

NIST GCR 14-917-29



A Framework to Update the Plan to Coordinate NEHRP Post-Earthquake Investigations

NEHRP Consultants Joint Venture
*A partnership of the Applied Technology Council and the
Consortium of Universities for Research in Earthquake Engineering*



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National Institute of
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U.S. Department of Commerce

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Cover image – Damage in the San Francisco Marina district after the 1989 Loma Prieta earthquake (courtesy of J.K. Nakata, U.S. Geological Survey).

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Prepared for
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National Institute of Standards and Technology
Engineering Laboratory
Gaithersburg, MD 20899*

By
NEHRP Consultants Joint Venture
*A partnership of the Applied Technology Council and the
Consortium of Universities for Research in Earthquake Engineering*

November 2013



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Preface

Four agencies are included in the National Earthquake Hazards Reduction Program (NEHRP): the Federal Emergency Management Agency (FEMA), the National Institute of Standards and Technology (NIST), the National Science Foundation (NSF), and the U.S. Geological Survey (USGS). The agencies have complementary but unique roles in NEHRP that extend to their activities in performing field investigations following earthquakes. In 2002, with support from NSF, the Earthquake Engineering Research Institute (EERI) conducted a workshop that examined many of the key post-earthquake investigation issues relevant to NEHRP. The result was the publication of USGS Circular 1242, *The Plan to Coordinate NEHRP Post-Earthquake Investigations* (USGS, 2003), which outlines interactions that were envisioned for the NEHRP agencies to employ in investigating earthquakes.

In 2007, the National Institute of Standards and Technology (NIST) awarded a National Earthquake Hazards Reduction Program (NEHRP) “Earthquake Structural and Engineering Research” contract (SB1341-07-CQ-0019) to the NEHRP Consultants Joint Venture, a partnership between the Applied Technology Council (ATC) and the Consortium of Universities for Research in Earthquake Engineering (CUREE), to conduct a variety of tasks, including Task Order 12-478 entitled, “Development of Updated NEHRP Post-Earthquake Investigations Strategy: Phase I.” The objective of this project was to develop a framework that could be used to update the plan to coordinate NEHRP post-earthquake investigations, currently presented in USGS Circular 1242. The result is a series of issues, documented in this report, ranging from how and when the plan should be updated to the content and detail of specific elements that should be included in the plan. The issues, along with their recommended solutions, form a framework that may be used in the development of an updated plan.

The NEHRP Consultants Joint Venture is indebted to the leadership of Bill Holmes, Project Director, and to the members of the Project Technical Committee, consisting of Jon Bray, Tom Holzer, Laurie Johnson, Jack Moehle, and Sharon Wood, for their contributions in developing this report and the resulting recommendations. The Project Review Panel, consisting of Greg Anderson, Michael Blanpied, Sergio Breña, Michel Bruneau, John Filson, David Frost, Marjorie Greene, Eric Letvin, Mike Mahoney, Joy Pauschke, Santiago Pujol, and Kathleen Tierney, provided critical review and commentary at key developmental stages of the report. The names and

affiliations of all who contributed to this report are provided in the list of Project Participants.

The NEHRP Consultants Joint Venture also gratefully acknowledges Jack Hayes (NEHRP Director) and Steve McCabe (NEHRP Deputy Director) for their input and guidance in the preparation of this report, Laura Dwelley Samant for ATC Project Management services, and Ayse Hortacsu and Amber Houchen for ATC report production services.

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1.1 Background

Four agencies comprise the National Earthquake Hazards Reduction Program (NEHRP): the Federal Emergency Management Agency (FEMA), the National Institute of Standards and Technology (NIST), the National Science Foundation (NSF), and the U.S. Geological Survey (USGS). These agencies have complementary but unique roles in NEHRP that extend to their activities in performing field investigations following earthquakes.

In 2001, with support from the USGS, the Applied Technology Council (ATC) and the Earthquake Engineering Research Institute (EERI) conducted a multidisciplinary workshop that examined the many issues related to post-earthquake investigations relevant to NEHRP. Based on information from that workshop, USGS published Circular 1242, *The Plan to Coordinate NEHRP Post-Earthquake Investigations* (USGS, 2003).

USGS Circular 1242 is a plan for coordinating domestic and foreign post-earthquake investigations that are supported by NEHRP. It outlines procedures for how NEHRP agencies and their partners should interact when investigating earthquakes. It identifies responsibilities for investigations, but does not specify what will be done. The plan describes its scope and purpose as follows:

“The plan includes measures for: (1) gaining rapid and general agreement on high-priority research opportunities; and (2) conducting the data gathering and field studies in a coordinated manner. It deals with identification, collection, processing, documentation, archiving, and dissemination of the results of post-earthquake work in a timely manner and easily accessible format.”

“For the purposes of this plan, a significant domestic earthquake is defined as either: (1) an earthquake resulting in a Presidential disaster declaration; or (2) an earthquake considered by NEHRP agencies to provide an opportunity to learn how to reduce future earthquake losses in the United States.”

“The objectives of the present plan are to improve coordination during post-earthquake investigation efforts, minimize duplication of efforts, identify activities that could be supported with additional resources (such as disaster funds from FEMA or supplemental appropriations), and maximize the opportunity to learn from both domestic and foreign earthquakes.”

USGS Circular 1242 defines three time frames during which NEHRP agency investigations should be coordinated. These time frames may be briefly described as follows:

- Phase I (immediate to several days): activities taken immediately after an earthquake that are focused on defining the scope of the disaster and are reconnaissance in nature.
- Phase II (several days to one month): intensive gathering and archiving of perishable data, and assessment of opportunities for further investigation based on the results of initial reconnaissance efforts.
- Phase III (one month to five years): research and investigations in the subsequent months and years, including gathering of additional data, archiving, and dissemination of lessons learned.

To assist in NEHRP agency coordination, the plan recommends establishment of an Investigations Coordinator, and defines the roles and responsibilities of this position. The Investigations Coordinator is responsible for facilitating coordination among NEHRP agencies and meeting the goals of the coordination plan.

1.2 Motivation and Purpose

Public Law 108-360, 2004, *National Earthquake Hazards Reduction Program Reauthorization* (2004) defines both a Lead Agency for NEHRP (currently NIST) and a Coordinating Agency for the NEHRP Post-Earthquake Investigations Program (currently USGS). The last reauthorization of NEHRP occurred in 2004. It is possible that, in future legislation, Congress could change the agencies currently assigned with the authority to lead NEHRP or coordinate post-earthquake investigations.

In the time since USGS Circular 1242 was published, some of the conditions assumed in the plan have changed, technology has advanced significantly, and coordination among the NEHRP agencies has evolved through other initiatives. Each agency has applied individualized approaches in the investigation of recent foreign earthquakes, and no large-scale domestic earthquakes have occurred since the plan was published. As a result, the procedures recommended in USGS Circular 1242 have never been exercised on a large-scale basis.

This report identifies a number of issues that should be considered in the development of an updated plan for coordination of NEHRP post-earthquake investigations. The issues cover a wide range of topics from how and when the plan should be updated, to whether specific aspects of the plan should be changed from the current approach outlined in USGS Circular 1242. It is envisioned that a future

effort will update the plan considering the framework presented in this report, information contained in USGS Circular 1242, and future legislation for NEHRP.

This report was developed by a group of post-earthquake investigation experts, including specialists from outside of government and a representative from USGS who was involved in the original development of USGS Circular 1242. An internal review panel, including representatives from the four NEHRP agencies, and additional non-government post-earthquake investigation specialists, reviewed the report and the developing recommendations. Work included a review of relevant legislation, research into post-earthquake investigation procedures from a variety of resources and organizations (Appendix A), interviews with NEHRP agency representatives, and discussions with stakeholders on the internal review panel.

1.3 Organization and Content

Chapter 2 presents a collection of issues to be considered in the development of an updated plan for coordination of NEHRP post-earthquake investigations, discusses the background and relevant information for each issue, identifies possible ways each issue could be resolved, and provides a recommended course of action.

Chapter 3 provides a brief summary of recommendations, and highlights issues of special importance that should be addressed if and when the current plan is updated.

Appendix A provides a bibliography of resources that are considered relevant to NEHRP post-earthquake investigation planning and coordination activities. Selected passages describing the purpose and content of resources judged to be most relevant are also included.

Appendix B provides a collection of terminology and definitions intended to serve as an illustration and a starting point for the development of a standard nomenclature for use in post-earthquake coordination and investigation activities.

A list of acronyms used and references cited, along with a list of project participants, are provided at the end of this report.

This chapter presents a list of issues to be considered in updating USGS Circular 1242 to create a new or revised plan for coordination of NEHRP post-earthquake investigations. The issues range from how and when the plan should be updated to the content and detail of specific elements that should be included in the plan. It discusses the background and relevant information for each issue, identifies possible ways each issue could be resolved, and provides a recommended course of action. This presentation format is intended to capture the varied thoughts, recommendations, and opinions of those who contributed to the development of this report, and provide additional background for the wide-ranging decisions that will need to be made if and when the plan is updated.

The issues, along with their recommended solutions, form a potential framework to be considered in the development of an updated plan. They are grouped into the following categories:

- **Scope, Development, and Maintenance.** This category focuses on the overall scope of the plan, when it should be updated, by whom, and how it should be maintained in the long term.
- **Coordination.** This category covers specific aspects of coordination addressed by the plan. These include defining the roles of the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program and the NEHRP Investigations Coordinator. They also include when the plan should be triggered, how the plan should interface with organizations outside of NEHRP (e.g., technical clearinghouses), how it should relate to emergency response and recovery frameworks, how it should coordinate the terminology used by each agency, and how it should address secondary hazards and damage to infrastructure not addressed by NEHRP.
- **Data and Technology.** This category addresses how the plan should incorporate technological advancements related to coordination, data collection, and data storage.
- **Funding.** This category discusses funding for post-earthquake investigations, and the need for ongoing support for coordination between disasters.
- **Site Access.** This category covers permissions for gaining access to restricted areas, managing the expected number of public and private investigators that

Funding Affects All Issues

It is important to note that many of the recommendations presented in this report would require additional funding to be implemented in the most effective manner. Although the issue of funding is specifically explored in Issue F1, it is an overarching concern that affects all other issues and, ultimately, the ability to have a fully functioning post-earthquake investigations strategy for NEHRP.

earthquakes are likely to attract, and avoiding interference with emergency response activities while ensuring safety.

- **International Considerations.** This category addresses coordination of NEHRP investigations of foreign earthquakes and considerations for hosting foreign investigators of domestic earthquakes.

Table 2-1 provides a summary list of issues identified by the project team. Each issue is discussed in a consistent format that includes: (1) a *Question Presented*, which succinctly summarizes the issue; (2) a *Background*, which discusses the issue in detail, including a summary of the status quo and challenges associated with resolving the issue; (3) a list of *Alternative Solutions*, which presents a range of possible solutions for how each issue could be resolved; and (4) *Recommendations*, which present the recommended approach for resolving each issue along with a brief explanation of why a particular resolution was chosen.

2.1 Scope, Development, and Maintenance

2.1.1 Issue S1: Scope of the Plan

Question Presented

What should be the scope of the plan in terms of which agencies and organizations are directed by the plan and what activities are covered by the plan?

Background

A comprehensive plan to coordinate post-earthquake investigations should cover all aspects of an earthquake and its related physical effects, and should coordinate the activities of all relevant organizations, to ensure that the investigations are thorough and that all potential lessons from the event can be extracted. NEHRP post-earthquake investigations, however, face both legislative and financial restrictions.

Legislatively, NEHRP agencies must fulfill the statutory requirements assigned to them in the NEHRP legislation (currently Public Law 108-360), and cannot be directed by another agency to perform tasks that are not assigned by Congress. USGS Circular 1242 defines the Investigations Coordinator position, which is charged with leading coordination efforts. USGS Circular 1242 points out that, “it is impossible to delegate authority to the proposed Investigation Coordinator” to direct the activities of other NEHRP agencies. Coordination, as defined in USGS Circular 1242, depends on voluntary cooperation among the NEHRP agencies.

Reliance on voluntary cooperation is also true for Federal agencies outside of NEHRP. There are physical effects associated with earthquakes (e.g., tsunamis and damage to transportation infrastructure) that are not specifically designated as part of NEHRP within the legislation. Considering these constraints, it may be unrealistic

Table 2-1 List of Issues

Reference No.	Issue Title	Report Section
<i>SCOPE, DEVELOPMENT, AND MAINTENANCE</i>		
S1	Scope of the plan	2.1.1
S2	Timing for update of the existing plan	2.1.2
S3	Participants in the development of an updated plan	2.1.3
S4	Format of the plan	2.1.4
S5	Maintaining the plan	2.1.5
<i>COORDINATION</i>		
C1	Developing technical clearinghouses	2.2.1
C2	Role of the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program	2.2.2
C3	Role of the NEHRP Investigations Coordinator	2.2.3
C4	Triggering coordinated post-earthquake investigations	2.2.4
C5	Terminology for discussing post-earthquake investigations	2.2.5
C6	Engaging non-NEHRP Federal agencies	2.2.6
C7	Engaging regional, state, and local agencies	2.2.7
C8	Engaging non-governmental organizations	2.2.8
C9	Investigating effects that are not included in NEHRP legislation	2.2.9
C10	Coordinating with post-earthquake response and recovery operations	2.2.10
<i>DATA AND TECHNOLOGY</i>		
D1	Using technology for post-earthquake reconnaissance coordination	2.3.1
D2	Using technology for data collection	2.3.2
D3	Archiving data	2.3.3
<i>FUNDING</i>		
F1	Funding for coordinated NEHRP post-earthquake investigations	2.4.1
<i>SITE ACCESS</i>		
A1	Obtaining permission to access restricted areas	2.5.1
A2	Managing and coordinating access for non-NEHRP post-earthquake investigators	2.5.2
A3	Avoiding interference with emergency response operations and emphasizing personal safety	2.5.3
<i>INTERNATIONAL CONSIDERATIONS</i>		
I1	Coordinating investigations of foreign earthquakes	2.6.1
I2	Hosting foreign post-earthquake investigators of domestic earthquakes	2.6.2

for a plan to assign responsibility to, or to expect long-term cooperation from, organizations that are outside of the four NEHRP agencies.

Immediately following an earthquake, FEMA, NIST, NSF, and USGS have the responsibility to determine the level of activity that will be associated with the Federal response to the earthquake and the scope of the associated investigations. The NEHRP agencies have limited ability to redirect internal funding to support post-earthquake activities. For a major earthquake in the United States, supplemental funding from Congress would be needed to conduct comprehensive post-earthquake investigations. Without additional funding, it would not be possible for the NEHRP agencies to perform many of the steps outlined in the current plan.

Appropriate post-earthquake interests and activities for each NEHRP agency must be deduced from authorized activities delineated in the NEHRP legislation. Based on information provided by representatives from each agency, roles assigned in USGS Circular 1242, and recent post-earthquake activities, the current responsibility of each agency is summarized as follows:

- USGS issues information immediately following an earthquake through the Earthquake Notification Service (ENS), which announces the time, location, and size of the earthquake, and the Prompt Assessment of Global Earthquakes for Response (PAGER), which estimates fatalities, economic losses, distribution of damage, and the likelihood of a tsunami (using data from the National Oceanic and Atmospheric Administration (NOAA)). USGS may also issue aftershock advisories.
- USGS collects, interprets, and maps reports of shaking and other observations by citizens affected by the earthquake.
- USGS hosts a series of coordination phone calls with NEHRP agencies and other organizations to address a variety of issues related to post-earthquake investigations, including seismological, engineering, and geological aspects. In the case of a foreign earthquake, political considerations may also be addressed.
- Initial data collection efforts following a domestic earthquake are led by staff at USGS, NIST, and FEMA. For a foreign earthquake, USGS teams must be formally invited through the Department of State, and the participation of NIST and FEMA staff must be justified based on potential relevance to codes and standards in the United States.
- NSF has a long history of funding groups to conduct post-earthquake investigations, such as the Earthquake Engineering Research Institute (EERI) Learning from Earthquakes (LFE) program and the Geotechnical Extreme Events Reconnaissance (GEER) Association. NSF also accepts unsolicited proposals from individual researchers for Rapid Response Research (RAPID) grants to

collect perishable data following a disaster. In the case of extremely damaging events (e.g., the 2011 earthquakes in New Zealand and Japan, and the 2010 earthquakes in Haiti and Chile), NSF may issue a “Dear Colleague Letter” to encourage researchers to apply for funding through the RAPID grant program.

- Supported with disaster-specific Stafford Act (i.e., non-NEHRP) funding, FEMA has the option of sending Mitigation Assessment Teams (MATs) into the field to investigate building performance following a natural disaster. Mitigation Assessment Teams are used to study damaged and undamaged buildings that were designed and constructed in accordance with current or recent codes to determine if the cause of damage was inadequate code provisions, inadequate construction, or conditions that exceeded code limits. Contractors and paid subject matter experts, generally accompanied by at least one FEMA headquarters or regional staff member, serve on teams that are scheduled to arrive in the field one or two weeks following a disaster to avoid interference with emergency response activities. MATs have been used in the past to document damage from domestic hurricanes, floods, and tornadoes, but, to date, they have not been used following an earthquake. Members of FEMA technical staff, however, have participated on teams investigating selected foreign earthquakes (e.g., EERI teams investigating the 1999 Taiwan and 2010 Chile earthquakes).
- In the case of a domestic earthquake, NIST has the option of invoking the National Construction Safety Team (NCST) Act to study individual building failures. The Act grants NIST authority for entry and inspection, collection, and preservation of building components, materials, and artifacts. The NCST Act states that, in most cases, NCST shall have priority over investigations conducted by any other Federal agency. The statute also specifies coordination, to the extent practicable, with qualified researchers who are conducting engineering or scientific (including social science) research related to the failure of the building. Therefore, if multiple agencies seek to study a building covered by an NCST investigation, NIST is required to coordinate as deemed appropriate.

In addition to NEHRP activities, there are non-NEHRP Federal agencies and other non-governmental organizations that conduct post-earthquake investigations, such as the Federal Highway Administration (FHWA), the National Tsunami Hazard Mitigation Program (NTHMP), the Earthquake Engineering Research Institute (EERI), and the American Society of Civil Engineers (ASCE).

Alternative Solutions

1. The plan could be strictly limited to the four NEHRP agencies and the activities expressly delineated in the latest NEHRP authorization.

2. The plan could focus on the four NEHRP agencies but could direct the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program, to the extent practicable, to collaborate with other Federal earthquake-related programs (e.g., NTHMP), other agencies interested in earthquake effects (e.g., FHWA), appropriate state agencies, and non-governmental organizations that have been involved in post-earthquake investigations (e.g., EERI, GEER, and ASCE).
3. The plan could acknowledge and incorporate all expected post-earthquake investigation activities by all Federal agencies and non-governmental organizations. Memoranda of understanding or informal agreements between the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program and non-NEHRP entities could be obtained as soon as possible, presumably prior to any major event.

