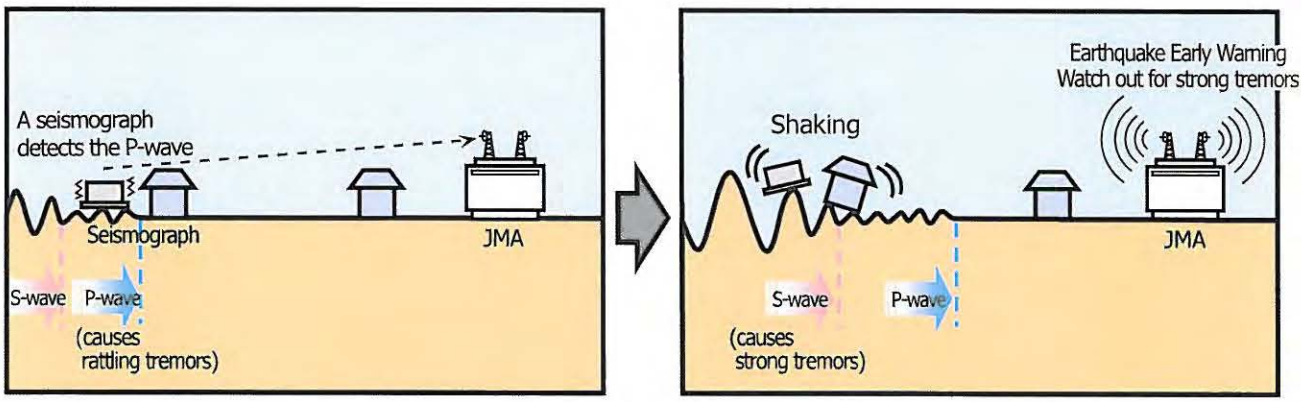
# Earthquake Early Warning

## or "緊急地震速報 (Kinkyu Jishin Sokuho)" in Japanese

## A New Advance Earthquake Alert

# Starting 1 October 2007

As of 1 October 2007, the Japan Meteorological Agency (JMA) will start the Earthquake Early Warning, a new service that advises of strong tremors before they arrive.



