POST-DISASTER DAMAGE AND SAFETY ASSESSMENT OF THE BUILT

ENVIRONMENT

CSSP-2016-CP-2268

Deliverable 6.9.1e

Technical Report

BC HOUSING

JUSTICE INSTITUTE of BRITISH COLUMBIA

ENGINEERS & GEOSCIENTISTS BRITISH COLUMBIA

AIBC ARCHITECTURAL INSTITUTE OF BRITISH COLUMBIA

Final: January, 2019

Project Partners and Project Team

Project Partners:

- BC Housing
- Justice Institute of British Columbia
- Professional Engineers and Geoscientists of BC
- Architectural Institute of British Columbia

Authors and Core Research Team:

- Ron Bowles, PhD, Justice Institute of British Columbia
- Steven Bibby, BC Housing
- Pete Learoyd, Justice Institute of British Columbia
- Peter Mitchell, PEng, Professional Engineers and Geoscientists of BC
- Robyn Fenton, MAIBC, Architectural Institute of British Columbia
- Marguerite Laquinte Francis, MAIBC, Architectural Institute of British Columbia
- Dawn Ursuliak, BComm, Justice Institute of British Columbia
- Cindy Moran, BC Housing
- Jim Forrest, BC Housing

Prepared by:

Justice Institute of British Columbia
January, 2019

Acknowledgements

The project was funded by the Canadian Safety and Security Program, a federal program led by Defence Research and Development Canada's Centre for Security Science (DRDC CSS) in partnership with Public Safety Canada.

We would also like to acknowledge the support of project partners: BC Housing, Justice Institute of British Columbia, Engineers and Geoscientists BC, and the Architectural Institute of British Columbia.

Most of all, we thank the many participants who contributed their time and their expertise to further the research and the recommendations contained within this Framework.

Table of Contents

Table of Figures

List of Tables

Introduction

This report presents a summary of the BC Post Disaster Building Damage Assessment (PDBA) project.

The BC PDBA research project was an applied research project conducted through a partnership between BC Housing, Justice Institute of British Columbia (JIBC), the Professional Engineers and Geoscientists of BC, and the Architectural Institute of British Columbia (AIBC). This two year project was funded through the Canadian Safety and Security Program, a federal program of Defence Research and Development Canada's Centre for Security Science, in partnership with Public Safety Canada.

The PDBA project developed a building damage and safety assessment framework and recommendations, along with companion resources and references to support provincial and community-level PDBA planning. In addition, the project fostered the inauguration of a provincial PDBA Advisory Committee. The goal of PDBA is to enable communities in an emergency to more rapidly assess the safety of structures and allow people to remain in, or return to their homes and businesses as soon as possible. This will reduce the social impact of such events, allowing communities to recover more quickly, and reducing the impact on emergency and social service resources.

Research outcomes included the tools, models, processes and approaches to empower community-level professional and public engagement in emergency planning and safety assessment. Specifically, the research team developed 1) a provincial framework and recommendations for post-disaster building assessment (see the *BC PDBA Framework and Recommendations* and 2) a model that allows credentialed and trained non-credentialed personnel to perform safety assessment in an emergency situation (the BC PDBA Assessment Matrix; see the *BC PDBA Framework and Recommendations*, Appendix 2), and 3) establishment of a BC Post Disaster Building Assessment Advisory Committee.

The research embraced a "system of systems" approach to guiding building damage safety assessment in a provincial context that can be applied at various scales across small and large, rural and urban communities throughout Canada. While the initial project focused on the BC context, processes and resources were developed to be adaptable and scalable for implementation across Canada and internationally. The second goal of this project was to develop a network of stakeholder organizations to implement, sustain, and enrich the resulting process over time.

The objectives of the research program were to:

(a) Develop a provincial framework for building damage and safety assessment through research, consultation and collaboration with stakeholders and practitioners.
(b) Develop a community-level framework to empower professional (credentialed) and public (non-credentialed) personnel to engage in emergency planning and building damage and safety assessment.
(c) Establish a sustainable network of stakeholder organizations to guide, deliver, and sustain the resulting suite of processes, approaches, and resources.

Research Questions

The research questions focus on two areas: gathering data on existing building damage safety assessment programs and exploring the experience of those who have used them.

Part I: Building Damage Safety Assessment (PDBA) Framework

How does Building Damage Safety Assessment fit within the overall Emergency Management planning and response structure?

- Who has the overall (e.g., legislative) responsibility for PDBA?
- Who are the stakeholders groups involving in developing, implementing and sustaining PDBA processes and infrastructure?
- What are the roles and relationships between stakeholders in PDBA?

Describe the elements/structure of existing PDBA programs.