Recommendations

Alternative Solution 2 is recommended. Although the responsibilities of the NEHRP agencies and the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program are limited by legislation, it is recommended that collaboration and cooperation among all interested parties be encouraged to the extent practicable. Issues C6, C7, C8, and C9 provide additional more detailed discussion on this topic.

2.1.2 Issue S2: Timing for Update of the Existing Plan

Question Presented

When should the existing plan be updated?

Background

The current plan, outlined in USGS Circular 1242, was published in 2003 based on information from a workshop that was held in 2001. Some of the conditions assumed in the existing plan have changed, technology has advanced significantly, and coordination among the NEHRP agencies has evolved through other initiatives.

Most agree that the plan needs to be updated; however, conditions that are critical to formulating an updated plan are currently unknown or inadequately defined. For example, NEHRP legislation was last reauthorized in 2004, and it is possible that future legislation could change the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program (currently USGS), or even the overall Lead Agency for NEHRP (currently NIST). Post-earthquake reconnaissance efforts currently funded by NSF through EERI's Learning from Earthquakes program or GEER, may or may not be funded in the future. In addition, the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) could play a significant role

in future post-earthquake research and data archiving activities, but the future of this organization is uncertain at this time.

Alternative Solutions

1. The existing plan could be updated after NEHRP is reauthorized.
2. Ideally, the Lead Agency for NEHRP and the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program should be identified before the plan is updated, but if NEHRP is not reauthorized in the near future, the existing plan could be updated to the extent practicable.
3. The conditions surrounding the coordination of post-earthquake investigations will never be completely defined, so the existing plan should be updated as soon as possible.

Recommendations

It is critical to have an up-to-date coordination plan in place because a significant earthquake could strike at any time. Alternative Solution 3 is recommended, even though it is acknowledged that an updated plan could be more specific if the details of new NEHRP authorizing legislation were known. As the current Coordinating Agency for the NEHRP Post-Earthquake Investigations Program, USGS would be responsible for launching an update of the existing plan.

2.1.3 Issue S3: Participants in the Development of an Updated Plan

Question Presented

Who should be involved in developing an updated plan?

Background

USGS Circular 1242 was written by a multidisciplinary committee of seven post-earthquake investigation experts, including five non-governmental participants and two USGS personnel. The plan was based on input received from a multidisciplinary workshop attended by government and non-governmental participants. Before it was finalized, the plan was reviewed by a multi-institutional oversight committee, including representatives from all NEHRP agencies and other stakeholders.

It is expected that significant involvement of NEHRP agency personnel, and NEHRP resources, would be needed to update the plan. It is also expected that non-governmental personnel should be involved. Funded development, and compensation for non-governmental participants on the update or review committees, is a model that has been used in the past and could be considered in developing an updated plan.

Alternative Solutions

1. The four NEHRP agencies could update the plan under the leadership of the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program (USGS) or the NEHRP Lead Agency (NIST), using structures that are already in place, such as the Advisory Committee on Earthquake Hazards Reduction (ACEHR).
2. This report was developed by a funded team of experts, including government and non-governmental participants, under a contract with NIST as the NEHRP Lead Agency. This effort included provision for input from all four NEHRP agencies and oversight by an additional group of experts and other stakeholders. A similar funded development process could be used to update the plan.
3. The plan could be updated by a multidisciplinary committee knowledgeable in post-earthquake investigations through the conduct of a workshop designed to obtain input from stakeholders including Federal, state, and local government representatives, and non-governmental organizations.

Recommendations

Alternative Solution 2 was identified as being the most expedient solution for updating the existing plan, but there was strong support for the conduct of a workshop, as outlined in Alternative Solution 3, prior to final update of the plan.

2.1.4 Issue S4: Format of the Plan

Question Presented

What should be the format of an updated plan?

Background

The current plan, as depicted in USGS Circular 1242, is a 20-page document that is available in hard copy format and on the internet in Portable Document Format (PDF). The current document includes material about the development process and recommendations for further action. The recommendations are important, but not always directly related to coordination activities outlined in the plan.

The following observations were made by the project team and NEHRP agency representatives regarding the format of the current document and potential future updated plan documents:

- USGS Circular 1242 combines post-earthquake coordination material with other discussions and recommendations. The additional material distracts from the material outlining the coordination activities.

- Regular updating is important, and can be more easily accomplished in an electronic format without published hard copies. The format could be updated to function as more of an evolving document in an online environment.
- Elements of a plan that depend on technology will require more frequent updating.
- The plan should be coordinated with, or even combined with, plans for other disaster investigations.
- Coordination for post-earthquake investigations should be better aligned with the day-to-day operations of the NEHRP agencies.
- Considering that one NEHRP agency cannot direct the activities of another agency, and the uncertainty of funding for post-earthquake investigations, the plan must be acceptable to each agency. The duties of the NEHRP Investigations Coordinator are important to successfully implementing a plan, but there is no official authority vested in this position. The plan should be more regularly updated to account for shifts in agency policies.
- NEHRP Agencies should develop standard operating procedures for post-earthquake investigations.

Alternative Solutions with regard to length and content

1. An updated plan could follow the current format and content of USGS Circular 1242.
2. An updated plan could include only material pertinent to the coordination of NEHRP agencies. Discussion of the development process, explanatory commentary, and recommendations for future changes would be excluded.
3. An updated plan could include a description of the development process and explanatory commentary language provided in appendices.
4. The development process and commentary language could be in a separate document (i.e., an “update report”) because it is valuable for the record and important for future updates.

Alternative Solutions with regard to characterization of agency roles and responsibilities

5. An updated plan could concentrate only on coordination activities, such as the timeline and responsibilities for organizing coordination phone calls, meetings, and workshops. The investigative roles, responsibilities, and activities of each agency could be taken solely from the authorizing NEHRP legislation, with no additional discussion.

6. An updated plan could maintain the same tone as USGS Circular 1242 (i.e., delineate consensus roles and responsibilities from the authorizing NEHRP legislation), but indicate that NEHRP agencies must work closely and cooperatively with other agencies during post-earthquake investigations to take advantage of all learning opportunities.
7. An updated plan could delineate consensus roles and responsibilities, with the assumption that issues not dealt with in the plan are the responsibility of the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program.

Recommendations

There was no support for Alternative Solution 1, which retained the current format of USGS Circular 1242. Considering length and content, there was strong consensus for Alternative Solution 4, in which the development process, explanatory commentary, and recommendations for the future are documented in a separate report.

Considering the characterization of agency roles and responsibilities, Alternative Solution 6 was recommended. As discussed in Issues S1, C6, C7, C8, and C9, it is recognized that although the authority of the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program is limited, and the roles and responsibilities of each agency in post-earthquake investigations are defined in authorizing NEHRP legislation, the plan should encourage cooperation among all interested government and non-governmental entities on all relevant issues.

2.1.5 Issue S5: Maintaining the Plan

Question Presented

How should a NEHRP post-earthquake coordination plan be maintained (i.e., kept up to date)?

Background

There is general agreement that the plan for coordinating NEHRP post-earthquake investigations needs to be updated to consider: changes in agency roles, responsibilities, and policies; new or changed laws relating to NEHRP; changes in policies and capabilities of state and local agencies; and increased or decreased capacity of non-governmental organizations interested in post-earthquake investigations. To date, there have been no resources available for update of the plan, other than redirection of existing NEHRP agency personnel and resources.

Changes that might affect the plan do not occur on a regular basis. Periodic updates that occur on a set schedule may not fully capture these changes unless updates are scheduled to occur somewhat frequently. More frequent updates might enable the

plan to function more effectively at the time of a future earthquake; however, they would require more resources.

Alternative Solutions

1. The plan could be reviewed and updated every other year.
2. The plan could be reviewed and updated every five years.
3. The plan could be reviewed and updated any time that significant legal and policy conditions that control the plan change, as judged by an existing body (e.g., the Advisory Committee on Earthquake Hazards Reduction (ACEHR) or the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program), or after every event that triggers the plan.

Recommendations

A combination of Alternative Solutions 2 and 3 is recommended. The plan should be reviewed and updated by the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program after every event that triggers the plan, and after significant changes to legal and policy conditions that control the plan. At a minimum, review and update should occur every five years. This approach is envisioned as a balance between the need to keep the plan up to date and the expenditure of resources that would be necessary to do so.

2.2 Coordination

2.2.1 Issue C1: Developing Technical Clearinghouses

Question Presented

How should the plan incorporate technical clearinghouses to support post-earthquake investigations?

Background

A technical clearinghouse is defined as the field location in a region affected by an earthquake where post-earthquake investigators meet to organize and coordinate activities. Technical clearinghouses are considered to be an integral part of post-earthquake investigations.

USGS Circular 1242 assigns USGS, FEMA, and EERI with the responsibility of working with state agencies to organize a technical clearinghouse within 24 hours of a damaging earthquake in the United States. Working with state and local agencies, and maintaining direct communications with the Federal Coordinating Officer (FCO) and the State Coordinating Officer (SCO) for the earthquake (or their respective designees), is important to ensure that post-earthquake investigation activities do not interfere with emergency response activities. In addition, opportunities for

technology transfer are enhanced if state and local agencies are involved from the beginning.

In some parts of the United States, the epicentral region could be expected to cross state boundaries, and multi-state consortia (e.g., the Western States Seismic Policy Council (WSSPC) and the Central United States Earthquake Consortium (CUSEC)), have addressed coordination issues. The degree of leadership or responsibility assigned to the NEHRP agencies in establishing a technical clearinghouse will depend on the extent of planning that has taken place at the state, local, and regional levels before an event.

USGS Circular 1242 notes that, if a clearinghouse is to be established quickly after an earthquake, the general operational plans must be prepared in advance. USGS was assigned responsibility for earth science aspects, and a non-Federal entity, EERI, was assigned responsibility for engineering and socioeconomic aspects of operating a clearinghouse. USGS Circular 1242 also recommends that agreements with affiliated earthquake engineering centers, earth science centers, universities, and professional groups be established before an earthquake in order to develop comprehensive plans for post-earthquake investigations.

Funding of clearinghouses is not always available. In cases where a clearinghouse would have life-saving or life-sustaining benefits to response activities, clearinghouses have been funded using Stafford Act disaster funds (e.g., 1994 Northridge and 2001 Nisqually earthquakes). In other cases, requests to fund clearinghouses have been denied.

Alternative Solutions

1. The procedures for establishing field technical clearinghouses could be the same as those outlined in USGS Circular 1242.
2. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could assume responsibility for developing technical clearinghouses.
3. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could work with state agencies or regional consortia to establish technical clearinghouses. In the event that planning at the state, local, or regional levels has not taken place, the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could encourage establishment of technical clearinghouses.

Recommendations

Alternative Solution 3 is recommended. This solution is similar to the current procedures in USGS Circular 1242, but also leverages the planning activities that could take place at the state, local, and regional levels.

2.2.2 Issue C2: Role of the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program

Question Presented

What should be the responsibilities of the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program?

Background

NEHRP legislation (Public Law 108-360) assigns USGS as the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program and defines this role as:

“There is established within the United States Geological Survey a post-earthquake investigations program, the purpose of which is to investigate major earthquakes, so as to learn lessons which can be applied to reduce the loss of lives and property in future earthquakes. The United States Geological Survey, in consultation with each Program agency, shall organize investigations to study the implications of the earthquake in the areas of responsibility of each Program agency. The investigations shall begin as rapidly as possible and may be conducted by grantees and contractors. The Program agencies shall ensure that the results of investigations are disseminated widely. The Director of the Survey is authorized to utilize earthquake expertise from the Agency, the National Science Foundation, the National Institute of Standards and Technology, other Federal agencies, and private contractors, on a reimbursable basis, in the conduct of such earthquake investigations. At a minimum, investigations under this section shall include:

1. analysis by the National Science Foundation and the United States Geological Survey of the causes of the earthquake and the nature of the resulting ground motion;
2. analysis by the National Science Foundation and the National Institute of Standards and Technology of the behavior of structures and lifelines, both those that were damaged and those that were undamaged; and
3. analysis by each of the Program agencies of the effectiveness of the earthquake hazards mitigation programs and actions relating to its area of responsibility under the Program, and how those programs and actions could be strengthened.”

At present, House of Representatives Bill 2132 (H.R. 2132, 2013), *Natural Hazards Risk Reduction Act of 2013*, has been introduced, but NEHRP legislation has not been reauthorized. In H.R. 2132, the Lead Agency for NEHRP would also be assigned the responsibility of organizing post-earthquake investigations. This would transfer the role of Coordinating Agency for the NEHRP Post-Earthquake Investigations Program

from USGS to NIST. The role of the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program is defined more generally in H.R. 2132 than in the existing NEHRP legislation, as follows:

“The Program shall include a post-earthquake investigations program, the purpose of which is to investigate major earthquakes so as to learn lessons which can be applied to reduce the loss of lives and property in future earthquakes. The lead Program agency, in consultation with each Program agency, shall organize investigations to study the implications of earthquakes in the areas of responsibility of each Program agency. The investigations shall begin as rapidly as possible and may be conducted by grantees and contractors. The Program agencies will ensure that the results of the investigations are disseminated widely.”

NEHRP agencies must fulfill the statutory requirements assigned to them in the authorizing NEHRP legislation, and cannot be directed by another agency to perform tasks that are not assigned by Congress. Immediate dissemination of scientific information regarding the location, magnitude, and extent of shaking after an earthquake is within the statutory responsibilities of USGS. Therefore, it is anticipated that USGS will be the primary source of technical information in the first few days after an event. In addition, USGS has strong relationships with state and local agencies through regional offices and ongoing coordination efforts. This local presence is extremely important in determining the scope of the damage and the likely impact of a coordinated post-earthquake investigation.

Although the existing NEHRP legislation and H.R. 2132 do not differentiate between actions that are taken immediately after an earthquake and those that occur several years after the event, USGS Circular 1242 defines three phases of activity, and identifies coordination issues within each phase. Phase I includes activities taken immediately after an earthquake (within several days of the event). Phase II includes intensive data gathering and assessment of opportunities for further investigation based on results of initial reconnaissance efforts (several days to one month after the event). Phase III represents the period when research activities are underway and the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program is responsible for dissemination of information learned from the post-earthquake investigations (one month to five years after the event).

Activities in Phase II focus on the decision to organize a coordinated NEHRP response to the earthquake and whether or not supplemental funding should be requested from Congress. In Phase III, the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program becomes responsible for organizing workshops and publishing reports to ensure that the results of the post-earthquake investigations and lessons learned are widely disseminated. This includes a

workshop to discuss priorities for long-term investigations and the publication of a three-month event summary report.

With a duration of up to five years, Phase III is notably long, although it is likely that much of the anticipated longer term research following an event might be completed before five years. NEHRP agency representatives cautioned that, due the different statutory responsibilities of each agency, oversight of coordination issues in Phase III may be more difficult than anticipated in USGS Circular 1242.

In the time since USGS Circular 1242 was published, no major domestic earthquake has occurred, and an opportunity to fully implement the plan has not presented itself. However, in its current role as the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program, USGS has organized a series of conference calls immediately following earthquakes (foreign and domestic) that have occurred over this time period. These calls have provided an opportunity for NEHRP agencies to exchange information regarding necessary response activities. Representatives from other Federal agencies, and from other interested non-governmental agencies and organizations, have often been included in these calls.

Alternative Solutions

1. The role of the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could remain the same as currently described in USGS Circular 1242.
2. The role of the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could be revised to focus on coordination issues during what is currently defined as Phase I and Phase II after an earthquake. The duration of Phase II could be extended to include the priority-setting workshop and the development of a three-month event summary report. At the conclusion of Phase II, each NEHRP agency would then be responsible for setting its own agenda for additional investigations, dissemination of information, and archiving of data. Ongoing coordination issues related to risk mitigation, hazard assessment, and planning with state, local, and regional organizations would be explicitly assigned to each NEHRP agency based on statutory responsibilities, and would not need to be included in the post-earthquake investigation plan.

Recommendations

Alternative Solution 1 is recommended. The role of the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program, and approach described in USGS Circular 1242, which includes Phase III, is considered the most appropriate for maintaining structured, interagency communication, identifying lessons learned, and ensuring that information is properly disseminated.

2.2.3 Issue C3: Role of the NEHRP Investigations Coordinator

Question Presented

Should an updated plan include the role of NEHRP Investigations Coordinator, as envisioned in USGS Circular 1242?

Background

USGS Circular 1242 sets forth the role of NEHRP Investigations Coordinator for providing oversight of all NEHRP post-earthquake investigation activities. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program (currently USGS) is responsible for naming the NEHRP Investigations Coordinator within 24 hours of a significant earthquake. This person is to be chosen from a consensus list agreed upon in advance. USGS Circular 1242 defines the following responsibilities for the NEHRP Investigations Coordinator:

“(1) to ensure that disaster response activities are not impeded by scientific and technical investigations; (2) to provide emergency managers with timely and relevant information about ongoing field investigations; (3) to facilitate coordination of NEHRP agencies; (4) to ensure that NEHRP press releases are coordinated and consistent; and (5) to work with scientific and engineering leaders to identify critical investigations and gaps in the ongoing investigation.”

From an administrative perspective, several concerns were raised about the NEHRP Investigations Coordinator position. First, any interagency collaboration must be voluntary because employees from one Federal agency cannot direct employees from another Federal agency. In recognition of this, it was envisioned that the position would be filled by an individual who was well-respected and well-connected within the NEHRP agencies. Second, a person serving as the point of contact for emergency managers and local officials is likely to need strong ties to the state and local communities in the epicentral region. A person with the necessary local connections may not have the Federal contacts necessary to optimize deployment of NEHRP resources and set priorities for NEHRP post-earthquake investigations.

USGS and FEMA have regional offices in which staff have developed strong relationships with state and local officials who will be leading emergency response efforts. FEMA regional staff also work closely with the Federal Coordinating Officer and the State Coordinating Officer, which are appointed in the event of a disaster declaration.