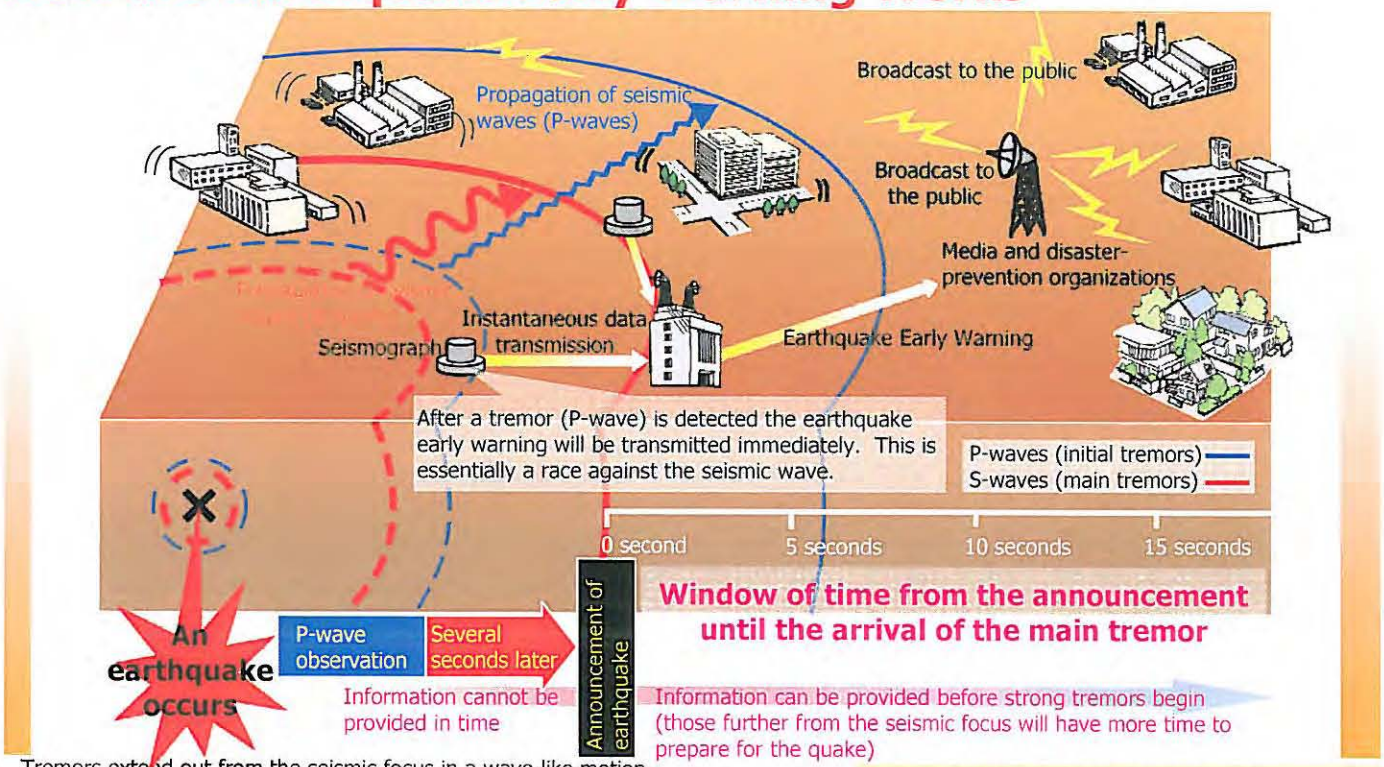

- The Earthquake Early Warning system automatically calculates the focus and magnitude of the earthquake and estimates the seismic intensity for each location by detecting the quake (i.e. the P-wave, or the preliminary tremor) near its focus. An Earthquake Early Warning is then given a matter of seconds (i.e. a few seconds to a few tens of seconds) before the arrival of strong tremors (i.e. the S-wave, or principal motion).
- Earthquake Early Warnings will be provided through various media outlets such as TV and radio.
- Please note that strong tremors may arrive at the same time as the Earthquake Early Warning in areas that are close to the focus of the earthquake.

2007
Japan Meteorological Agency
Ministry of Land, Infrastructure and Transport

# Earthquake Early Warning: How can an earthquake alert be announced before tremors are felt?

Attachment C

## How the Earthquake Early Warning Works




Tremors extend out from the seismic focus in a wave-like motion.

There are two main types of seismic waves: P-waves, or initial tremors, and S-wave, or main tremors.

P-waves are the first to travel outward. They are followed by S-waves, which cause stronger tremors. Most earthquake-induced damage results from these S-waves.

--- Traveling speed of seismic waves ---
P-waves (cause rattling tremors): around 7km/s
S-waves (cause larger, more powerful tremors): around 4km/s

The purpose of the earthquake early warning is to quickly announce to the public that an earthquake has occurred and to inform them of the estimated seismic intensity several seconds or more before the arrival of strong tremors caused by the quake. In those areas close to the focus of the earthquake, however, the earthquake early warning may not be transmitted before the tremors hit.

Hundreds of seismographs are installed in locations all around Japan, with the Japan Meteorological Agency maintaining around 200 of the devices and the National Research Institute for Earth Science and Disaster Prevention some 800. Using theses devices, the location and size of an earthquake can be estimated immediately, followed by an approximation of the extent of the tremors (seismic intensity) expected to result from the quake.

Prompt warnings delivered using the latest information technology (Earthquake Early Warning)

## How to Use the Information

In order to make effective use of the earthquake early warning, it is important to hold emergency response training so that you can take appropriate action as soon as you receive the warning.

--- Examples of appropriate actions ---
Most important of all is to remain calm and not panic.
- If inside a home, move away from large appliances or pieces of furniture that could fall over and take cover under a sturdy table or other object that provides similar protection.
- When in other types of buildings, do not panic and do not rush for the exit or stairs.

Earthquake early warning
Strong tremors are coming!
(Tremor forecast)

The Japan Meteorological Agency is currently preparing to start the earthquake early warning system in order to warn the public as widely and as quickly as possible. The agency is also developing a planned course of action when people receive an alert in the variety of situation.

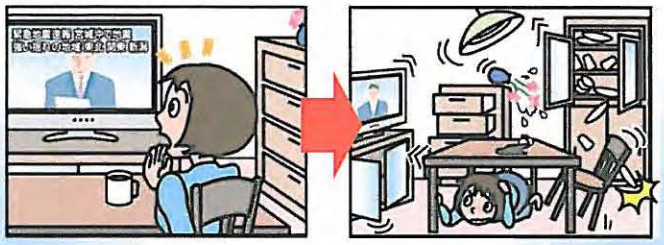
Take cover!

For more information about the earthquake early warning system, please contact the Administration Division of the Japan Meteorological Agency's Seismological and Volcanological Department or visit the agency's website.