- What is the overall goal of PDBA?
- What types of PDBA are performed, by whom, with what goals/outcomes, and following what procedures or processes?
- How is PDBA information gathered, recorded, transferred, and employed?
- What are the credentials, background, &/or experience required to perform each type of PDBA?
- What training and/or education is available to support personnel performing PDBA?
- Is there a performance standard identified for how PDBA is carried out and is there a different standard used for PDBA's carried out by credentialed and non-credentialed individuals?
- Are credentialed and non-credentialed individuals carrying out PDBA's fully indemnified against any liability or from claims being made against them?

Describe the administration and control of PDBA.

- Who has operational control or administration of PDBA?
- How are PDBA teams and personnel recruited, selected, operationalized, and supported?

Describe the context for PDBA in your jurisdiction: history, evolution, and current state.

- How have PDBA processes evolved to incorporate experience, best and emerging practices?
- What are the key assumptions or principles upon which your PDBA program is based?
- Why has it developed the way it has (e.g., political considerations, experience, etc)?

Part II: Participants' Experience in Building Damage Safety Assessment

Please describe your recent experience in using PDBA.

- Describe the event: location, timing, extent of damage, etc.
- Describe the operational functioning of PDBA: who managed/administered the overall process, who identified indicator buildings (and what process was used to identify these buildings), who set operational priorities, what were the operational principles on which decisions were based?

6.9.1e TECHNICAL REPORT
RESEARCH QUESTIONS

- Describe recruitment, deployment and use of PDBA teams.
- Describe extent of PDBA: # of teams, composition, selection, logistics, timeline, # buildings assessed, and outcomes of assessment.
- Were PDBA's carried out in order to confirm that buildings actually met a certain performance level?
- What types of information were collected, how was information recorded, where did information "go," and what types of decisions did information influence?
- Describe the actual performance of PDBA in comparison to your planned response: what worked, what didn't, what would you change?

The "Blue Sky" question: what would an ideal PDBA program "look like"?

- Based on your experience, what would an ideal PDBA program "look like?"
- What are the strengths and challenges with your current PDBA program?
- What changes are you currently making in PDBA processes and infrastructure?
- What changes would you like to make? What keeps you from making these changes?
- What advice would you give us regarding development of a PDBA process for the British Columbia context?

Methods

Design

This pragmatic, applied research project employed concurrent mixed methods and an emergent design, bringing together an interdisciplinary group of researchers, emergency management, architectural, engineering, and education experts.

The project consisted of three phases (see Figure 1. Research Design):

- Phase I: Description and exploration of existing building assessment (BA) models and systems to identify leading practices and gaps in practice, employing several data collection streams:
    - Literature review
    - Key Informant Interviews
    - Visit to Exemplar Site
    - Stakeholder Workshop
    - Consultation with Expert Working Group members
- Phase II: Analysis and synthesis to describe operational building assessment processes, explore current and best practices, and develop evidence-informed recommendations to support a BC-based process. Development and dissemination of a draft framework describing selected aspects and considerations for national/provincial, regional, local authorities, and individual team members who are conducting post-disaster building assessment.
- Phase III: Validation and development of production-versions of the BC PDBA Framework and Recommendations and Companion Manual of resources and references.

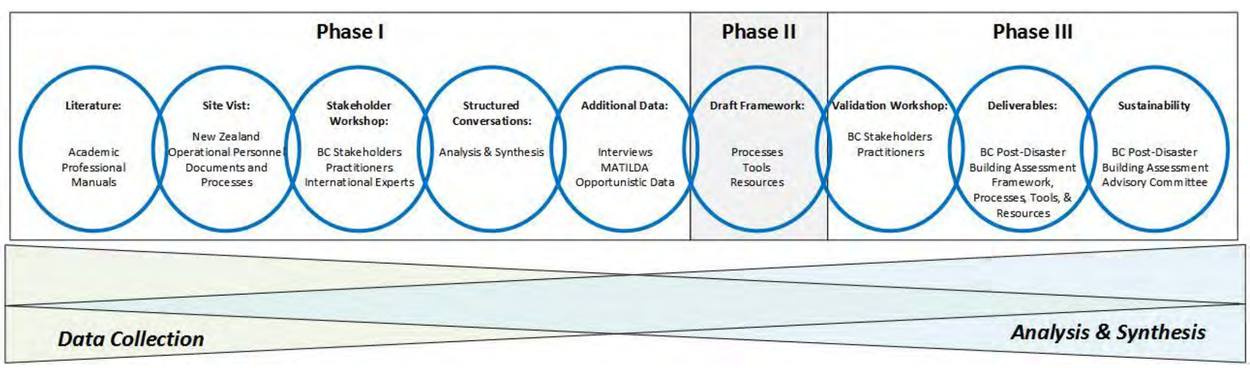


Figure 1. Research Design.