Alternative Solutions

1. An updated plan could have a NEHRP Investigations Coordinator, as envisioned in USGS Circular 1242.

2. Although the level of coordination envisioned in USGS Circular 1242 offers a number of advantages for post-earthquake investigations, it is unlikely that a single person could achieve all the goals envisioned for the NEHRP Investigations Coordinator. An updated plan should recognize the fact that the individual with the operational and technical skills needed to coordinate activities immediately after an event may not also have the administrative skills necessary to coordinate later phases of the plan among the NEHRP agencies. Therefore, the responsibilities could be divided among multiple people within the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program.
3. Recognizing that one person is not likely to have the skills necessary to coordinate the operational and administrative responsibilities assigned to the NEHRP Investigations Coordinator in USGS Circular 1242, other options for assigning these responsibilities should be considered. Although the coordinator for the administrative and policy issues must be a Federal employee working for the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program, the coordinator for the operational and technical issues could possibly be a contractor located in the epicentral region. Ideally, the coordinator for operational issues would have established ties with state and local emergency management personnel. The coordinator for operational and technical issues would be selected from a preapproved list by the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program immediately following the earthquake.

Recommendations

If USGS remains the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program, then Alternative Solution 2 is recommended. Under this solution, the NEHRP Investigations Coordinator is likely to have the administrative skills necessary to engage the NEHRP Agencies. If NIST is assigned the responsibilities for the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program, then Alternative Solution 3 is recommended. This solution provides the flexibility to select a person who is well-suited to meet the operational and technical needs for coordinating with state and local officials immediately after an earthquake, while retaining the administrative and policy coordination responsibilities within NIST.

2.2.4 Issue C4: Triggering Coordinated Post-Earthquake Investigations

Question Presented

What decision criteria should be used to trigger a coordinated NEHRP post-earthquake investigation?

Background

In USGS Circular 1242, significant domestic and foreign earthquakes are subject to coordinated investigation. For domestic earthquakes, the plan is triggered if: (1) there is a Presidential disaster declaration; or (2) the NEHRP agencies determine that an earthquake provides an opportunity to learn how to reduce future earthquake losses in the United States. For foreign earthquakes, the criteria are not as clearly defined. Teams must be formally invited by the impacted country through the Department of State, and participation by NIST and FEMA must be justified based on potential relevance to U.S. codes and standards. USGS Circular 1242 highlights the role for international coordination that has been performed by EERI through its Learning from Earthquakes program. USGS Circular 1242 also notes that uncoordinated deployment of U.S. investigators to foreign earthquakes has drawn complaints from affected countries to the Department of State. Optional aspects for triggering the plan include events of sufficient scale to justify supplemental funding.

NIST has developed a comprehensive set of decision criteria that are used to determine if a National Construction Safety Team investigation is justified. These criteria include: (1) extent of loss of life; (2) exposed population; (3) magnitude of the hazard; (4) scale of the damage (in terms of consequences to resilience); (5) evacuation and emergency response; and (6) codes, standards, and enforcement (for international events). Six additional questions addressing general principles are also provided to help guide a decision: (1) whether new knowledge can be gained from the study; (2) anticipated impact on standards, codes, and practices; (3) available resources (in terms of people and funding); (4) safety of the site; (5) stakeholder concerns; and (6) whether NIST has primary authority or unique expertise.

Since the development of USGS Circular 1242, USGS has significantly refined its tools for information dissemination immediately following an earthquake. PAGER is an automated system that estimates the impact of an earthquake in terms of economic loss and the number of fatalities. This information has proven to be extremely important for determining the scope of post-earthquake investigations for large earthquakes in foreign countries in recent years. Data from PAGER are reviewed during the coordination calls immediately after an earthquake, and the research potential is discussed by NEHRP agency personnel.

One of the complicating factors for coordinated investigations of foreign earthquakes is that NIST and FEMA must demonstrate that the information obtained from post-earthquake investigations will be directly relevant to codes and standards in the United States. This criterion for participation can be difficult to achieve, especially in developing countries where construction practices are frequently not representative of those in the United States. USGS and NSF, however, often fund researchers to

collect perishable data following foreign earthquakes, provided that the research results are likely to influence practice in the United States.

Although the plan has not been triggered since USGS Circular 1242 was published, NEHRP agency staff have collaborated immediately following earthquakes, through conference calls hosted by USGS, to determine the appropriate level of NEHRP response. These activities, in effect, could be considered a lower threshold of coordination among NEHRP agencies that does not trigger full-scale implementation of the plan.

Alternative Solutions for Domestic Earthquakes

1. For domestic earthquakes, the current triggers listed in USGS Circular 1242 could be retained.
2. A more detailed set of criteria could be developed for determining if coordinated post-earthquake investigations are warranted for domestic earthquakes.

Alternative Solutions for Foreign Earthquakes

3. For foreign earthquakes, each earthquake could be evaluated independently, and the plan could be triggered if more than one agency believes that the earthquake provides an opportunity to learn how to reduce future earthquake losses in the United States.
4. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could develop a list of countries in which the seismological or geological settings, the level of codes and construction practices, and the emergency response capabilities are such that post-earthquake investigations are likely to have a direct impact on design and construction practices in the United States. This list could be used to determine when to activate the plan.
5. Post-earthquake investigations of foreign earthquakes could be limited to situations in which the affected country has requested assistance from the United States.

Recommendations

For response to domestic earthquakes, Alternative Solution 1 is recommended because the current triggers seem to be adequate.

For response to foreign earthquakes, Alternative Solution 3 is recommended. USGS and NSF have a long history of supporting post-earthquake investigations of foreign earthquakes, but a new criterion for participation of NIST and FEMA is needed. A significant issue could arise if future legislation assigns NIST as the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program, but NIST is not allowed to participate in post-earthquake investigations of a foreign earthquake. The

participation of two NEHRP agencies should be sufficient to justify triggering the full plan for coordinated NEHRP post-earthquake investigations.

2.2.5 Issue C5: Terminology for Discussing Post-Earthquake Investigations

Question Presented

How should an updated plan address the varying terminology used by different NEHRP agencies to improve coordination?

Background

In discussions among NEHRP agency representatives, it was noted that different agencies and disciplines use different terminologies when discussing earthquake reconnaissance and related data. This can lead to misunderstandings that may impede coordination. In addition to conducting earthquake reconnaissance, some agencies record and archive data. Having a clear understanding of regularly used terminology would help in sharing these data.

One such example is the term *research*. Some agencies perceive this term to refer to the activities of data collection and interpretation that occur within a short period following an earthquake. Other agencies perceive this term to refer to longer-term studies, perhaps supported with special funds triggered by the event, which begin months after the event and can extend for years. Some agencies do not have research included as part of their mandate and, therefore, do not use the term. Such agencies might support technical studies, but these studies, by some interpretations, might be considered similar to research.

There is also terminology associated with specific programs operated by each agency following an earthquake or other disaster. Examples include the Hazards Data Distribution System at USGS, the Mitigation Assessment Team program at FEMA, the National Construction Safety Team Act at NIST, and grants for Rapid Response Research at NSF. Additionally, the post-earthquake coordination plan, itself, might define specific activities, roles, or responsibilities associated with coordination after an event. Having a clear definition and understanding of the various programs, activities, roles, and responsibilities is necessary to facilitate coordination.

In evaluating this issue, an effort was undertaken to identify key terminology associated with post-earthquake activities that are possible sources of misunderstanding and important for coordinating response. Appendix B presents a list of selected terminology along with definitions taken from a variety of sources. This list is intended to serve as background and a starting point for future development of a set of standard nomenclature. It is not intended to set definitions for standard nomenclature at this time.

Alternative Solutions

1. An updated plan could be developed without a standard nomenclature. NEHRP agency programs and terminology in different disciplines are moving targets for which a standard nomenclature could become out of date, potentially leading to more confusion than already exists.
2. An updated plan could clearly define the terms that are potentially misleading in post-earthquake coordination planning to avoid confusion, but could stop short of attempting to develop a standard nomenclature.
3. An updated plan could define a standard nomenclature for all terms deemed critical for coordination.
4. An updated plan could define standard nomenclature in an online entity (e.g., a wiki) to more readily allow for update as terminology and programs evolve.

Recommendations

Alternative Solution 3 is recommended. A standard nomenclature for terms that are critical for coordination should be developed and included in an updated post-earthquake coordination plan. Alternative Solution 4 should be considered as an additional activity, developing a standard nomenclature as an evolving electronic resource.

2.2.6 Issue C6: Engaging Non-NEHRP Federal Agencies

Question Presented

How should an updated plan engage non-NEHRP Federal agencies?

Background

Several non-NEHRP Federal agencies conduct earthquake-related programs, and some actively support post-earthquake reconnaissance. These agencies include: the Department of Defense (DOD) along with the U.S. Army Corps of Engineers (USACE), the Department of Energy (DOE), the Federal Highway Administration (FHWA), the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Nuclear Regulatory Commission (USNRC). Coordination among these agencies could facilitate post-earthquake reconnaissance activities for all the involved agencies.

For example, none of the four NEHRP agencies has a mandate to carry out activities related to highway infrastructure. FHWA, a non-NEHRP Federal agency, regularly supports research and development activities related to seismic design of highway infrastructure. FHWA also commonly conducts post-earthquake reconnaissance focused on highway infrastructure. Undoubtedly, coordination among the NEHRP agencies and FHWA would broaden post-earthquake learning opportunities.

Another example is NOAA, which is a member of the International Charter for Space and Major Disasters (www.disasterscharter.org) that aims to provide a unified system of space data acquisition and delivery to those affected by natural or man-made disasters. After an earthquake, NOAA coordinates with USGS in providing data.

Although NEHRP agencies are not authorized to coordinate the activities of these other Federal agencies, voluntary cooperation among agencies could facilitate access and data collection associated with post-earthquake investigations. It should be noted however, that in the authorizing legislation, NEHRP activities are limited to certain specific aspects of earthquakes and their related physical effects, so coordination with other Federal agencies should emphasize coordination on the physical effects of earthquakes that are included in the NEHRP authorization.

Alternative Solutions

1. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could postpone coordination efforts with non-NEHRP Federal agencies until after an event occurs, allowing the coordination effort to take place once the nature of the event and the coordination needs are more clear.
2. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could commit to engaging appropriate organizations in post-event coordination calls. The actual level of coordination would depend on the scope of the disaster, but contacts would be established in advance of an earthquake.
3. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program, along with its appropriate NEHRP agency partners, could meet with non-NEHRP Federal agencies and discuss potential participation and coordination of post-earthquake investigations in advance of an earthquake.
4. In addition to meetings conducted under Alternative Solution 3, the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program, along with its appropriate NEHRP agency partners, could identify non-NEHRP Federal agencies for which coordination almost certainly would be required for domestic earthquakes, and develop, where appropriate, memoranda of understanding or other cooperative agreements with those organizations in advance of an earthquake.
5. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could identify non-NEHRP Federal agencies that may have interests in earthquake-related activities, or who may facilitate access to sites or data, and conduct a workshop to identify optimal approaches for achieving pre-event agreement for post-event cooperation. This effort could be followed with the development of memoranda of understanding or other arrangements, where appropriate, in advance of an earthquake.

Recommendations

Alternative Solutions 2, 3, and 4 are recommended. In its current role as the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program, USGS has engaged appropriate non-NEHRP Federal agencies in conference calls immediately following foreign and domestic earthquakes that have occurred, and maintained a contact list. These efforts should continue.

To the degree possible, the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program should consider meeting with non-NEHRP Federal agencies that will potentially participate in post-earthquake investigations to discuss avenues for coordination. Where appropriate and necessary to accomplish the NEHRP authorization mandates, memoranda of understanding or other cooperative agreements should be pursued between agencies. After an event, if other organizations are identified for which coordination would be beneficial, coordination should be pursued with those organizations.

Because NEHRP agencies do not have the authority to direct any agency outside of NEHRP, an updated plan should not assign any essential post-earthquake activities to non-NEHRP Federal agencies.

2.2.7 Issue C7: Engaging Regional, State, and Local Agencies

Question Presented

How should an updated plan engage regional, state, and local agencies?

Background

Many state and local organizations have programs that relate to post-earthquake reconnaissance and investigation. For example, some state transportation departments conduct earthquake reconnaissance as part of their maintenance and learning activities, and some cities have building inspection programs that could contribute to data collection. Such activities should be considered in the overall plan for NEHRP post-earthquake investigations.

In addition, some states and multi-state regions have well-developed post-earthquake clearinghouse organizations, and others are developing plans for them. Examples include the California Earthquake Clearinghouse and Central United States Earthquake Consortium (CUSEC). Following the 1994 Northridge and 2001 Nisqually earthquakes, clearinghouses were particularly effective in coordinating post-earthquake reconnaissance activities. It is anticipated that clearinghouses will continue to be central to reconnaissance activities in California, the Pacific Northwest, Utah, and other regions of the United States. Whether future clearinghouse activities need to be centrally located, distributed, or virtual will depend on the extent of the earthquake effects and the technological capabilities

adopted by the various entities. Post-earthquake reconnaissance activities of NEHRP agencies are likely to be closely linked to regional clearinghouse activities.

Alternative Solutions

1. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could postpone coordination efforts with regional, state, and local agencies until after an event occurs, allowing the coordination effort to take place after the nature of the event and the coordination needs are more clear.
2. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could commit to engaging appropriate regional, state, and local agencies in post-event coordination calls. The actual level of coordination would depend on the scope of the disaster, but contacts would be established in advance of an earthquake.
3. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program, along with appropriate NEHRP agency partners, could meet with regional, state, and local agencies that will potentially participate in post-earthquake investigations to discuss potential participation and coordination in advance of an earthquake.
4. In addition to meetings conducted under Alternative Solution 3, the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could develop memoranda of understanding or other cooperative agreements with appropriate regional, state, and local agencies, in advance of an earthquake.
5. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could identify appropriate state and regional agencies (and key local agencies) and conduct a workshop to identify optimal approaches for achieving pre-event agreement for post-event cooperation. This effort could be followed with the development of memoranda of understanding or other cooperative agreements, where appropriate, in advance of an earthquake.

Recommendations

Alternative Solutions 2, 3, and 4 are all recommended. Regional, state, and local earthquake response and reconnaissance activities should be considered in the plan for coordination of NEHRP post-earthquake investigations following domestic earthquakes. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program should, as a minimum, make a commitment to engage appropriate regional, state, and local agencies in post-event coordination calls, and should maintain a contact list. Meetings with agencies that will potentially participate in post-earthquake investigations should be held to discuss avenues for possible coordination. Where appropriate, where necessary to accomplish the NEHRP authorization mandates, or where otherwise beneficial, memoranda of

understanding or other cooperative agreements should be pursued between individual NEHRP agencies and state or regional agencies. After an event, if other state or regional agencies are identified for which coordination would be beneficial, coordination should be pursued. FEMA has ongoing relationships with many state and regional agencies. These existing relationships should be leveraged in planning for post-earthquake investigations.

Because NEHRP agencies do not have the authority to direct the activities of regional, state, or local agencies, an updated plan should not assign any essential post-earthquake activities to such agencies.

2.2.8 Issue C8: Engaging Non-Governmental Organizations

Question Presented

How should an updated plan engage non-governmental organizations?

Background

There are numerous non-governmental organizations that have interest in earthquakes and active programs in post-earthquake reconnaissance and data collection. These include the American Concrete Institute (ACI), ASCE, EERI, GEER, the Natural Hazards Center, the Pacific Earthquake Engineering Research Center (PEER), the Southern California Earthquake Center (SCEC), and the Technical Council on Lifeline Earthquake Engineering (TCLEE).

Some of these organizations have interests in specific materials (e.g., ACI is interested in concrete-related construction), in building codes (e.g., ASCE), or in specific disciplines (e.g., GEER for geotechnical effects, SCEC for earthquake mechanisms and ground motions, and the Natural Hazards Center for hazards mitigation and disaster preparedness, response, and recovery). Other organizations have a broader mission in earthquake engineering (e.g., EERI approaches investigations primarily from a professional practice perspective, and PEER approaches investigations primarily from a research perspective).

A number of non-governmental organizations have long histories of earthquake reconnaissance following both domestic and foreign earthquakes. Currently, USGS Circular 1242 defines a number of roles for EERI, which is a non-governmental organization that has coordinated many multidisciplinary reconnaissance teams. It should be noted that some organizations receive funding in whole, or in part, from NEHRP agencies, while others receive no funding, and the level of support provided to non-governmental organizations in post-earthquake investigations has been evolving over time. Coordination with non-governmental organizations could facilitate post-earthquake investigations for all, and improve overall learning from earthquakes.

Alternative Solutions

1. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could postpone coordination efforts with non-governmental organizations until after an event occurs, allowing the coordination effort to take place after the nature of the event and the coordination needs are more clear.
2. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could commit to engaging appropriate non-governmental organizations in post-event coordination calls. The actual level of coordination would depend on the scope of the disaster, but contacts would be established in advance of an earthquake.
3. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program, along with its appropriate NEHRP agency partners, could identify appropriate non-governmental organizations and develop memoranda of understanding or other cooperative agreements in advance of an earthquake.
4. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could identify leading non-governmental organizations and conduct a workshop to identify optimal approaches for achieving pre-event agreement for post-event cooperation. This effort could be followed with the development of memoranda of understanding or other cooperative agreements, where appropriate, in advance of an earthquake.

Recommendations

Alternative Solutions 2 and 3 are recommended. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program should, as a minimum, make a commitment to engage appropriate non-governmental organizations in post-event coordination calls, and should maintain a contact list. Discussions with organizations that will potentially participate in post-earthquake investigations should be held to determine possible avenues for coordination. Where appropriate, where necessary to accomplish the NEHRP authorization mandates, or where otherwise beneficial, memoranda of understanding or other cooperative agreements should be pursued between individual NEHRP agencies and non-governmental organizations. After an event, if other non-governmental organizations are identified for which coordination would be beneficial, coordination should be pursued.

Because NEHRP agencies do not have the authority to direct the activities of non-governmental organizations, an updated plan should not assign any essential post-earthquake activities to non-governmental organizations. Furthermore, NEHRP agencies should not assume that historical activities of non-governmental organizations will continue in the future.

2.2.9 Issue C9: Investigating Effects that are not included in NEHRP Legislation

Question Presented

How should an updated plan address the investigation of important earthquake-related effects and damage to infrastructure that are not included in the authorizing NEHRP legislation?

Background

Earthquakes affect all aspects of the built environment, can result in additional physical effects beyond earthquake shaking (e.g., liquefaction, landslides, subsidence, and tsunamis), and can generate secondary hazards (e.g., fire, chemical release, and flooding). NEHRP, however, does not cover all earthquake-related phenomena or damage to all types of structures, and there are non-NEHRP agencies and organizations that focus on these other hazards and effects. It could be beneficial to integrate all government responses to an earthquake and related physical effects, but this must be done within current statutory requirements.