Administration Division, Seismological and Volcanological Department
Japan Meteorological Agency
1-3-4 Otemachi, Chiyoda-ku, Tokyo 100-8122
Phone: (03) 3212-8341
Website: http://www.jma.go.jp/jma/indexe.html

## At Home

- Protect your head and shelter under a table
- Don't rush outside
- Don't worry about turning off the gas in the kitchen



## In Public Buildings

- Follow the attendant's instructions
- Remain calm
- Don't rush to the exit

Attachment D

# Earthquake Early Warning: Dos & Don'ts

## When Driving

- Don't slow down suddenly
- Turn on your hazard lights to alert other drivers, then slow down smoothly
- If you are still moving when you feel the earthquake, pull safely over to the left and stop

**Remain calm, and secure your personal safety based on your surroundings!**

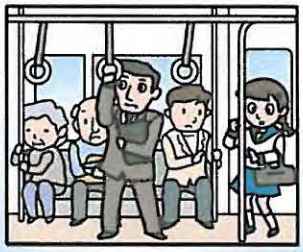
After seeing or hearing an Earthquake Early Warning, you have only a matter of seconds before strong tremors arrive. This means you need to act quickly to protect yourself.

## Outdoors

- Look out for collapsing concrete-block walls
- Be careful of falling signs and broken glass
- Take shelter in a sturdy building if there is one close enough

## On Buses or Trains

Hold on tight to a strap or a handrail

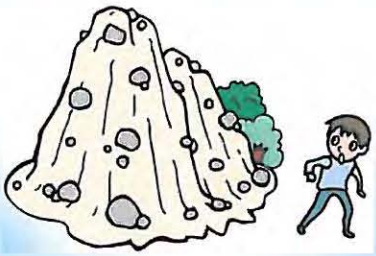


## In Elevators

Stop the elevator at the nearest floor and get off immediately

## Near Mountains/Cliffs

Watch out for rockfalls and landslides



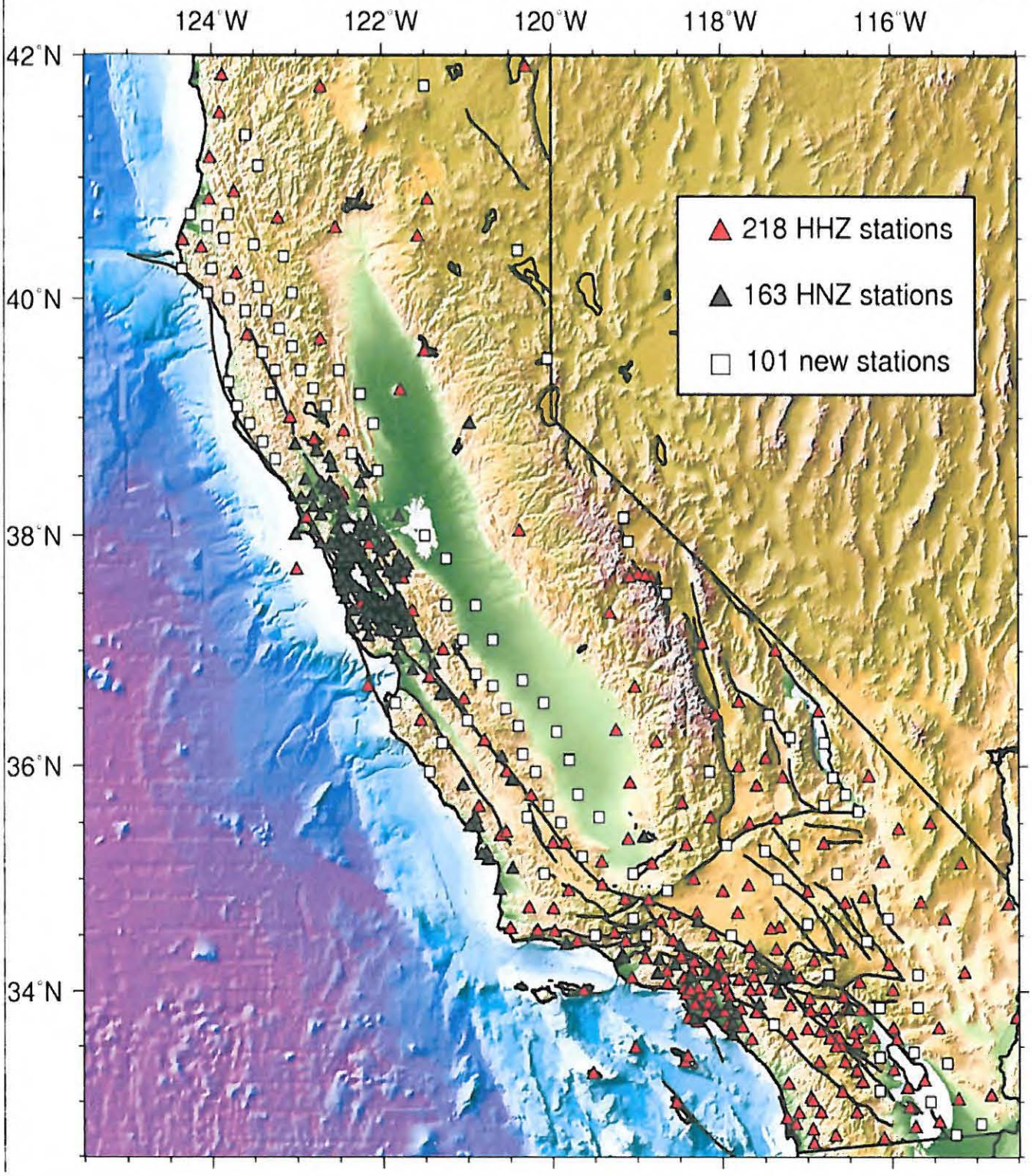
For more information about the Earthquake Early Warning system, please contact the following department or visit the agency's website.