Data Collection

Data sources included:

- Relevant peer reviewed and professional/trade literature
- Professional, operational, and educational documentation and processes
- Documents describing relevant case studies and post-event debriefings
- Transcripts and documentation from interactions with key informants
- Artefacts from stakeholder engagement workshops and activities, including presentation material, handouts, worksheets, flip charts, wall notes, and discussion summaries

- Researcher field notes, journals, and discussion summaries

The project employed multiple strategies to gather and interpret data.

An initial literature review used common academic search procedures of online databases and physical journals, supplemented by inspection of relevant literature identified by members of the research team, hand searches of relevant journals, and following citations and references within the literature. In addition, researchers surveyed websites and sought additional resources from personnel within key organizations and agencies involved in PBDA. While initially focusing on peer-reviewed literature, the researchers quickly shifted focus to professional and operational sources, supplemented with publically available reports from news and popular media.

Five members of the research team conducted a seven-day **site visit to New Zealand**, meeting with individuals and groups from Auckland, Christchurch, the Kaikoura region, and Wellington. Team members gathered data through email correspondence (pre- and post-visit), semi-structured interviews and presentations with individuals and groups, field visits, a workshop, and informal discussions. In addition, team members met each morning to review and plan for upcoming sessions, and at the end of each day to summarize and document key take-aways and identify areas and opportunities for further exploration.

Stakeholder Workshop. The research team conducted a one-day workshop with key stakeholders in British Columbia's emergency management and building assessment community. The session consisted of presentations from national and international experts, followed by a series of structured activities designed to identify stakeholder expectations, needs, and capabilities related to the current and desired state of PDBA in BC.

Expert Working Group Workshop. A sub-group of the Stakeholder workshop remained and participated in a second day of structured workshop activity aimed at consolidating, validating, and extending information gathered from the Stakeholder Workshop. The Expert Working Group consisted of the research team, several international experts, and selected BC stakeholders.

Throughout Phase I, the research team met on a regular basis to review incoming data, conduct interim discussions and activities aimed at categorizing and developing an initial understanding of the data. The **field notes, notes and minutes from team meetings and artefacts** from these sessions became an additional source of data and, following an emergent design approach, allowed the team to focus and adapt subsequent data collection. In particular, the research team continually assessed the data and emerging areas of exploration for effective saturation (e.g., when little or no new information on a question was being obtained through subsequent data collection) and for gaps (e.g., areas where little or no data was being obtained). While the team continued to collect data on all questions when available, data collection was strategically focused to explore gaps and areas of specific interest.

Following initial data gathering in Phase I, the research team engaged in a series of **Structured Conversations** to analyze and synthesize the findings-to-date. The research team conducted five sessions (the structured conversations) to explore, analyze, and synthesize the data with the goal of establishing guiding principles, exploring core concepts, developing a structure for the BC PDBA framework, and identifying requirements for key elements of the framework.

Analysis

The researchers employed an inductive, thematic analysis approach, based on principles of grounded theory (Chamaz, 2014; Corbin & Strauss, 2014) with the goal of identifying effective processes to support an integrated approach to building damage and safety assessment. Data from Phase I was combined, then organized and coded both against the research questions and for emergent themes.

This data was further analyzed across the coding categories to identify and/or develop:

- Key points that would inform development of the BC PDBA framework (e.g., importance of data management, etc.)
- Strategies, principles, guidelines, and concepts which participants used to make decisions within their own PDBA processes and experience (e.g., "don't rush in; set up administrative structures before brining personnel into the area")
- Core concepts and emerging themes (e.g., the concept of "building status" in contrast to a building's "placard," etc.)
- Elements, knowledge structures, and information that will be required to inform the BC framework (e.g., taxonomies of building types, etc.)
- Recommendations for the BC framework (both explicit recommendations made by participants and recommendations developed by the research team), which formed the basis for the structured conversations.

Finally, the research team analyzed the research questions, existing frameworks, and core concepts to develop a structure and approach for writing the BC PDBA framework.