As an example, the effects of tsunamis generated by earthquakes are carefully documented by the tsunami research community, but funding is not provided through NEHRP. The National Tsunami Hazard Mitigation Program (NTHMP) was first formed by Congressional action in 1995 and strengthened by the Tsunami Warning and Education Act of 2006. The program is a partnership among NOAA, USGS, FEMA, NSF, and 28 U.S. coastal states, territories, and commonwealths. The Tsunami Warning and Education Act of 2006 also assigns NOAA, through the National Weather Service (NWS), the responsibility to provide tsunami alerts and notifications for tsunamis generated anywhere in the world that might impact U.S. states and territories. The NTHMP is a major source of Federal support for the tsunami warning system, the state tsunami programs, and the TsunamiReady program, which promotes community preparedness for tsunamis, and hazard assessment, mitigation, and readiness activities. The NTHMP also sets the standards for tsunami source identification, numerical modeling, and inundation and hazard mapping. Unless the Tsunami Warning and Education Act of 2006 is reauthorized, the future of the TsunamiReady program and state leadership for local tsunami hazard assessment, mitigation and preparedness will be at significant risk.

Other secondary hazards, such as fire following an earthquake, chemical release, flooding from dam or levee failure, or nuclear radiation, are important to post-earthquake investigations, but also are not specifically covered under the NEHRP legislation. USGS Circular 1242 does not mention investigation of these secondary hazards. Most, if not all, are already under the responsibility of Federal agencies, often not directly related to earthquake causation. However, certain NEHRP agencies, or the Coordinating Agency for the NEHRP Post-Earthquake

Investigations, may be involved in activities that cross over from NEHRP issues into these areas. Access to areas affected by some of these secondary hazards requires high-level expertise and training (e.g., fire, chemical release, and radiation), so it is prudent to restrict these activities to designated Federal agencies, who could then share data at a later date.

In addition to building structures, transportation systems and other infrastructure may be significantly affected by earthquakes. These systems are not included in NEHRP, but other agencies, such as FHWA and state transportation organizations (for transportation infrastructure), and U.S. Army Corps of Engineers (for dams or levees), frequently send out reconnaissance teams to collect important data.

At this time, the authorizing NEHRP legislation does not include tsunami effects, damage to transportation infrastructure, and other important earthquake hazards and effects, including chemical release, flooding, and nuclear radiation. NEHRP agencies cannot address issues outside of their authorization, which makes it challenging to provide a coordinated effort that addresses all important earthquake hazards and effects. At present, government agencies collaborate informally and share data after earthquakes, as is currently done by USGS and NOAA. NOAA uses data from USGS to issue tsunami warnings, and USGS includes links to the NOAA website on their event webpages.

Alternative Solutions

1. An updated plan could be strictly limited to the scope of the four NEHRP agencies, as defined in the latest reauthorization. Thus, it would not consider impacts from tsunamis, damage to transportation infrastructure, and other issues excluded from NEHRP authorization.
2. An updated plan could focus on the scope of the four NEHRP agencies, as defined in the latest reauthorization, but could direct the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program, to the extent practicable, to prepare for collaboration with other Federal agencies, earthquake-related programs, and non-governmental organizations that will be involved in investigating non-NEHRP earthquake hazards and effects.
3. An updated plan could explicitly acknowledge important secondary hazards and earthquake effects, and coordinate the activities of other Federal agencies, earthquake-related programs, and non-governmental organizations that will be investigating these effects. This would involve the development of memoranda of understanding or other cooperative agreements to facilitate post-earthquake coordination in advance of an earthquake.

Recommendations

Alternative Solution 2 is recommended. NEHRP agencies are limited by law from coordinating post-earthquake investigations in areas outside of their authorization. However, in the case of some earthquakes, secondary hazards and other earthquake-related effects can become extremely important, and the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program should be prepared to coordinate with relevant agencies when warranted, and when resources are sufficient.

2.2.10 Issue C10: Coordinating with Post-Earthquake Response and Recovery Operations

Question Presented

Should an updated plan acknowledge coordination with agencies defined in the National Response Framework and the National Disaster Recovery Framework, and can NEHRP post-earthquake investigations inform post-earthquake response and recovery?

Background

As described in USGS Circular 1242, a key purpose of coordinating post-earthquake investigations is to enable NEHRP to be in a stronger position to provide input, and to work more effectively, with officials involved in post-earthquake emergency response activities. However, USGS Circular 1242 primarily emphasizes information gathering and documentation, and does not address Federal response and planning (primarily because the two main frameworks for disaster response and recovery did not exist when it was developed). The National Response Framework (DHS, 2013) was first developed in 2008, and updated May 2013, and the National Disaster Recovery Framework (FEMA, 2011) was developed in 2011. These are two of five National Planning Frameworks that help fulfill *Presidential Policy Directive/PPD-8: National Preparedness* (PPD-8, 2011) calling on Federal agencies to work with the whole community in developing a national preparedness goal and a series of frameworks and plans related to reaching the goal.

The National Response Framework is a guide on how the nation responds to all types of disasters and emergencies. It is built on scalable, flexible, and adaptable concepts identified in the National Incident Management System (NIMS), which is based on the Incident Command System (ICS), to align key managing roles, responsibilities, and coordinating structures across multiple levels of government and with other partner organizations. The framework focuses on immediate response in the initial recovery period following an incident. Fifteen Federal emergency support functions (ESFs) comprise the primary, but not exclusive, coordinating structure for building, sustaining, and delivering the capabilities of Federal departments and other national-level assets (DHS, 2013). Each emergency support function has a designated Federal

agency as the ESF Coordinator along with a number of primary and support agencies. Federal agencies supporting emergency support functions may be selectively activated by FEMA, or directed by the Secretary of Homeland Security, to support response activities. FEMA may also assign Federal agencies to obtain specific response resources and services.

The National Disaster Recovery Framework is a guide that enables effective recovery support to disaster-impacted states, tribes, territories, and local jurisdictions. It also defines a coordinating structure that can be activated and scaled as appropriate, depending upon the size and nature of the disaster. The coordinating structure centers around several key positions, including Federal, State, and Tribal Disaster Recovery Coordinators (FDRC, SDRC, and TDRC, respectively) and Local Disaster Recovery Managers (LDRMs), as well as six recovery support functions (RSFs). FEMA is designated as the lead Federal agency to facilitate and coordinate recovery support function activities and recovery planning at the national level, and a Federal agency is designated as the RSF Coordinator along with a number of primary agencies and supporting organizations. The timeframe of the National Disaster Recovery Framework can extend for months, even years, following a major disaster.

Input from NEHRP agency representatives suggests that an updated plan for coordinating post-earthquake investigations should be more clearly linked with the National Response Framework and National Disaster Recovery Framework activities to enhance support and potential funding for NEHRP post-earthquake investigation activities. An updated plan, interagency coordination, communication, data sharing, and investigation products also need to be consistent and interchangeable with National Incident Management System practices, such as the Unified Incident Command and Decision Support (UICDS), which provides information sharing middleware that continuously receives and shares standardized data among many agencies during an incident (<http://www.uicds.us/>). Furthermore, NEHRP post-earthquake investigation products and insights could be a potential resource available to National Response Framework and National Disaster Recovery Framework activities and other post-earthquake response and recovery operations. Thus, there is a real opportunity for benefiting both the NEHRP investigations and response and recovery operations.

Because NEHRP is not an agency in and of itself, and funds cannot be transferred to it, NEHRP would not be directly tasked to perform this work. However, individual NEHRP agencies perform response and recovery related activities under their own authority and funding, or through reciprocal mutual assistance and reimbursement agreements, and do not require a Presidential declaration to do so. Also, with respect to the National Response Framework and National Disaster Recovery Framework, individual NEHRP agencies have specifically defined roles, and can also be individually tasked to perform required response and recovery functions.

For example, the National Response Framework states that any Federal agency responding to an incident may also request support from the Secretary of Homeland Security in obtaining and coordinating additional Federal assistance. The Secretary of Homeland Security may activate one or more emergency support functions to provide the requested support (DHS, 2013). However, it will be difficult to task non-Federal partner organizations with key roles in an updated NEHRP post-earthquake coordination plan, and this problem is likely to persist regardless of linkages made to the National Response Framework and National Disaster Recovery Framework.

Alternative Solutions

1. Response and recovery operations are beyond the scope of a NEHRP coordination effort. Therefore, an updated plan could ignore consideration of issues associated with response and recovery.
2. Each NEHRP agency has specific roles and functions that are defined by agency standard operating procedures, and the current definition of NEHRP agency post-earthquake coordination activities contained in USGS Circular 1242 could be deemed adequate.
3. An updated plan could reflect the coordinating structures established by the National Planning Framework, including the National Response Framework, the National Disaster Recovery Framework, and supporting annexes. It could clarify how NEHRP interagency coordination, communication, data sharing, site access, logistics, and safety fit within these coordinating structures. It could also better indicate how NEHRP post-earthquake investigations, and the real time, on-site information they can provide, could be a resource for emergency support functions and recovery support functions in the National Planning Framework, and other post-earthquake response and recovery operations. In order to be effective, the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could work in advance of an earthquake to develop alliances with other Federal agencies in accordance with the responsibilities assigned to them in the National Response Framework and the National Disaster Recovery Framework, and then work to facilitate voluntary coordination following a major earthquake.
4. Response and recovery roles and products for NEHRP post-earthquake investigations could be detailed in an appendix to an updated plan. Roles and products could be aligned with the emergency support functions and recovery support functions and coordinating structure established by the National Planning Framework, including the National Response Framework, the National Disaster Recovery Framework, and supporting annexes. The appendix would need to be periodically reviewed to ensure consistency with the National Planning Framework as it evolves.

Recommendations

Alternative Solution 3 is recommended so that the plan reflects the coordinating structures established by the National Planning Framework, including the National Response Framework, the National Disaster Recovery Framework, and supporting annexes, and better indicates how NEHRP post-earthquake investigations fit within, and support, response and recovery plans, incident management systems and practices, and coordinating structures.

2.3 Data and Technology

2.3.1 Issue D1: Using Technology for Post-Earthquake Reconnaissance Coordination

Question Presented

How should information technology be used to coordinate post-earthquake reconnaissance activities?

Background

Modern information technology has revolutionized the manner in which the effects of an earthquake are communicated. The ever-expanding number of online geographic information system (GIS) technologies has transformed the way that data are managed and displayed. Remote sensing (e.g., satellite imagery through prearranged agreements such as the International Charter for Space and Major Disasters) can provide images of damage across large areas. Web-based tools, such as USGS ShakeMap, “Did You Feel It?,” and PAGER provide estimates of the distribution of ground shaking and associated consequences soon after an event, which are updated as additional information becomes available. The USGS ShakeCast tool provides specific information to agencies and owners, such as peak ground acceleration estimated at each Caltrans bridge or each Department of Veterans Affairs hospital. News agencies quickly obtain and disseminate available information, and the general public uses various forms of social media to share images and videos in affected areas. An event website can collect, track, and share data with investigators and the general public around the world.

Current technologies provide many opportunities to coordinate post-earthquake reconnaissance activities, and additional technological developments are likely to occur over relatively short periods of time. As technology and tools evolve, capabilities increase, but challenges can arise. Existing tools can become quickly outdated, and it can be difficult and costly to stay abreast of the latest technologies and how to best utilize them. Additionally, Federal agencies may not be able to use certain specific commercial technologies for a number of reasons (e.g., legal and security concerns), and such restrictions need to be considered.

Alternative Solutions Regarding the Use of Information Technology to Coordinate Post-Earthquake Activities

1. The use of information technology is a constantly evolving technical issue that affects how individual investigators operate, but it could be too costly to develop methods that effectively capitalize on the use of information technology to coordinate post-earthquake investigation activities. Therefore, an updated plan could ignore consideration of the use of information technology in coordination.
2. Advanced technologies for data sharing and visualization can help coordinate post-earthquake investigation activities more effectively. For example, GIS platforms provide the most effective means for displaying data spatially, and GIS inventories of infrastructure can be loaded into a system before an event to be used as a GIS platform for post-event coordination. Thus, information technology can be an integral part of coordinating post-earthquake investigations, and should be considered in an updated plan.
3. Satellite resources (e.g., the International Charter for Space and Major Disasters) and aerial reconnaissance (e.g., airborne light detection and ranging (LIDAR) systems) can provide powerful data for visualizing the effects of earthquakes. Protocols necessary for accessing and utilizing these data immediately following an event could be developed prior to an earthquake to better permit formulating plans and coordinating post-earthquake investigations.

Alternative Solutions Regarding the Hosting of a Post-Earthquake Reconnaissance Event Website

1. The USGS is in the best position to host a post-earthquake reconnaissance event website that could be used to coordinate post-earthquake activities, because it already hosts an event website that includes tools such as ShakeMap and PAGER.
2. Depending on the future of the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES), the online NEEShub portal could host a post-earthquake reconnaissance event website that would be used to help coordinate post-earthquake activities and apply its data management tools to most effectively share data across multiple investigative and research teams.
3. No single organization will be able to host all aspects of post-earthquake reconnaissance activities. In addition, redundancy is desirable. Thus, several linked websites could be employed in a coordinated manner to host all necessary post-earthquake reconnaissance information.

Recommendations

For coordination of post-earthquake activities, Alternative Solutions 2 and 3 are recommended for incorporating the use of information technology because GIS and

satellite resources are considered to have immense potential for improving post-earthquake coordination and investigation.

For hosting of a post-earthquake reconnaissance event website, Alternative Solution 3 is recommended to maximize redundancy and flexibility.

2.3.2 Issue D2: Using Technology for Data Collection

Question Presented

How should information technology be used to improve the collection of data?

Background

Modern information technology has revolutionized the manner in which data on earthquake effects are collected. USGS Circular 1242 discusses this issue in detail in its recommendations for further action. Data are amenable to collection using remote sensing, digital imaging, global positioning systems, and other new and emerging technologies in ways that are more efficient than ever before. A wide variety of data, which previously could not be collected, or only collected with great effort, can now be collected and analyzed rapidly, often in near-real time. Digital photography with GPS-enabled devices provides for the collection of images that are each geo-located and time-stamped. Smartphones, personal electronic devices, and tablet computers can digitally record observations, which can then be readily shared among team members. A variety of GIS platforms have transformed the way that collected data are managed and displayed. Satellite imagery can depict damage across large areas. LIDAR devices can rapidly collect quantitative data documenting the ground topography and facility geometry at key sites. Total stations and other digital mapping tools can quickly capture quantitative data. An event website can be used to collect, share, store, and archive data that have been collected.

Current and future technologies can be used to provide information on:

- Regional geodetic and geological effects through remote sensing.
- Recordings of strong shaking by smartphones on the ground and in engineered structures during the main shock and aftershocks.
- Ground deformations associated with faulting, liquefaction, landslides, and shaking.
- System responses (e.g., pressures and flows in gas, water, and wastewater systems; telephone demand surges; and traffic patterns).
- Collateral dynamic phenomena (e.g., growth and spread of post-earthquake fires and hazardous material releases) through remote sensors.
- Data on earthquake casualties and on other social and economic impacts using crowdsourcing.

There is a pressing need to more efficiently capture perishable data in the field and to ensure that collected data are in a format that is compatible with an accepted national data repository (e.g., NEEShub or the NIST Disaster and Failure Studies Data Repository). There are challenges, however, as data collected by some Federal agencies (e.g., NIST) may not be shared with other agencies until after the investigation is complete. In some cases, security of data is also a concern. Moreover, the minimum data collection criteria utilized by NEHRP agencies and post-earthquake reconnaissance teams need to consider the basic requirements for archiving data. It is important to recognize that it is most important to collect highly perishable data during the window of opportunity, and any standardized approach needs to maintain flexibility so that researchers can respond to conditions in the field.

Alternative Solutions

1. The use of information technology is a constantly evolving technical issue that affects how individual investigators operate, but it could be too costly to develop a comprehensive plan utilizing the latest technology to collect data after each earthquake. Therefore, an updated plan could ignore consideration of the use of information technology in data collection.
2. Advanced technologies can be used to collect post-earthquake data more effectively than traditional data collection techniques. Post-earthquake reconnaissance team members could be trained and supported in the use of the latest technologies so that critical data are not lost. However, it could be too cumbersome to implement a standardized data collection protocol for all to use, although a minimum set of data collection criteria could be established as a guide.
3. Discipline-specific standardized data collection protocols could be developed, because it is unlikely that one standardized data collection protocol could be developed that would efficiently capture all relevant data for all disciplines. However, discipline-specific protocols could be developed such that they share a common structure to allow data to be shared.
4. A standardized data collection protocol could be established by the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program, and all post-earthquake reconnaissance teams could be required to adhere to this protocol. A GIS platform could be an integral part of the data collection protocol because it provides the most effective means for spatially displaying data.

Recommendations

Alternative Solution 3 is recommended because it is achievable, and represents a good first step forward in utilizing advances in information technology to more effectively collect post-earthquake performance data on a discipline-specific basis.

2.3.3 Issue D3: Archiving Data

Question Presented

Should an updated plan consider how data from post-earthquake investigations are archived?

Background

No mechanism currently exists to archive data from post-earthquake investigations or to make data readily accessible to the research community at a later date. These data, which focus on the natural, built, and socioeconomic environments, document the effects of a variety of phenomena. The data are voluminous and are acquired in many forms (e.g., digital recordings, digital images, electronic notes, and handwritten notes). If not organized and archived soon after an event, they are effectively lost. Because of failure to adequately document, preserve, and archive data, an enormous volume of highly relevant data are not readily available from past earthquakes. It is considered critical to develop strategies for the formal and systematic archiving of data collected during post-earthquake investigations. This issue was discussed in some detail in USGS Circular 1242 recommendations for further action.

As technology and tools evolve, capabilities increase, but challenges can arise as the data become more voluminous and must then be processed and archived for future use. A successful data archiving system should enable investigators to efficiently store collected data, and allow researchers to locate and use these data in independent research efforts years after the event.

Alternative Solutions

1. Data archiving is not a post-earthquake coordination issue. Therefore, an updated plan could ignore consideration of data archiving issues.
2. Well-documented case histories are highly desirable, tangible outcomes of post-earthquake reconnaissance. A properly coordinated post-earthquake reconnaissance effort could attempt to maximize the quantity and quality of well-documented case histories with data in the proper format for archiving. Thus, data collection and archiving protocols are an integral part of coordination of post-earthquake investigations, and should be included in an updated plan.
3. A standardized data archiving protocol could be established by the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program and all post-earthquake reconnaissance teams could be required to adhere to this protocol. All data could be uploaded into a post-earthquake reconnaissance database soon after it is collected so that it is not lost.
4. Data archiving can be difficult because software may become obsolete. In addition, the diversity of data collected in the field might make it difficult to

develop a single workable data repository for archiving all available data. Multiple discipline-specific archives could be developed using the technology available at the time, with the recognition that data needs may differ between disciplines, and that data formats may need to be periodically updated as software becomes obsolete.