Administration Division, Seismological and Volcanological Department
Japan Meteorological Agency
Address: 1-3-4 Otemachi, Chiyoda-ku, Tokyo 100-8122
Phone: 03-3212-8341
Website: http://www.jma.go.jp/jma/indexe.html

The Earthquake Early Warning system has been made possible through joint technological development by the Japan Meteorological Agency and the Railway Technical Research Institute, as well as through achievements in technological development by the National Research Institute for Earth Science and Disaster Prevention.

# Earthquake Early Warning in California

Attachment E




*Map showing topography, active faults, existing stations (red and black triangles) and the new proposed stations (white squares). The red triangles are more capable seismic stations.*

REPORT OF THE EXECUTIVE OFFICER
State Allocation Board Meeting, July 22, 2009

## STATUS OF EMERGENCY REPAIR PROGRAM FUNDING

### PURPOSE OF REPORT

To update the Board on the status of the Emergency Repair Program (ERP).

### BACKGROUND

The ERP, implemented under settlement legislation in the case *Williams vs. California,* is set up to provide up to $800 million to cover 100 percent of project costs for Local Educational Agencies (LEA) to address facility related emergency health and safety conditions at eligible schools. Chaptered legislation altered the program to allow school districts to receive advance funding to undertake repairs in addition to receiving reimbursement for completed repairs. This change resulted in a dramatic influx of funding requests beginning in the fall of 2007.

### AUTHORITY

Education Code Section 17592.73 states:

(a) There is hereby established in the State Treasury the School Facilities Emergency Repair Account. The State Allocation Board shall administer the account.
(b) (1) Commencing with the 2005-06 fiscal year, an amount of moneys shall be transferred in the annual Budget Act from the Proposition 98 Reversion Account to the School Facilities Emergency Repair Account, equaling 50 percent of the unappropriated balance of the Proposition 98 Reversion Account or one hundred million dollars ($100,000,000), whichever amount is greater. Moneys transferred pursuant to this subdivision shall be used for the purpose of addressing emergency facilities needs pursuant to Section 17592.72.
(2) Notwithstanding paragraph (1), for the 2008-09 fiscal year, the amount of money to be transferred from the Proposition 98 Reversion Account to the School Facilities Emergency Repair Account pursuant to paragraph (1) shall not exceed one hundred one million dollars ($101,000,000).
(3) Notwithstanding paragraph (1), for the 2009-10 fiscal year, the amount of money to be transferred from the Proposition 98 Reversion Account to the School Facilities Emergency Repair Account pursuant to paragraph (1) shall be zero.
(c) The Legislature may transfer to the School Facilities Emergency Repair Account other one-time Proposition 98 funds, except funds specified pursuant to Section 41207. Donations by private entities shall be deposited in the account and, for tax purposes, be treated as otherwise provided by law.
(d) Funds shall be transferred pursuant to this section until a total of eight hundred million dollars ($800,000,000) has been disbursed from the School Facilities Emergency Repair Account.

### STAFF COMMENTS

To date, the program has received $338 million – including $50 million in 2008-09 fiscal year – of which $317.5 million has been allocated to eligible projects. An additional $51 million from the 2008-09 fiscal year appropriation, once available through the Proposition 98 Reversion Account, will be provided. This will bring the funding level to nearly half of the $800 million committed to the program through the *Williams* settlement legislation.

The OPSC will continue processing applications and present to the SAB for apportionment (or unfunded approval, when funds are not available) until $800 million is provided to eligible applications. The table below summarizes the current status of the ERP participation and funding.

| | Number of School Sites | Number of Applications | Value of Applications |
|---|---|---|---|
| Projects funded as of June 24, 2009 | 1,058 | 6,061 | $317.5 million |
| OPSC workload list volume | 951 | 2,365 | $776.1 million |
| Estimated demand over $800 million | 675 | 1,033 | $294.7 million |