Project Outputs

The project generated a substantial body of data and numerous outputs (see Figure 2. Overall Research Project Components and Deliverables):

- 6.1.1 Project Plan
- 6.1.2 BC Building Damage Safety Assessment Research Protocol
- 6.1.3 Ethics Approval certificate
- 6.1.4 Workshop Participants and Travel List
- 6.2.1 Needs Analysis: Literature Review Report
- 6.3.1 Stakeholder Participant and Travel List
- 6.3.2 Workshop Agenda
- 6.3.3 Stakeholder Workshop Report
- 6.4 Needs Analysis Final Report
- 6.5.1 Analysis and Synthesis Report
- 6.6.1 and 6.6.2 Draft BC PDBA Framework and Recommendations
- 6.7.1 Validation Workshop Report
- 6.7.2 Draft Provincial and Community Level Framework & Resources
- 6.7.3 Final versions of BC PDBA Framework and Recommendations and Companion Document: Resources and References
- 6.8.1 TOR for PDBA Advisory Committee

6.9.1e TECHNICAL REPORT
METHODS

- 6.8.2 Inaugural Advisory Committee Report
- 6.8.3 White paper on DA Framework
- 6.8.4 Presentation(s) for peer-level conference (MATILDA, EPBC, and NCSEER)

6.9.1e TECHNICAL REPORT METHODS

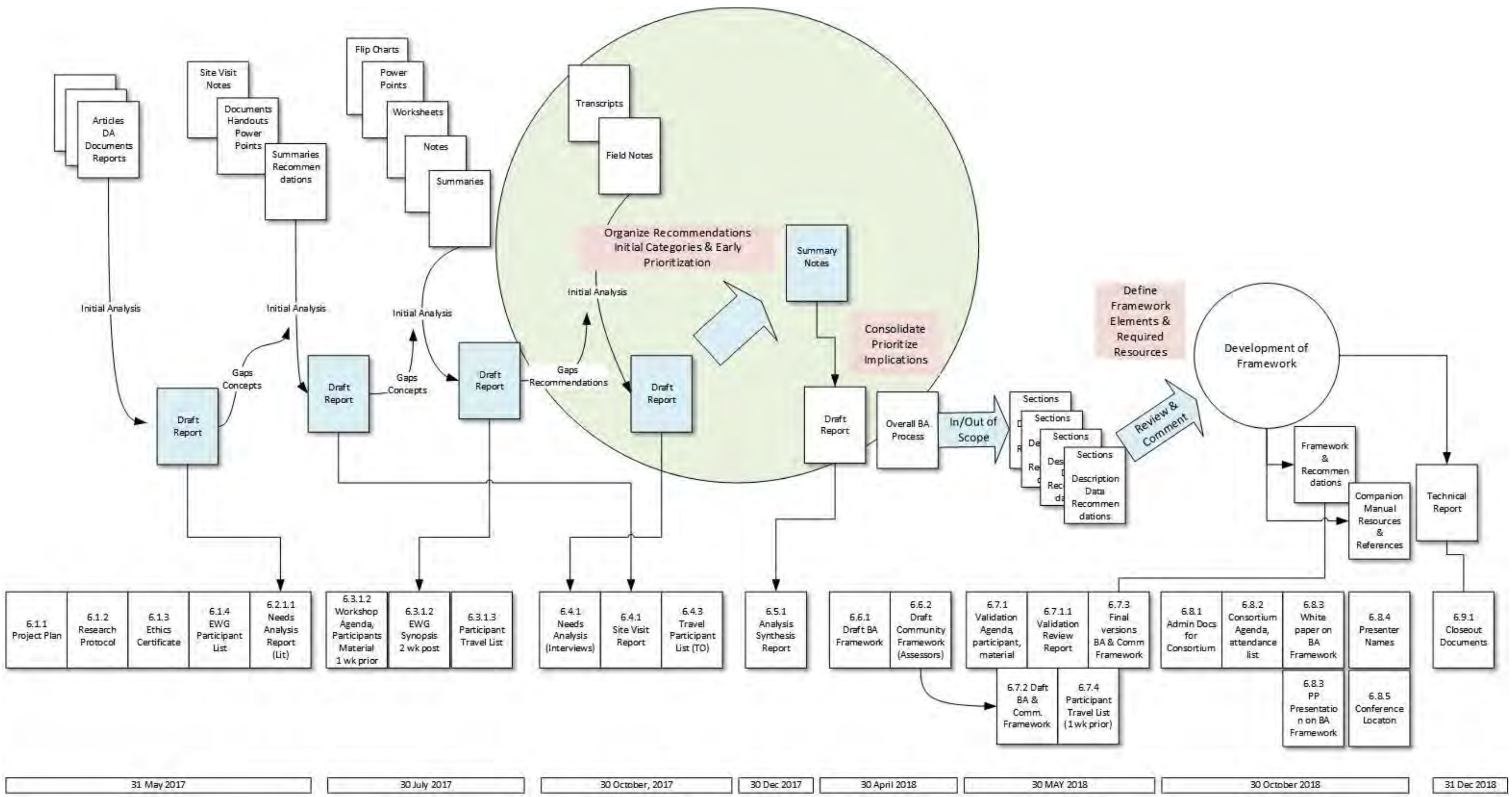


Figure 2. Overall Research Project Components and Deliverables.