Recommendations

Alternative Solution 1 is recommended. Data archiving is a critical element in the ability to learn from earthquakes, but it should be done outside of the plan for coordinating NEHRP post-earthquake investigations. This is a challenging issue that will likely take significant time and resources to resolve.

2.4 Funding

2.4.1 Issue F1: Funding for Coordinated NEHRP Post-Earthquake Investigations

Question Presented

How should funding for NEHRP post-earthquake investigations, including ongoing support for coordination activities between disasters, be handled?

Background

As noted in USGS Circular 1242, the absence of readily available financial resources to fund immediate, short-term, and long-term post-earthquake investigations has resulted in a failure to collect valuable data vital for the development of earthquake disaster reduction measures, and has handicapped substantial follow-up research investigations. However, funding can only be provided to the individual NEHRP agencies and not to NEHRP itself.

For the 1989 Loma Prieta and 1994 Northridge earthquakes, Congress approved emergency supplemental funding for post-earthquake investigations with allocations made to NEHRP agencies. USGS Circular 1242 specifies that “NEHRP agencies shall convene within a few days after the earthquake to consider a request for a budget supplement.” USGS Circular 1242 also recommends that a standing post-earthquake investigation selection committee be created to assist the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program in identifying investigation topics, distribution of the funds, and reporting of results to Congress.

The NEHRP agencies have long acknowledged that reliance on emergency supplemental budget requests is neither the best, nor the most efficient means to fund post-earthquake investigations. A 1993 report to Congress, prepared by FEMA, summarized the benefits of post-earthquake investigations, and suggested several alternative approaches for establishing a permanent fund for this purpose (FEMA, 1993). To date, such a fund has not been established.

FEMA has the ability to develop a mission assignment in advance of disasters, which can help with securing post-disaster funding for agencies or partner organizations, but this may not be easily achieved. To date, FEMA Earthquake Program staff has been unable to secure post-earthquake clearinghouses as a prescribed mission assignment.

There has never been a dedicated budget for NEHRP agencies to maintain a plan for coordination of post-earthquake investigations. NEHRP agencies have relied upon existing appropriations to fund ongoing NEHRP coordination activities between disasters; however, this reliance has become increasingly difficult as agency budgets have tightened.

An effective plan needs to be updated regularly to reflect changes in agency policies and budgets, changes in technology, and updates to the national disaster planning frameworks. Successful implementation of a plan also requires that there is staff and funding to perform necessary duties between disasters, and that there is ongoing collaboration and communication between the NEHRP agencies and partner organizations to ensure that post-earthquake investigation procedures are up to date and consistent with plan assumptions when a disaster occurs.

Alternative Solutions

1. Although funding is critical for implementation of post-earthquake investigation activities, it is beyond the scope of a NEHRP coordination effort. Therefore, an updated plan could ignore consideration of funding issues.
2. NEHRP agencies could continue to rely on existing appropriations to fund ongoing activities related to the plan, as well as post-earthquake investigations, and prepare budgets accordingly. This would include provision for ongoing funding of the work of the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program in between disasters.
3. The current process described in USGS Circular 1242 could be continued, in which NEHRP agencies develop an event-specific budget and request emergency supplemental funding to investigate an earthquake event after it occurs.
4. The current process of requesting emergency supplemental funding could be continued, but the procedures outlined in USGS Circular 1242 could be revised in an updated strategy. The following options could be considered as part of the revision process:
 - a. The Stafford Act could be amended to provide dedicated funding for post-earthquake investigations, and follow-on focused research efforts, for earthquakes in which a Presidential disaster declaration has occurred. USGS Circular 1242 proposed that 1% of the overall Federal disaster-related expenditures could be dedicated to this purpose. This approach is similar to

how Section 404 of the Stafford Act provides funds for post-disaster hazard mitigation projects.

- b. NEHRP agencies could work through FEMA to develop a mission assignment in advance of disasters that can help to secure post-disaster funding, as well as ongoing funding, for agencies or partner organizations.
- c. For earthquakes that have resulted in a Presidential disaster declaration, NEHRP agencies could work through FEMA and the disaster Federal Coordinating Officer to obtain funding for post-disaster investigation activities.
- d. NEHRP agencies could use the National Construction Safety Team Act, and NIST-funded teams enabled by the Act, to investigate building failures. However, other NEHRP investigation activities would need to be funded by existing agency funds, or alternative means.

Recommendations

Funding decisions are outside the control of NEHRP, and were considered beyond the scope of the development of an updated coordination plan. As a result, none of the alternative solutions for funding was specifically recommended.

Funding is critical to the implementation of a post-earthquake investigation plan. Implicit with a decision to implement any of the elements of an updated plan is the assumption that the necessary funding will be provided. *NEHRP agencies are strongly encouraged to continue working to secure a permanent and dedicated funding source for ongoing post-earthquake planning activities, and eventual post-earthquake investigation activities.*

2.5 Site Access

2.5.1 Issue A1: Obtaining Permission to Access Restricted Areas

Question Presented

How should permission to access restricted areas be obtained for post-earthquake investigators representing NEHRP agencies and their partner organizations?

Background

Since the terrorist attacks in the United States on September 11, 2001, response to disasters has become more visible and organized. Historically, access to earthquake disaster areas has been largely unfettered, but no major earthquakes have occurred in the United States since 1994. It is noted that access was restricted following more recent moderate-level earthquakes: the 2008 Wells, Nevada M_w 6.0 earthquake, and the 2012 Mineral, Virginia M_w 5.8 earthquake.

It is anticipated that access to disaster areas will become more restricted in the future. Motivation for restricting access to disaster areas includes: (1) potential interference with emergency responders and recovery efforts; (2) safety of non-essential personnel; (3) liability; (4) security of property; and (5) concern over tampering with evidence. However, important opportunities for collection of perishable data may be lost if timely access for post-earthquake investigators is denied.

Most disasters will affect many jurisdictions, and access to restricted areas will be controlled by a combination of state and local law enforcement officials (e.g., police officers, sheriffs, highway patrol, and the National Guard). As a result, gaining access to restricted areas may require permissions from multiple entities. Qualifications for entry are established by the authorizing official (or officials), but actual entry will be determined by personnel at access points. The decision to approve entry is generally determined by the credentials of the visitor and the stated purpose for entry.

Alternative Solutions

1. Access could be handled on an individual, case-by-case basis. Often earthquake professionals know public officials with whom they can negotiate access.
2. In advance of an earthquake, Federal agencies could designate employees who are expected to participate in post-earthquake investigations as Federal Emergency Response Officials (F/ERO). These are employees who are needed to restore or maintain continuity of operations after a disaster. The designation is indicated on the standardized Federal employee identification cards (or SmartCards) by a red stripe at the bottom front of the card. Such designations have already been made by FEMA and NIST.
3. Following an earthquake, Federal agencies could create and provide individual documentation that requests permission to enter restricted areas. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could also contact local resources to determine a uniform process for gaining access to restricted areas.
4. Technical clearinghouses can provide an organized process for obtaining credentials that will permit access to restricted areas. For example, the California Earthquake Clearinghouse has an agreement with the California Office of Emergency Services (CalOES), and is in the process of formalizing a credentialing process that would apply to both Federal and non-Federal personnel. In areas where plans for clearinghouses are less advanced, the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could encourage rapid establishment of clearinghouses that include provisions for coordinated access to restricted areas.

Recommendations

Alternative Solution 4 is recommended, but all alternative solutions should be pursued because the authorizing NEHRP legislation does not contain statutory authority to either seek or grant access to restricted areas. NEHRP agencies should determine how potential post-earthquake investigators, contractors, and partnering organizations could obtain appropriate credentials before an event.

2.5.2 Issue A2: Managing and Coordinating Access for Non-NEHRP Post-Earthquake Investigators

Question Presented

Should NEHRP manage and coordinate access for post-earthquake investigators that are not affiliated with NEHRP agencies? This issue includes prioritizing and possibly leading post-earthquake investigations, coordinating schedules of large groups of outside investigators, and organizing and coordinating meetings (or briefings) with impacted agencies and entities.

Background

Modern earthquake disasters are attracting a growing number of scientists and engineers who are interested in observing and documenting the nature of the event and its associated impacts. Investigators come from private and public sectors, as well as the academic and professional practice communities. While post-earthquake investigators frequently have collegial relations, there is no overarching organizational control of how their investigations are conducted or coordinated. The number of investigators can potentially become large enough to interfere with emergency response, recovery, and reconstruction activities.

Although NEHRP interests are broad in scope, NEHRP post-earthquake investigators are only a subset of the community interested in post-earthquake investigations. Some informal organizational leadership currently exists, and generally follows professional interests. NEHRP agencies participate, to some extent, in many of these organizations and interests. For example, USGS commonly coordinates fault rupture mapping and deployments of portable seismic instrumentation, GEER coordinates geotechnical surveys, and TCLEE organizes investigations of pipeline performance. Historically, EERI has coordinated a broad spectrum of professional interests ranging from earth science, to engineering and social science. This informal leadership, while strong in the period immediately following an earthquake, may diminish over time.

Another self-organizing factor in a post-earthquake environment is the technical clearinghouse. The California Earthquake Clearinghouse has evolved from an impromptu organization to a quasi-permanent organization with a well-defined

structure. Other states have sought to emulate this model. The organizational role of clearinghouses, however, also tends to diminish with time following an earthquake.

Alternative Solutions

1. NEHRP agencies may play a lead role in coordinating post-earthquake investigations, but NEHRP does not have the authority or staff to manage and coordinate access for all post-earthquake investigators. Therefore, an updated plan could ignore the coordination of access for investigators that are not affiliated with NEHRP.
2. NEHRP agencies could defer to technical clearinghouses to coordinate the various investigations teams. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could ensure that local, state, or Federal clearinghouses are established as soon as possible after the event, and that these clearinghouses include a system or protocol for coordinating the activities of all investigators who visit the affected region.
3. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could assign a technical person to coordinate access for all post-earthquake investigators representing NEHRP agencies, and this role could also include coordination of investigators that are not affiliated with NEHRP.

Recommendations

Alternative Solution 2 is recommended. Managing and coordinating the schedules of the potential number of scientists and engineers who are interested in observing and documenting earthquake effects is recognized as an important but challenging issue. A solution or process is needed, and working through clearinghouses seems to be the most efficient and effective alternative. In locations where state or regional planning for a clearinghouse has not taken place, the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could encourage the establishment of one.

2.5.3 Issue A3: Avoiding Interference with Emergency Response Operations and Emphasizing Personal Safety

Question Presented

How should NEHRP agencies ensure that post-earthquake investigators avoid interference with emergency response operations and emphasize safety for themselves and their colleagues?

Background

Post-earthquake investigations conducted in the immediate aftermath of an earthquake can potentially interfere with emergency response and recovery operations. Because most of the affected population typically shelters in place, the

presence of post-earthquake investigators can also disturb, or draw resources from, victims of the disaster.

The safety of NEHRP post-earthquake investigators, and the resulting liability for their safety, is also a concern. In addition to the normal perils associated with field work, earthquake disaster areas are inherently more dangerous immediately after an event. Aftershocks can trigger additional damage, collapses, and rock falls. Structures and infrastructure that are modestly damaged can pose environmental hazards.

Alternative Solutions

1. An updated plan could continue the current ad hoc safety system, and rely on experienced mentors to guide investigators in the field.
2. The Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could develop a policy statement that: (1) emphasizes to investigators the priority of emergency responders and reminds them not to interfere with emergency response operations; and (2) alerts investigators to the increased hazard present in earthquake disaster areas, and reminds them of the importance of enhanced personal safety.
3. Each NEHRP agency could develop and distribute a policy statement (similar to that identified in Alternative Solution 2) to its Federal employees who conduct post-earthquake investigations, and require that they sign it. Each agency could engage in training to ensure that its employees are adequately informed about this issue. USGS and NSF could also distribute such a policy statement to grantees, contractors, and volunteers who are involved in a post-earthquake investigation at the time that awards are made.
4. The technical clearinghouses could be relied upon to provide guidance on avoiding interference with emergency response and adhering to good safety practices while in the field.

Recommendations

Alternative Solution 3 is recommended. It was suggested that a combination of Alternative Solutions 2 and 3 might provide the best approach, but NEHRP agency representatives generally felt that this issue was best addressed by the individual NEHRP agencies rather by the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program.

2.6 International Considerations

2.6.1 Issue 11: Coordinating Investigations of Foreign Earthquakes

Question Presented

How should investigations of foreign earthquakes by NEHRP agencies and partner organizations be coordinated?

Background

Post-earthquake investigations in foreign countries can pose special challenges for NEHRP agencies. These challenges include:

- Some earthquakes provide political opportunities to use NEHRP in improving foreign relations with affected countries. One such example is the 1988 Armenian earthquake, in which the Soviet Union requested technical assistance from the United States. This request led to a multidisciplinary post-earthquake investigation by both U.S. government and non-government scientists and engineers, and a long-term deployment of portable seismic stations in Armenia. The team was organized by the USGS in collaboration with NSF. Taking place near the end of the cold war, the deployment contributed to improving foreign relations between the United States and the Soviet Union. A second example is the USGS Earthquake Disaster Assistance Team program, which is supported by the U.S. Agency for International Development Office of Foreign Disaster Assistance. These teams are organized after an earthquake disaster to provide technical support to foreign countries that have been severely impacted.
- Some earthquakes occur in countries with which relations are severely strained, or are inherently unstable and dangerous. One such example is the 2013 Iranian earthquake. Post-earthquake investigations under these circumstances are primarily for scientific learning, rather than for political gain. Such investigations, however, have the potential to aggravate already poor foreign relations and put investigators at risk.
- Some earthquakes are deemed to be particularly relevant to U.S. practice, and attract a large number of U.S. scientists and engineers. In smaller countries (e.g., the 1999 Chi Chi, Taiwan earthquake), a large number of foreign investigators can be a possible imposition on local technical professionals, and these professionals may be an important part of foreign emergency response efforts. Even in larger, well-developed countries, a large number of post-earthquake investigators (even if well-organized) can be a distraction to local scientists and engineers who are actively involved in the post-earthquake response.

The decision to implement a coordinated NEHRP investigation of a foreign earthquake is impacted by political considerations. The trigger for investigation is

subjective, and may involve consultation with the U.S. Department of State. It is important to note that FEMA and NIST, due to their mandates, may only participate in the investigation of foreign earthquakes when there is strong relevance to U.S. codes and standards. At present, USGS Circular 1242 emphasizes the role for international coordination that has been performed by EERI through its Learning from Earthquakes program. Some earthquakes may only attract modest attention from U.S. investigators, and organizations like EERI and GEER can take advantage of their international membership to organize post-earthquake investigations that include local professionals and researchers.

Alternative Solutions

1. An updated plan could ignore coordinated investigation of foreign earthquakes, and consider investigation on an ad hoc basis.
2. An updated plan could include NEHRP agencies reporting to the overall Lead Agency for NEHRP (currently NIST) before providing support to a foreign post-earthquake investigation.
3. An updated plan could assign to the overall Lead Agency for NEHRP (currently NIST) the responsibility to identify earthquakes that are: (1) politically significant; and (2) capable of attracting a large number of investigators from the United States, and to determine the number of investigators and scope of potential investigations. Upon establishing the size and scope of potential U.S. investigations, the Lead Agency for NEHRP could establish a plan for a coordinated deployment, if appropriate. This could be done in consultation with the U.S. Department of State.
4. An updated plan could assign to the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program (currently USGS) the responsibility to identify earthquakes that are: (1) politically significant; and (2) capable of attracting a large number of investigators from the United States, and to determine the number of investigators and scope of potential investigations. Upon establishing the size and scope of potential U.S. investigations, the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program could establish a plan for a coordinated deployment, if appropriate. This could be done in consultation with the U.S. Department of State.

Recommendations

Alternative Solution 4 is recommended. There was no strong consensus for having a Federal agency in control of foreign earthquake investigations, but it is important to note that none of the proposed solutions have mechanisms for enforcing coordination between NEHRP agencies or partner organizations.

2.6.2 Issue 12: Hosting Foreign Post-Earthquake Investigators of Domestic Earthquakes

Question Presented

Should NEHRP have a system and protocol for hosting foreign post-earthquake investigators who come to study earthquakes in the United States?

Background

Experience with foreign earthquakes in the last two decades indicates that significant earthquakes can attract a large number of international scientists and engineers from around the world who are interested in observing and documenting earthquake effects. Thus, it can be anticipated that a large, consequential earthquake in the United States may attract many post-earthquake investigators from other countries. Local technical professionals and researchers in other countries have graciously hosted U.S. investigators after earthquakes, and it seems reasonable that they would expect the same courtesy after an earthquake in the United States. It is anticipated that foreign earthquake scientists and engineers who are in the United States at the time of an earthquake might participate in domestic post-earthquake response along with their host colleagues.

Scientists and engineers affiliated with NEHRP will likely have strong professional ties with potential foreign investigators. In many cases potential foreign investigators may have: (1) hosted investigators from the United States after earthquakes in their own country; (2) collaborated on research or consulting projects; or (3) been former students, professors, or employees of investigators in the United States. In addition, some U.S. organizations and agencies have protocols with their counterparts in other countries to promote such exchanges. An example is the United States-Japan Cooperative Program in Natural Resources (UJNR). The UJNR protocol was the basis for organized visits to Japan by many U.S. scientists and engineers after the 1995 Kobe Earthquake.

Alternative Solutions

1. An updated plan could handle hosting of foreign investigators on an ad hoc basis.
2. In advance of an earthquake, NEHRP agencies could convene a meeting with professional and scientific entities in other countries with an interest in post-earthquake investigations to develop a consensus plan for how foreign investigators could be hosted under various conditions.
3. Following an earthquake, NEHRP could identify scientists and engineers who are willing to serve as hosts and facilitators for foreign investigators. As facilitators, designated hosts would: (1) become familiar with access and logistics, as well as the identities of local officials and experts, and (2) organize visits to the disaster area.

Recommendations

Alternative Solution 2 is recommended because many foreign investigators will be hosted by domestic colleagues who may not be affiliated with NEHRP agency representatives. Any of the alternatives involving hosting of foreign investigators will be very resource intensive for the NEHRP Agencies to consider.

Twenty-four issues have been identified for consideration in updating USGS Circular 1242 to create a new or revised plan for coordination of NEHRP post-earthquake investigations. These issues, along with their recommended solutions, form a framework to be used in the development of an updated plan. The issues are intended to be used by an eventual team of experts and stakeholders charged with the development of an updated plan, considering the framework presented in this report, information contained in USGS Circular 1242, and any possible updated NEHRP legislation. This chapter provides a summary of the issues discussed, and highlights those issues that are considered to be of special importance.