6.9.1e TECHNICAL REPORT
METHODS

The following sections provide detailed information on the various phases and activities in the research project. Note that the sections are presented in chronological order and this differs from the numerical ordering of the Deliverables.

Deliverable 6.1: Project Initiation

The first phase of the project involved establishing a detailed project plan, developing the research protocol, and obtaining ethical approval for the project.

Please refer to the following project documents to review the project initiation deliverables:

- 6.1.1 Project Plan
- 6.1.2 BC Building Damage Safety Assessment Research Protocol
- 6.1.3 Ethics Approval certificate
- 6.1.4 Workshop Participants and Travel List (for the Stakeholder Workshop and Expert Working Group)

The key element of the project plan was a detailed task and timeline (Appendix 1: Project Gantt Chart).

The research protocol is outlined in Appendix 2.

The project received ethical approval and oversight from the Justice Institute of British Columbia Research Ethics Board (see Appendix 3: Ethics Certificate).

Deliverable 6.2.1: Needs Analysis: Literature Review

The Literature Review consisted of two components: a traditional academic literature review and a more focused review of post disaster building assessment in operation through the lens of several case studies.

An initial literature review used common academic search procedures of online databases and physical journals, supplemented by inspection of relevant literature identified by members of the research team, hand searches of relevant journals, and following citations and references within the literature. In addition, researchers surveyed websites and sought additional resources from personnel within key organizations and agencies involved in PBDA. While initially focusing on peer-reviewed literature, the researchers quickly shifted focus to professional and operational sources, supplemented with publically available reports from news and popular media.

Initial scoping surveys found limited academic and peer-reviewed literature on the subject of building damage safety assessment (PDBA). Much of this literature was situated in structural and earthquake engineering, often with descriptions of PDBA given as background on articles that then looked at a variety of topics such common damage patterns (such as Yamazaki, 2000). A second body of literature was found that discussed emergency management, response, and recovery associated with specific disasters and emergencies (see, for example CERC 0004.01, 2011). Again, this literature spoke **about** PDBA as an aspect of responding to the emergency, but did not often examine the processes themselves. A further set of educational and professional literature was found that forms the tools and resources that make up or support specific PDBA programs (see MBIE, 2014a).

The key outputs of the literature review included:

- Data extraction tables, identifying key information related to the research questions
- Case Studies, with an annotated list of resources describing PDBA systems and operations following events in New Zealand, Italy, and Japan
- A list of key gaps or areas requiring further investigation

Objectives

The overall research project sought to meet three objectives, one of which is pertinent to the literature review component:

- Provide information on the overall context of building damage safety assessment and its relationship with the broader field of emergency management

In addition, the research team examined literature related to specific PDBA programs and case studies showing PDBA in practice. The specific goals of literature review was to:

- Provide an overall context for the development of PDBA processes for British Columbia
- Identify data that would inform the research questions
- Identify gaps in the data to be explored through ongoing literature review, key informant interviews, a site visit, and workshops with stakeholders in BC PDBA

Methods

The literature review employed three strategies:

- Traditional key word search using Academic Search Premier and EBSCO databases
- Identification of key resources from research team members
- Snowball strategy, including review of citations in key articles, searches on authors of exemplar articles, suggestions from journal sites, and hand searches of selected journals

Titles, key words, and selected abstracts were reviewed for articles identified through all strategies.

Results

Overview

An initial search strategy generated substantial numbers of hits, but only five articles that directly addressed building assessment processes. The researchers then searched for known events, such as recent earthquakes in Italy, Japan, and New Zealand. This strategy again generated large numbers of initial hits, but few that described building assessment procedures in any detail. Finally, the research team pooled articles and resources gathered from their personal and professional experience, supplemented by hand searches of references lists and non-obvious articles by known building assessment authors. In all, 36 articles were identified for in-depth analysis. A review of professional and educational literature from known PDBA programs, educational programs, and related professional associations (e.g., engineering, architecture) was more successful. In total, 194 articles were identified for initial review, and 43 articles were analysed in depth. Two sets of data emerged from the literature review – comparative descriptions of BA processes from several exemplar systems and a list of “gaps” that served to focus further data collection.

Table 1. Literature Review Search Strategies.

Sources	Hits
Academic Documents	
• UBC databases	6,211
• JIBC “Search Me” aggregator	53,453
• Limiters: English language, full text, peer reviewed/academic journals, published between 2002 and 2017	3.446
• Subjects areas: earthquake, natural disaster, hurricane, risk assessment	36
• Selected for analysis	5
Case study, professional and operational documents	
• Documents identified	189
• Selected for analysis	38
Total documents for analysis	43

Search Strategies

An initial search using “damage assessment” was conducted using all online databases from the University of British Columbia on March 1, 2017, resulting in 6,211 hits. A similar search using the Justice

Institute of British Columbia's "Search Me" aggregator resulted in 53,453. The search was narrowed to English-language articles in peer-reviewed and academic journals, with full text availability within the last 15 years (2002 -2017), which reduced the total to 3,446 hits.

This initial search on damage assessment not useful, as the range of topics was too broad. A subject search on the results had the following selected findings: ecological (biology) 478, environmental impact 102), US 55, environmental monitoring 45, anthropogenic effects on nature 39, ecological survey 35, Biotic communities 32, ecology 32, etc. The following subjects were pulled out as most likely related to building damage assessment: earthquakes 7, natural disasters 6, hurricanes 9, risk assessment 14. After abstract review, only 5 of the resulting articles were related to building damage assessment.

A second strategy involved searching for known events, such as the Great Eastern Earthquake (Japan), the 2011 earthquakes in Italy, and the 2010/2011 earthquakes in Canterbury, New Zealand. Combining these events with terms such as damage assessment, building damage assessment, and emergency management continued to generate a substantial number of related articles, but few that addressed building damage assessment directly. The majority of these articles discussed specific damage patterns, damage to specific types of structures (e.g., reinforced concrete, or historical buildings, or lifeline infrastructure), or performing large-scale damage assessment using various forms of monitoring technology, GIS, and satellite imagery, without substantial discussion on the process of assessment of individual buildings on the ground. However, some of these articles did include descriptions of PDBA processes, or elements of those processes in the introductions or context-setting sections. Approximately 46 articles were gathered for abstract and full review.

A more productive line of research was found through exemplar articles identified by team members and through review of professional documentation related to specific incidents. Several team members submitted lists of articles and documents that they had encountered in their professional work. These were added to the pool of sources for abstract and full review.

One particularly useful series of documents emerged from the Canterbury Earthquakes Royal Commission Document Library for Building Assessments, which contained 57 documents related to the Canterbury earthquakes. These included formal submissions from key stakeholders (e.g., Civil Defence and Emergency Management, New Zealand Society for Earthquake Engineers, etc), and from specific personnel involved in PDBA. Several key documents were identified from this list. It's important to note that many of the documents are linked and self-referential – some are responses to initial reports, others use each other as reference points.

Throughout the search and review process, individual articles were reviewed for citations and links to additional sources. Promising documents were located through online databases including UBC, JIBC, and Google Scholar. Documents that were related to building damage assessment were added for abstract and full review.

By March 20, 2017, over 194 articles had been identified for further review. After title and abstract review, 43 articles were selected for more in-depth review. Throughout the review, the snowball strategy was employed to continue identifying potential sources. Note also, that not all documents were reviewed in-depth. As noted with the Canterbury articles, it was found that that many articles had very limited information on PDBA, or referred and relied upon related documents, or added no new information.

Findings

The source articles were analyzed and categorized into three sections: building damage assessment (generally), case studies, and specific programs. Key concepts, quotes, and content were identified, then extracted into data tables based on the research questions. This data formed the basis of a series resources that were then thematically analyzed. In addition, these data tables became an important source of information used throughout the research project to explore specific concepts and themes.

PDBA Program Summaries

The research team developed an initial icon-based informatics-style graphic identifying the key elements of PDBA. This initial model was used to create similar graphic images for several of the PDBA programs analysed in the literature review. These summaries are integrated in the Data Tables and Case Studies in the following section.

Data Tables

The Literature Review generated a series of data tables and case studies, which are presented in this document in Appendices 4.1 to 4.9:

New Zealand

Appendix 4.1: New Zealand Article Review Data Extraction

Appendix 4.2: New Zealand PDBA Processes (2010/11 and 2014)

Appendix 4.2.1: New Zealand Building Damage Safety Assessment Process 2010

Appendix 4.2.2: New Zealand Building Damage Safety Assessment Process 2014

Appendix 4.3: New Zealand Case Study: Christchurch Canterbury New Zealand Earthquakes 2010, 2011

Italy

Appendix 4.4: Article Review Data Extraction, Italy

Appendix 4.5: Italy Building Damage Safety Assessment Process

Appendix 4.6: Italy 2009 – 2011 Case Studies

Japan

Appendix 4.7: Article Review Data Extraction: Japan

Appendix 4.8: Japan Building Damage Safety Assessment Process

ATC

Appendix 4.9: ATC Building Damage Safety Assessment Process

General impressions

Very few articles were found in the academic literature that directly addressed the research questions in this study.