3.1 Overview of Issues

The issues cover a wide range of topics ranging from how and when the plan should be updated, to whether specific aspects of the plan should be changed from the current approach outlined in USGS Circular 1242. Presented in Table 2-1, the overall list of issues is organized in terms of the following categories:

- Scope, Development, and Maintenance
- Coordination
- Data and Technology
- Funding
- Site Access
- International Considerations

Considering their relative impact on a future effort to update USGS Circular 1242, the issues can be re-grouped into the following categories:

- Issues regarding the timing and development of an updated plan
- Issues regarding the scope and content of an updated plan
- Issues that are not considered to be part of an updated plan

These revised groupings are presented in Tables 3-1 through 3-3. Regarding timing for update of the plan contained in USGS Circular 1242, there was strong consensus that the plan should be updated as soon as possible. It was acknowledged that the

Table 3-1 Issues Regarding the Timing and Development of an Updated Plan

Reference No.	Issue Title	Report Section
S2	Timing for update of the existing plan	2.1.2
S3	Participants in the development of an updated plan	2.1.3
S5	Maintaining the plan	2.1.5

Table 3-2 Issues Regarding Scope and Content of an Updated Plan

Reference No.	Issue Title	Report Section
S1	Scope of the plan	2.1.1
S4	Format of the plan	2.1.4
C1	Developing technical clearinghouses	2.2.1
C2	Role of the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program	2.2.2
C3	Role of the NEHRP Investigations Coordinator	2.2.3
C4	Triggering coordinated post-earthquake investigations	2.2.4
C5	Terminology for discussing post-earthquake investigations	2.2.5
C6	Engaging non-NEHRP Federal agencies	2.2.6
C7	Engaging regional, state, and local agencies	2.2.7
C8	Engaging non-governmental organizations	2.2.8
C9	Investigating effects that are not included in NEHRP legislation	2.2.9
C10	Coordinating with post-earthquake response and recovery operations	2.2.10
D1	Using technology for post-earthquake reconnaissance coordination	2.3.1
A1	Obtaining permission to access restricted areas	2.5.1
A2	Managing and coordinating access for non-NEHRP post-earthquake investigators	2.5.2
A3	Avoiding interference with emergency response operations and emphasizing personal safety	2.5.3
I1	Coordinating investigations of foreign earthquakes	2.6.1
I2	Hosting foreign post-earthquake investigators of domestic earthquakes	2.6.2

Table 3-3 Issues Not Considered to be Part of an Updated Plan

Reference No.	Issue Title	Report Section
F1	Funding for coordinated NEHRP post-earthquake investigations	2.4.1
D2	Using technology for data collection	2.3.2
D3	Archiving data	2.3.3

plan could be updated more specifically, and more effectively, if the NEHRP legislation were reauthorized and any decisions regarding the overall Lead Agency for NEHRP (currently NIST) and the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program (currently USGS) were known. However, it was considered more critical to have an up-to-date coordination plan in place because a significant earthquake could occur at any time. It was envisioned that USGS, as the current Coordinating Agency for the NEHRP Post-Earthquake Investigations Program, would be responsible for launching any near-term update of the existing plan. The decision to update now, or to wait, could be made based on an assessment of the potential for prompt action on pending NEHRP legislation.

Issues outlining recommendations regarding the scope and content of an updated plan (Table 3-2) are intended to provide guidance for an eventual update, but there was strong consensus that a workshop attended by all significant parties interested in post-earthquake investigations should be held to gain broader consensus on the most appropriate resolution for each issue. The issues, as outlined, could be used to form an agenda for such a workshop.

Issues that are not considered to be part of an updated plan (Table 3-3) are considered important to the implementation of a coordinated NEHRP post-earthquake investigations plan, but beyond the scope of the plan itself. Some of these are discussed in relevant resources reviewed as background material for this report, and were also included as recommendations for further action outlined in USGS Circular 1242. Although they are not expected to be specifically included in an updated plan, it is recommended that they be considered as part of the overall context of a putting a plan in place to help ensure that NEHRP post-earthquake investigations are successfully implemented when a triggering event occurs.

3.2 Issues of Special Importance

The issues identified in Table 3-4 are highlighted as needing particular attention in the development of an updated plan for coordinated NEHRP post-earthquake investigations.

Table 3-4 Issues of Special Importance

Reference No.	Issue Title	Report Section
C1	Developing technical clearinghouses	2.2.1
C3	Role of the NEHRP Investigations Coordinator	2.2.3
C10	Coordinating with post-earthquake response and recovery operations	2.2.10
A1	Obtaining permission to access restricted areas	2.5.1

These issues were considered to have special importance because:

- The concept of a local or regional clearinghouse is considered to be an excellent coordination resource for NEHRP agencies, non-NEHRP agencies, and non-governmental organizations, but developing such a resource will require coordination in advance of the next earthquake. It is recommended that the plan rely heavily on such clearinghouses, either those that are already in place, or one set up for a specific event with the help of the Coordinating Agency for the NEHRP Post-Earthquake Investigations Program, as discussed in Issue C1 (Section 2.2.1).
- The role of the Investigation Coordinator is extremely important, but such a position has no authority for directing the work of another agency. To be effective, coordination agreements must be set up in advance, as discussed in Issue C3 (Section 2.2.3).
- It is recommended that, to the extent practicable, an updated plan be coordinated with the National Response Framework and National Disaster Recovery Framework and critical incident management systems, protocols, and practices, as discussed in Issue C10 (Section 2.2.10).
- Access to an earthquake disaster area is expected to become more restricted in the future. NEHRP agencies should have plans in place for obtaining permissions for NEHRP and partner organization investigators to gain access to disaster areas in advance of an event. It is recommended that NEHRP agencies coordinate with existing clearinghouses, organizations, and other local agencies to identify possible solutions, as discussed in Issue A1 (Section 2.5.1).

3.3 Necessary Funding

It is important to note that many of the recommendations presented in this report would require additional funding, beyond what appears to be allocated for post-earthquake activities now, in order to be implemented in the most effective manner. Agency funding allocations, however, were considered beyond the scope of the development of a framework for an updated coordination plan.

Funding, as discussed in Issue F1 (Section 2.4.1), is critical to the actual implementation of a post-earthquake investigation plan. Implicit with any decision to implement the elements of an updated plan is the assumption that the necessary funding will be provided. This policy issue requires action among the NEHRP agencies, as well as other appropriate Federal agencies that may be involved in developing funding mechanisms, to establish permanent and dedicated funding sources for post-earthquake investigation coordination and planning activities, actual field reconnaissance and investigation, and eventual post-earthquake analysis activities.

Relevant Resources

Past efforts, workshops, plans, publications, guidelines, documents, and organizations were reviewed for information that might be relevant to NEHRP post-earthquake investigation planning and coordination activities. This appendix presents a bibliographical list of resources that were found to be most relevant, divided into three categories based on degree of relevance: primary relevance, secondary relevance, and tertiary relevance. Passages that describe the purpose and content of each primary reference, and selected secondary references, are provided.

A.1 List of Relevant Resources

A.1.1 Primary Relevance

California Post-Earthquake Information Clearinghouse, 2009, *Draft Operation Plan*, California Post-Earthquake Information Clearinghouse Management Group, last accessed on September 16, 2013, <http://www.californiaeqclearinghouse.org/wp-content/uploads/2009/06/chplan090324.pdf>. Also, annual exercises to test various field data collection tools for use in post-earthquake reconnaissance (e.g., 2013 Golden Guardian Exercise May 13-15, 2013).

EERI, 1996, *Post-Earthquake Investigation Field Guide*, Earthquake Engineering Research Institute, Oakland, California.

EERI, 2003, *Collection and Management of Earthquake Data: Defining Issues for An Action Plan*, Publication Number 2003-03, Earthquake Engineering Research Institute, Oakland, California.

EERI, 2013, *Earthquake Engineering Research Institute (EERI), Learning from Earthquakes (LFE) Program: Operations*, Earthquake Engineering Research Institute, last accessed on September 23, 2013, <https://www.eeri.org/cohost/Learning%20from%20Earthquakes/EERI%20LFE%20Operations%20DRAFT%20022513.pdf>.

GEER, 2011, *Manual for GEER Reconnaissance Teams*, edited by Kayen, R., Geotechnical Extreme Events Reconnaissance Association, last accessed on September 16, 2013, <http://vqs751.pair.com/stevens3/asce/wp-content/uploads/2013/05/Manual-GEER-Reconnaissance-Teams.pdf>.

NIST, 2012, *NIST Disaster and Failure Studies*, National Institute of Standards and Technology, last accessed on September 23, 2013, <http://www.nist.gov/el/disasterstudies/upload/NISTDisasterandFailureStudiesFactsheet111212.pdf>.

USGS, 2003, *The Plan to Coordinate NEHRP Post-Earthquake Investigations*, Circular 1242, United States Geological Survey, Reston, Virginia.

A.1.2 Secondary Relevance

ACEHR, 2008, *Effectiveness of the National Earthquake Hazards Reduction Program, A Report from the Advisory Committee on Earthquake Hazards Reduction*, last accessed on September 16, 2013, <http://www.nehrp.gov/pdf/2008ACEHRReport.pdf>.

ACEHR, 2010, *Effectiveness of the National Earthquake Hazards Reduction Program, A Report from the Advisory Committee on Earthquake Hazards Reduction*, Advisory Committee on Earthquake Hazards Reduction, last accessed on September 16, 2013, <http://www.nehrp.gov/pdf/2010DraftACEHRReport.pdf>.

American Lifelines Alliance, 2008, *American Lifelines Alliance, Post-Earthquake Information Systems (PIMS), Scoping Study*, National Institute of Building Sciences, Washington, D.C.

Boehlert, S., Bordogna, J., Hoffbuhr, J., Snell, J.W., and Wulf, W., 2008, *Report on Engineering Reviews: Recommendations to the American Society of Civil Engineers*, Task Force on Engineering Reviews, American Society of Civil Engineers, Reston, Virginia.

Bray, J., Frost, D., and Rathje, E., 2011, "Turning disaster into knowledge," *Geo-Strata*, Vol. 15, No. 5, pp. 18, 20, 21, 26.

EERI, 2003, *Securing Society Against Catastrophic Earthquake Losses: A Research and Outreach Plan in Earthquake Engineering*, Earthquake Engineering Research Institute, Oakland, California.

FEMA, 2011, *National Disaster Recovery Framework: Strengthening Disaster Recovery for the Nation*, Federal Emergency Management Agency, Washington, D.C.

Kayen, R., and Collins, B., 2012, "Taking the measure of disaster with terrestrial laser scanning," *Geo-Strata*, Vol. 15, No. 4, pp. 14-20.

NEHRP, 2008, *Strategic Plan for the National Earthquake Hazards Reduction Program: Fiscal Years 2009-2013*, Interagency Coordinating Committee of the National Hazards Reduction Program, Gaithersburg, Maryland.

NIST, 2013, *Disaster and Failure Studies Repository*, National Institute of Standards and Technology, last accessed on September 23, 2013, <http://wtcdata.nist.gov/>.

NRC, 2006, *Facing Hazards and Disasters: Understanding Human Dimensions*, Committee on Disaster Research in Social Sciences: Future Challenges and

Opportunities, Division of Earth and Life Studies, National Research Council, The National Academies Press, Washington, D.C.

NRC, 2011, *Grand Challenges in Earthquake Engineering Research: A Community Workshop Report*, National Research Council, the National Academies Press, Washington, D.C.

O'Rourke, T., Holzer, T., Rojahn, C., and Tierney, K., 2008, *Contributions of Earthquake Engineering to Protecting Communities and Critical Infrastructure from Multihazards*, Earthquake Engineering Research Institute, Oakland, California.

Servin, V., 2010, *New Techniques for Earthquake Reconnaissance*, University of California, Berkeley, last accessed on September 16, 2013, <http://peer.berkeley.edu/education/files/2010-Servin-Paper-FINAL.pdf>.

A.1.3 Tertiary Relevance

Bardet, J.P., and Liu, F., 2010, "Towards virtual earthquakes: using post-earthquake reconnaissance information," *Online Information Review*, Vol. 34, No. 1, pp. 59-74.

Bisch, P., Labbe, P., and Pecker, A., Eds., 1999, *Proceedings*, Eleventh European Conference on Earthquake Engineering, Paris, France (the post-earthquake investigations and feedback experience session papers are of particular relevance).

Sardo, A.G., Sardo, T.E., and Harik, I.E., 2006, *Post Earthquake Investigation Field Manual for the State of Kentucky*, Research Report KTC-06-30/SPR234-01-1F, Kentucky Transportation Center, University of Kentucky, Lexington, Kentucky.

Schiff, A.J., 1997, *Guide to Post Earthquake Investigation of Lifelines*, Technical Council on Lifeline Earthquake Engineering, American Society of Civil Engineers, Reston, Virginia.

WSSPC, 2001, *Policy Recommendation 10-3: Post-Earthquake Technical Clearinghouses*, Western States Seismic Policy Council, Sacramento, California.

A.2 Selected Passages from Relevant Resources

This section presents short passages from resources considered to be of primary relevance, and selected resources of secondary relevance. These passages describe the purpose or objective of the resource.

A.2.1 USGS Circular 1242

The following passage is taken from USGS Circular 1242, *The Plan to Coordinate NEHRP Post-Earthquake Investigations* (USGS, 2003):

“This is the plan to coordinate domestic and foreign post-earthquake investigations supported by the National Earthquake Hazards Reduction Program (NEHRP). The plan addresses coordination of both the NEHRP agencies—Federal Emergency Management Agency (FEMA), National Institute of Standards and Technology (NIST), National Science Foundation (NSF), and U. S. Geological Survey (USGS)—and their partners. The plan is a framework for both coordinating what is going to be done and identifying responsibilities for post-earthquake investigations. It does not specify what will be done. Coordination is addressed in various time frames ranging from hours to years after an earthquake. The plan includes measures for (1) gaining rapid and general agreement on high-priority research opportunities, and (2) conducting the data gathering and field studies in a coordinated manner. It deals with identification, collection, processing, documentation, archiving, and dissemination of the results of post-earthquake work in a timely manner and easily accessible format.

For the purposes of this plan a significant domestic earthquake is defined as either (1) an earthquake resulting in a Presidential disaster declaration, or (2) an earthquake considered by NEHRP agencies to provide an opportunity to learn how to reduce future earthquake losses in the United States. The plan organizes domestic post-earthquake investigation and information dissemination activities into three phases...”

A.2.2 EERI Collection and Management of Earthquake Data

The following passage is taken from EERI’s *Collection and Management of Earthquake Data: Defining Issues for An Action Plan* (EERI, 2003):

“The earthquake community stands at a critical juncture in terms of how it learns about earthquakes. Rapid and profound changes in the technology used for data acquisition, computing and information management now allow the community to consider acquiring, analyzing and managing data in new ways. Improving the collection and management of data, immediately in post-earthquake reconnaissance as well as in long-term impact assessments, are central to improving knowledge gained from earthquakes. To help define these issues, EERI held an invitational workshop on September 19th and 20th, 2002, in Pasadena, California.

Over seventy members of the broad earthquake community, representing a wide range of disciplines and skills, came together for two days of brainstorming

sessions and discussion, developing preliminary recommendations that have been organized and are presented in this report. The recommendations are organized in three major categories: Improving Data Collection, Supporting Data Access and Improving Data Organization and Use. The various suggestions and ideas related to each of these three large concepts have been incorporated in the following recommendations. Because the workshop participants took a broad approach to this topic, priorities and specific funding requirements are not attached to these recommendations. Rather, the authors urge the establishment and funding of a series of focused working groups that will tackle these issues in a more systematic manner.”

A.2.3 EERI Post-Earthquake Investigation Field Guide

The following passage is taken from EERI’s *Post-Earthquake Investigation Field Guide* (EERI, 1996):

“This Post-Earthquake Investigation Field Guide (hereafter called Field Guide) stresses advance planning. It outlines procedures that enable EERI to dispatch investigation teams quickly and effectively when the need arises. This advance planning is essential if EERI is to use its resources to best advantage, avoid duplicating the efforts of others, and ensure that all important aspects of destructive earthquakes are adequately studied. This Post-Earthquake Investigation Field Guide describes procedures for deciding what earthquakes will be investigated; responsibilities of project participants; formation and dispatch of investigation teams; and dissemination of the information collected. It also offers guidelines for specific data collection in the field.”

A.2.4 Manual for GEER Reconnaissance Teams

The following passage is taken from the *Manual for GEER Reconnaissance Teams* (GEER, 2011):

“The purpose of this manual is to standardize reconnaissance practices among researchers so to maintain safety in the field, improve the overall quality of the data collection effort, and to best organize the findings for digital report and map delivery. The improvement of this manual is a GEER membership-wide responsibility. Your suggestions and input are essential in order to improve the usefulness of this manual for the next GEER field effort.

The primary goals of the GEER team is to survey the damaging geotechnical aspects of the event, to document key sites to develop well-documented case histories, and to identify opportunities for further research. Reconnaissance has served an important role in earthquake engineering research and have led to significant advancements in our understanding of geoenvironmental phenomena such as surface fault rupture, ground motions, site effects, soil liquefaction,

ground failure, slope instabilities, the performance of buildings, foundations, earth structures, and improved ground.”

A.2.5 California Post-Earthquake Information Clearinghouse Draft Operation Plan

The following passage is taken from the California Post-Earthquake Information Clearinghouse, *Draft Operation Plan* (2009):

“The California Post-Earthquake Information Clearinghouse was established in 1972 to provide State and Federal disaster response managers, affected agencies, and the scientific community with prompt information on ground failure, structural damage, and other consequences of a significant seismic event. The information is collected by scores of scientist, engineers, and other professionals who commonly arrive in affected areas to conduct research and/or assist in a Clearinghouse operation. The Clearinghouse core group is a collection of earth scientists, engineers and other professionals representing various state agencies, federal bureaus, universities, and private institutions. The group meets on a tri-annual basis to maintain operational preparedness and strong working relationships among the participating organizations.

Mission Statement: To facilitate the gathering and dissemination of post-earthquake information using the talents of scientists, engineers, sociologists, economists, and other professionals who arrive in the affected area.”

A.2.6 EERI Learning from Earthquakes Program Operations

The following passage is taken from *Earthquake Engineering Research Institute (EERI), Learning from Earthquakes (LFE) Program, Operations* (EERI, 2013):

“The purpose of this document is to define protocols for operations of the LFE program to maximize benefits to the Institute, the EERI membership, and society as a whole.”