As noted above the majority of the found literature is situated in structural and earthquake engineering. These articles usually address types of damage that occurred to specific types of structures (e.g. reinforced concrete buildings or historical buildings), damage to infrastructure, or use of seismic monitoring and imagery technology to determine both overall damage patterns and damage to specific buildings.

A series of articles and presentations were uncovered that compared various PDBA processes. These provide one of the more useful sets of resources for this project.

The most promising documents are reports and professional documents that either describe the emergency management and damage assessment processes after specific incidents (in particular, the documents that describe the Canterbury earthquakes of 2010/2011) and field guides for specific PDBA programs, such as the New Zealand model and ATC-20.

Surprisingly few articles were found that could support study of specific cases. The New Zealand case provided the most in-depth example and source of documents describing PDBA. Several articles were found on the Italian earthquakes of 2011. While many articles were found on Japan, 2011, very few provided any meaningful data for this study.

Program description data was found for New Zealand, Italy, Japan (very limited), and ATC. Other documents include data on Greece and several other European models, but this has not been reviewed in-depth in this report. However, the documents are included as potential data for further analysis in the project.

Very few articles were found within an architecture context, and the ones that did show up tended to discuss damage to types of buildings, rather than the use of architects in PDBA.

Note that the majority of sources focused on earthquake, with a smaller set of articles and resources on flooding and/or tsunami. Individual articles were seen on other hazards such as tornado, hurricane, terrorist activity; however, these articles did not contain references to PDBA. The research team is encouraged to continue to look for resources that go beyond earthquake response.

Key Themes and Topics

The findings of the Needs Analysis Report are included as a series of tables in the Case Study and Program in the Deliverable 6.2.1 Needs Analysis: Literature Review Report. The tables are based on the project's research questions. Data that will guide the research team in developing a PDBA process for British Columbia was found on the following topics:

- Relationship of PDBA to overall emergency management
- Legislative authority for PDBA and roles of stakeholders at various levels (e.g., senior government to local stakeholders)
- Goals and elements of several PDBA programs
- Types of PDBA assessments

- Use of placarding systems
- Outcomes of PDBA assessments and placard categories
- Types of buildings associated with specific types of PDBA assessment
- Recording and reporting of information
- Types of personnel involved in PDBA (somewhat limited)
- Liability (limited)
- Procedures for different types of PDBA assessments

Three particularly useful sets of data in the tables are sections on "Principles and Guidelines" which outline how various types of decisions were made, elements that should be in a PDBA process, and recommendations for changes to PDBA based on cases. Specifically, several sources noted the importance of having examples of specific types of damage associated with key decisions/categories. The recommendations from the Canterbury earthquakes were identified as key data studied for adaptation to the BC context.

Gaps

However, there are substantial gaps in the literature that was reviewed. The following topics required additional data, much of which was obtained from ongoing literature and document review, key informant interviews, exemplar site visits, and stakeholder consultation:

- Ownership and sustainability of PDBA processes, both specifically and within the overall context of emergency management
- Building taxonomies (various descriptions of types of buildings exist, but not what types of personnel can conduct those assessments)
- Procedures for assessment of specific types of buildings
- Fit of PDBA with transition to recovery
- Management of placards over time (e.g., who can modify/change/remove, etc.)
- Overlap of PDBA with USAR and other rescue/response activities
- Personnel
    - Types of personnel involved in PDBA
    - Desired credentials or certification
    - Use of non-credentialed personnel in PDBA
    - Recruitment of personnel for PDBA
    - Prior training
    - Just-in-time training and/or preparation for PDBA
    - Liability for personnel involved in PDBA
- PDBA Operations:
    - Overall management of PDBA
    - Decision-making and priority determination
    - Logistics and dispatching of PDBA teams
    - Data collection
    - Data reporting
    - Data management
    - Use of data in subsequent decision-making
    - Use of technology in data management
    - Team size and composition

Authors' conclusions

This literature review uncovered multiple sources of data that can guide the development of the British Columbia PDBA program. In particular, the Canterbury earthquake case study and program documents are exceptionally relevant and useful.

Please refer to *Deliverable 6.2.1 Needs Analysis: Literature Review* for additional information.

Deliverable 6.4: Needs Analysis: Site Visit

Overview

The project team conducted a site visit to New Zealand in May, 2017. The site visit consisted of interviews, focus group sessions, workshops, and field trips to Auckland, Christchurch, Kaikoura region, and Wellington. The team met with representatives from government, local governments, professional associations, agencies and individuals who participated in recent post-earthquake building assessment and those who developed and manage the New Zealand PDBA processes.