A.2.7 NIST Disaster and Failure Studies Fact Sheet

The following passage is taken from the *NIST Disaster and Failure Studies* fact sheet (NIST, 2012):

“The objectives of NIST's disaster and failure studies may include:

1. Establishing the likely technical factor or factors responsible for the damage, failure, and/or successful performance of buildings and/or infrastructure in the aftermath of a disaster or failure event;

2. Evaluating the technical aspects of evacuation and emergency response procedures that contributed to the extent of injuries and fatalities sustained during the event;
3. Determining the procedures and practices that were used in the design, construction, operation, and maintenance of the buildings and/or infrastructure; and
4. Recommending, as necessary, specific improvements to standards, codes, and practices as well as any research and other appropriate actions based on study findings.”

A.2.8 Report on Engineering Reviews to the American Society of Civil Engineers

The following passage is taken from *Report on Engineering Reviews: Recommendations to the American Society of Civil Engineers* (Boehlert et al., 2008):

“The Task Force believes ASCE remains the best option for our nation in conducting post disaster engineering assessments. However, the overall process by which future disaster engineering assessments are conducted must be improved to reflect emerging complexities in assessing disasters and evolving societal expectations. The Task Force identified four basic areas of needed reform; process transparency and efficacy, the funding of engineering reviews, communication with the public and press, and potential conflicts of interest.”

A.2.9 Effectiveness of the National Earthquake Hazards Reduction Program

The following passage is taken from *Effectiveness of the National Earthquake Hazards Reduction Program, A Report from the Advisory Committee on Earthquake Hazards Reduction* (ACEHR, 2008):

“Consistent with the change in the leadership of the NEHRP, ACEHR believes that the Program would benefit from a similar change in leadership related to post-earthquake investigations. Section 11 of Public Law 108-360 establishes a post-earthquake investigation program within USGS that involves NSF, NIST, as well as other federal agencies and private contractors. USGS Circular 1242 provides a road map for implementation. ACEHR fully supports the need for post-earthquake investigation, believes the Circular must be updated, and sees the following opportunities for significantly improving our ability to gather and process critical and perishable data immediately after an event.

- Assign discipline-oriented teams to investigate each facet of the earthquake rather than a single team with individual representatives of each discipline. Each team should be funded by its related organization or agency. Teams

should be identified to investigate earth science, geo-engineering, and lifelines, structural, social, and economic aspects of each major event.

- USGS should delegate leadership to an organization without any discipline-related responsibility, such as the NEHRP Secretariat, which can serve as the single point of coordination. Staff and funding must be provided to refine the response program, identify available participants, and maintain a state of response readiness.
- The results of the investigations and related research should be gathered and archived in the Post-Earthquake Information Management System (PIMS) and published in a set of discipline-oriented volumes that document in detail the immediate and long-term impacts of the event.”

Standard Nomenclature

Each NEHRP agency might use different terminology, or define specific terms in different ways, which could impede post-earthquake coordination. This appendix presents a list of terms and definitions collected as an illustrative example and possible starting point for future development of a standard nomenclature. This list is not intended to be all-inclusive, nor is it intended to definitively establish any definitions at this time.

Many of the definitions provided in this appendix were developed by the United Nations Office for Disaster Risk Reduction (UNISDR) and can be found at <http://www.unisdr.org/we/inform/terminology>. The terminology was developed for basic terms related to disaster risk reduction to promote a common understanding on the subject for use by the public, authorities, and practitioners. The UNISDR definitions, intended for an international audience, may or may not be relevant to NEHRP post-earthquake investigations. It was deemed appropriate for this effort, however, to present the UNISDR definitions as a possible source of terminology, so that decisions could be made on the basis of a broad perspective.

There are other potential sources that should be examined in developing a standard nomenclature for NEHRP post-earthquake investigations. A preliminary review of these sources was conducted for this appendix, but a more thorough examination of these sources (and similar documents) is recommended for future efforts. Selected Federal documents, such as the following, should be considered:

- National Response Framework (NRF)
- National Mitigation Framework (NMF)
- National Disaster Recovery Framework (NDRF)
- National Infrastructure Protection Plan (NIPP)
- Presidential Policy Directive/PPD-21: Critical Infrastructure Security and Resilience (PPD-21)

The primary source of the definition of each term is provided in parentheses at the end of each definition. Definitions without an identifiable source were written by the project team. Some terms are more relevant to coordination of post-earthquake investigations than others, but all of the terms identified during this effort were retained for the purpose of this report. In the eventual development of a standard

nomenclature, an effort should be undertaken to include only those terms that are most relevant to a NEHRP post-earthquake investigation plan, or those that could cause confusion or hinder coordination following an earthquake.

Acceptable Risk (source: UNISDR). The level of potential losses that a society or community considers acceptable given existing social, economic, political, cultural, technical, and environmental conditions. Comment: In engineering terms, acceptable risk is also used to assess and define the structural and nonstructural measures that are needed to reduce possible harm to people, property, services, and systems to a chosen tolerated level, according to codes or “accepted practices,” which are based on known probabilities of hazard and other factors.

All-Hazards (source: NIPP). A grouping classification encompassing all conditions, environmental or manmade, that have the potential to cause injury, illness, or death; damage to or loss of equipment, infrastructure services, or property; or alternatively causing functional degradation to social, economic, or environmental aspects.

Building Code (source: UNISDR). A set of ordinances or regulations and associated standards intended to control aspects of the design, construction, materials, alteration, and occupancy of structures that are necessary to ensure human safety and welfare, including resistance to collapse and damage. Comment: Building codes can include both technical and functional standards. They should incorporate lessons of international experience, and should be tailored to national and local circumstances. A systematic regime of enforcement is a critical supporting requirement for effective implementation of building codes.

Case Study, Post-Earthquake. An in-depth study of an earthquake or its effects, considered broadly, or isolated to an individual facility or societal aspect.

Catastrophic Incident (source: NDRF). Any natural or man-made incident, including terrorism, that results in extraordinary levels of mass casualties, damage, or disruption severely affecting the population, infrastructure, environment, economy, national morale, or government functions. A catastrophic event could result in sustained national impacts over a prolonged period of time; almost immediately exceeds resources normally available to local, state, tribal, and private sector authorities in the impacted area; and significantly interrupts governmental operations and emergency services to such an extent that national security could be threatened.

(The) Charter. See “International Charter for Space and Major Disasters.”

Community (source: NDRF). A network of individuals and families, businesses, governmental and non-governmental organizations and other civic organizations that

reside or operate within a shared geographical boundary and may be represented by a common political leadership at a regional, county, municipal or neighborhood level.

Coping Capacity (source: UNISDR). The ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters. Comment: The capacity to cope requires continuing awareness, resources, and good management, both in normal times as well as during crises or adverse conditions. Coping capacities contribute to the reduction of disaster risks.

Corrective Disaster Risk Management (source: UNISDR). Management activities that address and seek to correct or reduce disaster risks which are already present. Comment: This concept aims to distinguish between the risks that are already present, and which need to be managed and reduced now, and the prospective risks that may develop in the future if risk reduction policies are not put in place. See also “Prospective Disaster Risk Management.”

Critical Facilities (source: UNISDR). The primary physical structures, technical facilities, and systems that are socially, economically, or operationally essential to the functioning of a society or community, both in routine circumstances and in the extreme circumstances of an emergency. Comment: Critical facilities are elements of the infrastructure that support essential services in a society. They include such things as transport systems, air and sea ports, electricity, water and communications systems, hospitals and health clinics, and centers for fire, police and public administration services. The term also refers to those facilities, such as a dam or nuclear power plant, the failure of which may have widespread and devastating effects beyond the facility itself.

Critical Infrastructure (source: NDRF). Systems and assets, whether physical or virtual, so vital that the incapacity or destruction of such may have a debilitating impact on the security, economy, public health or safety, environment, or any combination of these matters, across any local, state, tribal and Federal jurisdiction.

Damage Assessment, Post-Earthquake. The assessment, usually by an engineer, of the condition of a constructed facility, usually emphasizing the safety condition.

Data. Quantitative, factual, reproducible, and archivable information directly observed in the field or through remote sensors that can be used to assess the cause, effects, or impacts of an earthquake.

Data Archive. A computer-based system for the storage and retrieval of post-earthquake data.

Data Collection. Any process involved in obtaining data.

Data, Perishable. Data (information) relevant to a post-earthquake situation that may be short-lived and lost due to recovery, rebuilding, or natural causes.

Data Processing. Any process involved in the organization, reduction, or analysis of data.

Disaster (source: UNISDR). A serious disruption of the functioning of a community or society involving widespread human, material, economic, or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources. Comment: Disasters are often described as a result of the combination of the exposure to a hazard, the conditions of vulnerability that are present, and insufficient capacity or measures to reduce or cope with the potential negative consequences. Disaster impacts may include loss of life, injury, disease, and other negative effects on human physical, mental and social well-being, together with damage to property, destruction of assets, loss of services, social and economic disruption and environmental degradation.

Disaster and Failure Events Data Repository (source: NIST). A repository of images, videos, and documents collected during and after disaster and failure events studied by the National Institute of Standards and Technology, as well as data generated from research on those events. The materials in the repository serve as an historical archive.

Disaster Assistance Process. The process by which the Federal government, primarily through FEMA and the U.S. Small Business Administration, provide disaster assistance authorized under the Stafford Act. This assistance includes individual assistance, public assistance, U.S. Small Business Administration disaster loans, and FEMA grants.

Disaster Mitigation Act of 2000. Public Law 106-390 (also referred to as DMA2K), which amended the Stafford Act provisions related to disaster relief. It revised and broadened the scope of existing disaster relief programs, encouraged better disaster preparedness, improved coordination between programs, and encouraged improved hazard mitigation.

Disaster Risk (source: UNISDR). The potential disaster losses, in lives, health status, livelihood, assets, and services, which could occur to a particular community or society over some specified future time period. Comment: The definition of disaster risk reflects the concept of disasters as the outcome of continuously present conditions of risk. Disaster risk comprises different types of potential losses, which are often difficult to quantify. Nevertheless, with knowledge of the prevailing hazards and the patterns of population and socioeconomic development, disaster risks can be assessed and mapped, at least in broad terms.

Disaster Risk Management (source: UNISDR). The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies, and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster. Comment: This term is an extension of the more general term “risk management” to address the specific issue of disaster risks. Disaster risk management aims to avoid, lessen, or transfer the adverse effects of hazards through activities and measures for prevention, mitigation and preparedness.

Disaster Risk Reduction (source: UNISDR). The concept and practice of reducing disaster risks through systematic efforts to analyze and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events. Comment: A comprehensive approach to reduce disaster risks is set out in the United Nations-endorsed *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters* (United Nations, 2007), whose expected outcome is “The substantial reduction of disaster losses, in lives and the social, economic and environmental assets of communities and countries.” The International Strategy for Disaster Reduction (ISDR) system provides a vehicle for cooperation among Governments, organizations and civil society actors to assist in the implementation of the Framework. Note that while the term “disaster reduction” is sometimes used, the term “disaster risk reduction” provides a better recognition of the ongoing nature of disaster risks and the ongoing potential to reduce these risks.

Disaster Risk Reduction Plan (source: UNISDR). A document prepared by an authority, sector, organization, or enterprise that sets out goals and specific objectives for reducing disaster risks together with related actions to accomplish these objectives. Comment: Disaster risk reduction plans should be guided by the *Hyogo Framework* (United Nations, 2007), and considered and coordinated within relevant development plans, resource allocations and program activities. National level plans needs to be specific to each level of administrative responsibility and adapted to the different social and geographical circumstances that are present. The time frame and responsibilities for implementation and the sources of funding should be specified in the plan. Linkages to climate change adaptation plans should be made where possible.

Early Warning System (source: UNISDR). The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities, and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss. Comment: This definition encompasses the range of factors necessary to achieve effective responses to warnings. A people-centered early warning system necessarily

comprises four key elements: knowledge of the risks; monitoring, analysis, and forecasting of the hazards; communication or dissemination of alerts and warnings; and local capabilities to respond to the warnings received. The expression “end-to-end warning system” is also used to emphasize that warning systems need to span all steps from hazard detection through to community response.

Emergency Management (source: UNISDR). The organization and management of resources and responsibilities for addressing all aspects of emergencies, in particular preparedness, response, and initial recovery steps. Comment: A crisis or emergency is a threatening condition that requires urgent action. Effective emergency action can avoid the escalation of an event into a disaster. Emergency management involves plans and institutional arrangements to engage and guide the efforts of government, non-governmental, voluntary, and private agencies in comprehensive and coordinated ways to respond to the entire spectrum of emergency needs. The expression “disaster management” is sometimes used instead of emergency management.

Emergency Response. See “Response.”

Emergency Services (source: UNISDR). The set of specialized agencies that have specific responsibilities and objectives in serving and protecting people and property in emergency situations. Comment: Emergency services include agencies such as civil protection authorities, police, fire, ambulance, paramedic and emergency medicine services, Red Cross and Red Crescent Societies, and specialized emergency units of electricity, transportation, communications, and other related services organizations.

Evaluation, Post-Earthquake. A post-earthquake evaluation is an assessment of the condition of a structure following an earthquake. See also “Post-earthquake safety evaluation of buildings.”

Event Website. A website established and maintained to serve as a repository of various data related to an earthquake event. Comment: USGS establishes an event page with technical, scientific, and impact information immediately following earthquakes.

Exposure (source: UNISDR). People, property, systems, or other elements present in hazard zones that are subject to potential losses. Comment: Measures of exposure can include the number of people or types of assets in an area. These can be combined with the specific vulnerability of the exposed elements to any particular hazard to estimate the quantitative risks associated with that hazard in the area of interest.

Extensive Risk (source: UNISDR). The widespread risk associated with the exposure of dispersed populations to repeated or persistent hazard conditions of low or moderate intensity, often of a highly localized nature, which can lead to debilitating cumulative disaster impacts. Comment: Extensive risk is mainly a characteristic of rural areas and urban margins where communities are exposed to, and vulnerable to, recurring localized floods, landslides storms or drought. Extensive risk is often associated with poverty, urbanization and environmental degradation. See also “Intensive Risk.”

Field Office. See “Joint Field Office.”

Field Studies. Studies involved in the collection of post-earthquake data and information at or near the site of the epicenter of the earthquake or any site impacted by the event.

Field Technical Clearinghouse (source: USGS Circular 1242). A place within the region affected by an earthquake where post-earthquake field investigators can meet to review progress and to organize and coordinate their activities. For large events, multiple places might be appropriate.

Forecast (source: UNISDR). Definite statement or statistical estimate of the likely occurrence of a future event or conditions for a specific area.

Geological Hazard (source: UNISDR). Geological process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihood and services, social and economic disruption, or environmental damage. Comment: Geological hazards include internal earth processes, such as earthquakes, volcanic activity and emissions, and related geophysical processes such as mass movements, landslides, rockslides, surface collapses, and debris or mud flows. Hydrometeorological factors are important contributors to some of these processes. Tsunamis are difficult to categorize; although they are triggered by undersea earthquakes and other geological events, they are essentially an oceanic process that is manifested as a coastal water-related hazard.

Hazard (source: UNISDR). A dangerous phenomenon, substance, human activity, or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihood and services, social and economic disruption, or environmental damage. Comment: The hazards of concern to disaster risk reduction as stated in the *Hyogo Framework* are “... hazards of natural origin and related environmental and technological hazards and risks,” (United Nations, 2007). Such hazards arise from a variety of geological, meteorological, hydrological, oceanic, biological, and technological sources, sometimes acting in combination. In technical settings, hazards are described quantitatively by the likely frequency of occurrence of different intensities for different areas, as determined from historical data or scientific

analysis. See other hazard-related terms: “Geological Hazard; Natural Hazard; Socio-Natural Hazard; Technological Hazard.”

Hazards Data Distribution System. A resource maintained by USGS that provides quick and easy access to imagery and geospatial data that supports emergency response and recovery operations. The Hazards Data Distribution System (HDDS) provides data access and delivery services through graphic or traditional directory-based interfaces that allow emergency response personnel to select and obtain pre-event baseline and post-event emergency response imagery.

HAZUS. A GIS-based, nationally applicable standardized methodology developed, maintained and distributed by FEMA for estimating potential losses from earthquakes, floods, and hurricanes.

Intensive Risk (source: UNISDR). The risk associated with the exposure of large concentrations of people and economic activities to intense hazard events, which can lead to potentially catastrophic disaster impacts involving high mortality and asset loss. Comment: Intensive risk is mainly a characteristic of large cities or densely populated areas that are not only exposed to intense hazards, such as strong earthquakes, active volcanoes, heavy floods, tsunamis, or major storms, but also have high levels of vulnerability to these hazards.

Intermediate Recovery (source: NDRF). Phase of recovery which involves returning individuals, families, critical infrastructure and essential government or commercial services to a functional, if not pre-disaster, state. Such activities are often characterized by temporary actions that provide a bridge to permanent measures.

International Charter for Space and Major Disasters. The International Charter for Space and Major Disasters aims to provide a unified system of space data acquisition and delivery to those affected by natural or man-made disasters through authorized users. Each member agency has committed resources to support the provisions of the Charter and thus is helping to mitigate the effects of disasters on human life and property.

Inventory. Usually refers to the building stock of a community, with information on building and construction types, construction age, numbers of buildings, and occupancy. May also refer to other constructed facilities, such as bridges.

Investigation, Post-Earthquake. Studies of the cause, effects, and impacts of an earthquake and the publication of the results of these studies.

Joint Field Office. An administrative office established at the scene of a Presidential disaster declaration.

Land-Use Planning (source: UNISDR). The process undertaken by public authorities to identify, evaluate, and decide on different options for the use of land, including consideration of long-term economic, social, and environmental objectives and the implications for different communities and interest groups, and the subsequent formulation and promulgation of plans that describe the permitted or acceptable uses. Comment: Land-use planning is an important contributor to sustainable development. It involves studies and mapping; analysis of economic, environmental, and hazard data; formulation of alternative land-use decisions; and design of long-range plans for different geographical and administrative scales. Land-use planning can help to mitigate disasters and reduce risks by discouraging settlements and construction of key installations in hazard-prone areas, including consideration of service routes for transport, power, water, sewage, and other critical facilities.

Long-Term Recovery (source: NDRF). Phase of recovery that may continue for months or years and addresses complete redevelopment and revitalization of the impacted area, rebuilding or relocating damaged or destroyed social, economic, natural and built environments and a move to self-sufficiency, sustainability and resilience.

Major Disaster (source: NDRF). As defined by the Stafford Act, any natural catastrophe (including any hurricane, tornado, storm, high water, wind-driven water, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snowstorm, or drought) or, regardless of cause, any fire, flood or explosion, in any part of the United States, which in the determination of the President causes damage of sufficient severity and magnitude to warrant major disaster assistance to supplement the efforts and available resources of local, state governments and disaster relief organizations in alleviating the damage, loss, hardship or suffering caused thereby.

Mitigation (sources: NRDF, FEMA, and UNISDR). Capabilities necessary to reduce loss of life and property by lessening the impact of disasters. Mitigation capabilities include: community-wide risk reduction projects; efforts to improve the resilience of critical infrastructure and key resource lifelines; risk reduction for specific vulnerabilities from natural hazards or acts of terrorism; initiatives to reduce future risks after a disaster has occurred; and actions taken before a disaster to reduce adverse impacts of hazards and related disasters. Actions can include analyzing risk, reducing risk, and insuring against risk. Comment: The adverse impacts of hazards often cannot be prevented fully, but their scale or severity can be substantially lessened by various strategies and actions. Mitigation measures encompass engineering techniques and hazard-resistant construction, as well as improved environmental policies and public awareness. It should be noted that in climate change policy, “mitigation” is defined differently, being the term used for the reduction of greenhouse gas emissions that are the source of climate change.

Mitigation Assessment Team Program (source: FEMA). Mitigation Assessment Team (MAT) is a FEMA program, drawing on the combined resources of a Federal, state, local, and private sector partnership, to assemble and quickly deploy teams of investigators to: (1) inspect buildings and related infrastructure; (2) conduct forensic engineering analyses to determine causes of structural failure and success; and (3) recommend actions that state and local governments, the construction industry, and building code organizations can take to reduce future damages and protect lives and property in hazard areas.

National Construction Safety Team Act. National Construction Safety Team (NCST) Act is the law authorizing NIST to establish teams, dispatched within 48 hours after major building disasters to: (1) establish the likely technical cause of building failures; (2) evaluate the technical aspects of procedures used for evacuation and emergency response; (3) recommend specific changes to building codes, standards, and practices; (4) recommend any research or other appropriate actions needed to improve the structural safety of buildings, or changes in emergency response and evacuation procedures; and (5) make final recommendations within 90 days of completing an investigation.

Natural Hazard (source: UNISDR). Natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihood and services, social and economic disruption, or environmental damage. Comment: Natural hazards are a subset of all hazards. The term is used to describe actual hazard events as well as the latent hazard conditions that may give rise to future events. Natural hazard events can be characterized by their magnitude or intensity, speed of onset, duration, and area of extent. For example, earthquakes have short durations and usually affect a relatively small region, whereas droughts are slow to develop, fade away, and often affect large regions. In some cases hazards may be coupled, such in flooding caused by a hurricane or the tsunami that is caused by an earthquake.

NEHRP Investigations Coordinator (source: USGS Circular 1242). An individual designated by USGS to: (1) ensure that disaster response activities are not impeded by scientific and technical investigations; (2) provide emergency managers with timely and relevant information from the ongoing field investigations; (3) facilitate coordination of NEHRP agencies; (4) ensure that NEHRP press releases are coordinated and consistent; and (5) to work with scientific and engineering leaders to identify critical investigations and gaps in the ongoing investigation. The NEHRP agencies are not authorized to delegate authority to the Investigations Coordinator; therefore, that individual operates under voluntary cooperation with the program managers of the NEHRP agencies.

NEHRP Post-Earthquake Coordination Plan. The post-earthquake coordination plan as described in USGS Circular 1242.

Post-Earthquake Information Management System. A proposed national information management system to facilitate post-earthquake data collection, data archiving, and use of data to improve protection against hazards.

Post-Earthquake Investigation Selection Committee. A standing committee proposed in USGS Circular 1242, with responsibility to assist the lead agency to identify investigation topics, distribution of funds, and reporting of results to Congress.

Post-Earthquake Safety Evaluation of Buildings. An assessment of the safety condition of a building following an earthquake. Maintained by the Applied Technology Council and referred to as ATC-20, this process is a widely accepted standard used by the local authority having jurisdiction for post-earthquake safety review and placarding, designed to allow the inspector to rapidly review a building and determine if it can be occupied (green – inspected placard), requires additional reviews or has partial damage (yellow – restricted use placard), or should be closed until demolition or upgrading (red – unsafe placard).

Preparedness (source: UNISDR). The knowledge, activities, and capacities developed by governments, professional response and recovery organizations, communities, and individuals prior to a disaster to help more effectively anticipate, respond to, and recover from the impacts of likely, imminent, or current hazard events or conditions. Comment: Preparedness action is carried out within the context of disaster risk management and aims to build the capacities needed to efficiently manage all types of emergencies and achieve orderly transitions from response through to sustained recovery. Preparedness is based on a sound analysis of disaster risks and good linkages with early warning systems, and includes such activities as contingency planning; stockpiling of equipment and supplies; the development of arrangements for coordination, evacuation, and public information; and associated training and field exercises. These must be supported by formal institutional, legal, and budgetary capacities. The related term “readiness” describes the ability to quickly and appropriately respond when required.

Presidential Emergency and Disaster Declaration. A disaster declaration issued by the President if a state submits a local emergency declaration and a state emergency proclamation, and if the situation is beyond the coping capabilities of the state and local governments. See also “Stafford Act.”

Prompt Assessment of Global Earthquakes for Response (source: USGS). Prompt Assessment of Global Earthquakes for Response (PAGER) is a USGS system that provides fatality and economic loss impact estimates following significant

earthquakes worldwide. PAGER does not directly consider secondary effects, such as landslides and tsunamis.

Prospective Disaster Risk Management (Source: UNISDR). Management activities that address and seek to avoid the development of new or increased disaster risks. Comment: This concept focuses on addressing risks that may develop in future if risk reduction policies are not put in place, rather than on the risks that are already present and that can be managed and reduced now. See also “Corrective Disaster Risk Management.”

Public Awareness (source: UNISDR). The extent of common knowledge about disaster risks, the factors that lead to disasters, and the actions that can be taken individually and collectively to reduce exposure and vulnerability to hazards. Comment: Public awareness is a key factor in effective disaster risk reduction. Its development is pursued, for example, through the development and dissemination of information through media and educational channels; the establishment of information centers, networks, and community or participation actions; and advocacy by senior public officials and community leaders.

Reconnaissance, Post-Earthquake. The observation and data collection activities of engineers, earth scientists, and social scientists within the epicentral area, for the purpose of reporting on the extent of the earthquake effects. Comment: In addition to reporting the physical effects, reconnaissance teams should also report on the living and transportation conditions and make recommendations for the size and expertise needed in follow-up investigation teams.

Recovery (sources: NDRF, UNISDR). Those capabilities necessary to assist communities affected by an incident to recover effectively, including rebuilding infrastructure systems; providing adequate interim and long-term housing for survivors; restoring health, social, and community services; promoting economic development; and restoring natural and cultural resources. Also, the restoration, and improvement of facilities, livelihood, and living conditions in disaster-affected communities, including efforts to reduce disaster risk factors. Comment: The recovery task of rehabilitation and reconstruction begins soon after the emergency phase has ended, and should be based on pre-existing strategies and policies that facilitate clear institutional responsibilities for recovery action and enable public participation. Recovery programs, coupled with the heightened public awareness and engagement after a disaster, afford a valuable opportunity to develop and implement disaster risk reduction measures and to apply the “build back better” principle.

Research. In the context of post-earthquake investigations, the study of data collected in these investigations to determine the geologic cause of the event, the reasons for structural failures and other damages, and the social and economic

impacts. Comment: Research activities usually follow the post-earthquake investigation phase and are funded separately. Such activities can be short-term (weeks and months) to long-term (years) in duration.

Residual Risk (source: UNISDR). The risk that remains in unmanaged form, even when effective disaster risk reduction measures are in place, and for which emergency response and recovery capacities must be maintained. Comment: The presence of residual risk implies a continuing need to develop and support effective capacities for emergency services, preparedness, response, and recovery together with socioeconomic policies such as safety nets and risk transfer mechanisms.

Resilience (source: various). The ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions (UNISDR). Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents (PPD-21). Ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies (NDRF). The ability of a system, community, or society exposed to hazards to resist, absorb, accommodate to, and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.

Response (source: various). Those capabilities necessary to save lives, protect property and the environment, and meet basic human needs after an incident has occurred (UNISDR). The provision of emergency services and public assistance during, or immediately after, a disaster in order to save lives, reduce health impacts, ensure public safety, and meet the basic subsistence needs of the people affected. Comment: Disaster response is predominantly focused on immediate and short-term needs and is sometimes called “disaster relief.” The division between this response stage and the subsequent recovery stage is not clear-cut. Some response actions, such as the supply of temporary housing and water supplies, may extend well into the recovery stage (NDRF).

Restoration (source: NDRF). Returning a physical structure, essential government or commercial services or a societal condition back to a former or normal state of use through repairs, rebuilding, or reestablishment.

Retrofitting (source: UNISDR). Reinforcement or upgrading of existing structures to become more resistant and resilient to the damaging effects of hazards. Also known as rehabilitation. Comment: Retrofitting requires consideration of the design and function of the structure, the stresses that the structure may be subject to from particular hazards or hazard scenarios, and the practicality and costs of different retrofitting options. Examples of retrofitting include adding bracing to stiffen walls,

reinforcing columns, adding steel ties between walls and roofs, and improving the protection of important facilities and equipment.

Risk (source: various). The potential for an unwanted outcome resulting from an incident, event, or occurrence, as determined by its likelihood and the associated consequences (UNISDR). The combination of the probability of an event and its negative consequences (NIPP). Comment: The word “risk” has two distinctive connotations: in popular usage the emphasis is usually placed on the concept of chance or possibility, such as in “the risk of an accident,” whereas in technical settings the emphasis is usually placed on the consequences, in terms of “potential losses” for some particular cause, place, and period. It can be noted that people do not necessarily share the same perceptions of the significance and underlying causes of different risks. See other risk-related terms: “Acceptable Risk; Corrective Disaster Risk Management; Disaster Risk; Disaster Risk Management; Disaster Risk Reduction; Disaster Risk Reduction Plan; Extensive Risk; Intensive Risk; Prospective Disaster Risk Management; Residual Risk; Risk Assessment; Risk Management; Risk Transfer.”

Risk and Disaster Resilience Assessment (source: NMF). The evaluation of threats, hazards, vulnerabilities, consequences, needs, and resources through algorithms or other methods to define and prioritize risks so community members, decision makers, and responders can make informed decisions and take the appropriate action.

Risk Assessment (source: UNISDR). A methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihood, and the environment on which they depend. Comment: Risk assessments (and associated risk mapping) include: a review of the technical characteristics of hazards such as their location, intensity, frequency, and probability; the analysis of exposure and vulnerability including the physical social, health, economic, and environmental dimensions; and the evaluation of the effectiveness of prevailing and alternative coping capacities in respect to likely risk scenarios. This series of activities is sometimes known as a risk analysis process.

Risk-Informed Decisionmaking (source: NIPP). The determination of a course of action predicated on the assessment of risk, the expected impact of that course of action on that risk, and other relevant factors.

Risk Management (source: UNISDR). The systematic approach and practice of managing uncertainty to minimize potential harm and loss. Comment: Risk management comprises risk assessment and analysis, and the implementation of strategies and specific actions to control, reduce, and transfer risks. It is widely

practiced by organizations to minimize risk in investment decisions and to address operational risks such as those of business disruption, production failure, environmental damage, social impacts, and damage from fire and natural hazards. Risk management is a core issue for sectors in which production is directly affected by extremes of weather and climate (e.g., water supply, energy, and agriculture).

Risk Management Framework (source: NIPP). A planning methodology that outlines the process for setting goals and objectives; identifying assets, systems, and networks; assessing risks; prioritizing and implementing protection programs and resiliency strategies; measuring performance; and taking corrective action. Public and private sector entities often include risk management frameworks in their business continuity plans.

Risk Transfer (source: UNISDR). The process of formally or informally shifting the financial consequences of particular risks from one party to another, whereby a household, community, enterprise, or state authority will obtain resources from the other party after a disaster occurs, in exchange for ongoing or compensatory social or financial benefits provided to that other party. Comment: Insurance is a well-known form of risk transfer, where coverage of a risk is obtained from an insurer in exchange for ongoing premiums paid to the insurer. Risk transfer can occur informally within family and community networks where there are reciprocal expectations of mutual aid by means of gifts or credit, as well as formally where governments, insurers, multi-lateral banks, and other large risk-bearing entities establish mechanisms to help cope with losses in major events. Such mechanisms include insurance and re-insurance contracts, catastrophe bonds, contingent credit facilities, and reserve funds, where the costs are covered by premiums, investor contributions, interest rates, and past savings, respectively.

Safety Inspection, Post-Earthquake. See “Post-Earthquake Safety Evaluation of Buildings.”

ShakeMap (source: USGS). ShakeMap is a product of the USGS Earthquake Hazards Program in conjunction with regional seismic network operators. ShakeMap sites provide near-real-time maps of ground motion and shaking intensity following significant earthquakes. These maps are used by Federal, state, and local organizations, both public and private, for post-earthquake response and recovery, public and scientific information, as well as for preparedness exercises and disaster planning.

Socio-Natural Hazard (source: UNISDR). The phenomenon of increased occurrence of certain geophysical and hydrometeorological hazard events, such as landslides, flooding, land subsidence, and drought, that arise from the interaction of natural hazards with overexploited or degraded land and environmental resources.

Comment: This term is used for the circumstances where human activity is increasing the occurrence of certain hazards beyond their natural probabilities. Evidence points to a growing disaster burden from such hazards. Socio-natural hazards can be reduced and avoided through wise management of land and environmental resources.

Stafford Act (Robert T. Stafford Disaster Relief and Emergency Assistance Act). Public Law 93-288, designed to bring an orderly and systemic means of Federal disaster assistance (financial and physical) for state and local governments in carrying out their responsibilities to aid citizens. The assistance is triggered by a Presidential disaster declaration. The Act gives FEMA the statutory authority for coordinating government-wide relief efforts. The Federal Response Plan implements include the contributions of 28 Federal agencies and non-governmental organizations, such as the American Red Cross.

Structural and Nonstructural Measures (source: UNISDR). Structural measures: Any physical construction to reduce or avoid possible impacts of hazards, or application of engineering techniques to achieve hazard-resistance and resilience in structures or systems. Nonstructural measures: In some fields, such as civil and structural engineering, nonstructural measures may refer to efforts taken to reduce losses to or consequences from failure of nonstructural components in a building. Outside that field, however, this term more generally refers to any measure not involving physical construction that uses knowledge, practice, or agreement to reduce risks and impacts, in particular through policies and laws, public awareness raising, training, and education. Comment: Common structural measures for disaster risk reduction include dams, flood levies, ocean wave barriers, earthquake-resistant construction, and evacuation shelters. Common nonstructural measures include building codes, land use planning laws and their enforcement, research and assessment, information resources, and public awareness programs. Note that in civil and structural engineering, the term “structural” is used in a more restricted sense to mean just the load-bearing structure, with other parts, such as wall cladding and interior fittings being termed nonstructural.

Sustainability (source: NDRF). Meeting the needs of the present without compromising the ability of future generations to meet their own needs.

Sustainable Development (source: UNISDR). Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Comment: This definition is succinct, but it leaves many unanswered questions regarding the meaning of the word development and the social, economic, and environmental processes involved. Disaster risk is associated with unsustainable elements of development, such as environmental degradation, while conversely disaster risk reduction can contribute to the achievement of sustainable development, through reduced losses and improved development practices.

Tagging, Post-Earthquake. See “Post-Earthquake Safety Evaluation of Buildings.”

Technical Clearinghouse. See “Field Technical Clearinghouse.”

Technological Hazard (source: UNISDR). A hazard originating from technological or industrial conditions, including accidents, dangerous procedures, infrastructure failures, or specific human activities, that may cause loss of life, injury, illness or other health impacts, property damage, loss of livelihood and services, social and economic disruption, or environmental damage. Comment: Examples of technological hazards include industrial pollution, nuclear radiation, toxic wastes, dam failures, transport accidents, factory explosions, fires, and chemical spills. Technological hazards also may arise directly as a result of the impacts of a natural hazard event.

Vulnerability (source: UNISDR). The characteristics and circumstances of a community, system, or asset that make it susceptible to the damaging effects of a hazard. Comment: There are many aspects of vulnerability, arising from various physical, social, economic, and environmental factors. Examples include poor design and construction of buildings, inadequate protection of assets, lack of public information and awareness, limited official recognition of risks and preparedness measures, and disregard for wise environmental management. Vulnerability varies significantly within a community and over time. In this definition, vulnerability is a characteristic of the element of interest (community, system, or asset) that is independent of its exposure. However, in common usage, the word is often used more broadly to include the element’s exposure to hazard.

Acronyms

ACEHR	Advisory Committee on Earthquake Hazards Reduction
ACI	American Concrete Institute
ASCE	American Society of Civil Engineers
ATC	Applied Technology Council
CalOES	California Office of Emergency Services
CUREE	Consortium of Universities for Research in Earthquake Engineering
CUSEC	Central United States Earthquake Consortium
DOD	Department of Defense
DOE	Department of Energy
EERI	Earthquake Engineering Research Institute
ENS	Earthquake Notification Service
ESF	Emergency Support Function
F/ERO	Federal Emergency Response Officials
FCO	Federal Coordinating Officer
FDRC	Federal Disaster Recovery Coordinators
FHWA	Federal Highway Administration
GEER	Geotechnical Extreme Events Reconnaissance Association
ICS	Incident Command System
LDRMS	Local Disaster Recovery Managers
LFE	Learning from Earthquakes
LIDAR	Light Detection and Ranging
MAT	Mitigation Assessment Team
NASA	National Aeronautics and Space Administration
NCST	National Construction Safety Team
NDRF	National Disaster Recovery Framework
NEES	George E. Brown, Jr. Network for Earthquake Engineering Simulation
NIMS	National Incident Management System
NIPP	National Infrastructure Protection Plan

NMF	National Mitigation Framework
NOAA	National Oceanic and Atmospheric Administration
NRF	National Response Framework
NTHMP	National Tsunami Hazard Mitigation Program
NWS	National Weather Service
PAGER	Prompt Assessment of Global Earthquakes for Response
PEER	Pacific Earthquake Engineering Research Center
RAPID	Rapid Response Research
RSF	Recovery Support Function
SCEC	Southern California Earthquake Center
SCO	State Coordinating Officer
SDRC	State Disaster Recovery Coordinators
TCLEE	Technical Council on Lifeline Earthquake Engineering
TDRC	Tribal Disaster Recovery Coordinators
UICDS	Unified Incident Command and Decision Support
UJNR	U.S.-Japan Cooperative Program in Natural Resources
UNISDR	United Nations Office for Disaster Risk Reduction
USACE	U.S. Army Corps of Engineers
USNRC	U.S. Nuclear Regulatory Commission
WSSPC	Western States Seismic Policy Council

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