The initial project plan conceived of a site visit as an opportunity to visit either an incident in progress or an exemplary system (based on the case study analysis conducted in the literature review). The Research Team determined that there were no appropriate incidents-in-progress during the initial phases of the project and that a visit to an exemplar site/program would generate higher quality and more useful data for the project.

Data collection methods for the site visit included a series of formal and informal meetings and presentations from both the research team and participants, a focused “workshop” session employing interactive sessions to obtain specific information related to the research questions, one-on-one discussions, and question and answer sessions. This data was analyzed using content and thematic analysis strategies with a particular focus on identifying and development recommendations for development and implementation of PDBA procedures, best practices, and suggestions for adaptation.

The site visit generated a substantial body of raw data, primarily in the form of text-based notes and files. The most important findings from the site visit were extracted in the form of recommendations and key points for consideration. These recommendations were consolidated, then coded against key research questions and topics. To review the full list of recommendations, please refer to *Deliverable 6.4 Needs Analysis: Site Visit, Appendix 5: Recommendations*.

Site Selection

The team conducted initial investigations into the logistics and potential liability issues regarding visiting an incident-in-progress and determined that the most useful time to visit an incident would be several weeks to months after the initial phases of the incident. This would ensure that travel and accommodation would be available without impacting local residents, allow the team to see the building assessment process in a mature enough state to evaluate yet still be in progress, and offer the best opportunity to engage assessors and managers of the BA program.

The team reviewed the project timelines and noted that the latest the team could visit such a site and be able to incorporate the data into analysis would be late summer, 2017. No appropriate incidents had been identified by May, 2017. The research team agreed that it would be beneficial to have the site visit data before the Expert Working Group and Stakeholder workshops were held (scheduled for June, 2017). In addition, the team was uncomfortable with adding logistical complexity to communities in the midst of dealing with a disaster.

Therefore, the team decided that a visit to an exemplar site would be a more beneficial approach. Several programs were considered, including Japan, California, Ecuador, Italy, and New Zealand. New Zealand was chosen for several reasons, including the:

- Nature of the New Zealand earthquake events since 2010, with several large earthquakes, allowing for comparison of a single BA processes in different communities,
- Ability to assess adaptations of the New Zealand process across several instances,
- Similarity of New Zealand's culture, governance structures, and building codes with BC,
- Abundance of professional documentation and governmental reports describing the New Zealand experience, and
- Availability of personnel in New Zealand who were willing to work with the research team.

The research team worked with personnel from Christchurch City Council, New Zealand Civil Defence and Emergency Management, the University of Canterbury, and the New Zealand Ministry of Business, Innovation, and Employment to establish a time frame and logistics for a visit from 9 – 19 June, 2017.

Team members included a representative from each partner organization, the lead investigator, and a second researcher:

- Dr. Ron Bowles, JIBC
- Steven Bibby, BC Housing
- Peter Learoyd, JIBC
- Peter Mitchell, APEGBC
- Robyn Fenton, AIBC
- Dawn Ursuliak, JIBC

New Zealand Case Description

The site visit focused on two earthquake events: the Canterbury (aka Darfield) earthquake series that initiated in September 4, 2010 and the Kaikoura earthquake of November 14, 2016.

Canterbury (Darfield) Earthquakes

New Zealand has a fairly active history of earthquakes, with over 55 events of magnitude 6.5 or greater between 1840 and 2011 (Cooper et al., 2012). The initial incident involved a magnitude 7.1 earthquake at 0435, 4 September, 2010, with an epicentre 40 km west of central Christchurch. Chirstchurch City Countil (CCC), along with neighbouring communities, inspected nearly 8,000 buildings in the first week following the event. A second earthquake – a magnitude 4.1 aftershock – occurred at 1030 26 December, 2011 with an epicentre 1.8 km from Christchurch Cathedral in central Christchurch. 177 buildings were re-evaluated after this event (CERC, 2012). Over 7,000 aftershock occurred in the following calendar year (Gallagher, Lizundia, & Barnes, 2011). On February 22, 2011, central Christchurch was severely damaged with extensive loss of life by a magnitude 6.2 aftershock with an epicentre 6 km southwest of the central business district (CBD) (Gallagher et al., 2011). Two significant aftershocks occurred on June 13, 2011 (M 5.7 and 6.0). While moderate damage occurred in the initial event, the subsequent aftershocks resulted in substantial damage – in particular "catastrophic damage" in the CBD and liquefaction which affected large suburban areas of the city, as well as significant loss of life (Gallagher et al., 2011).

Kaikoura Earthquake

The Kaikoura earthquake refers to a magnitude 7.8 earthquake that occurred near the north-east region of the South Island at 1102 on 13 November, 2016. This event caused substantial damage, including "extreme surface displacements, land deformations and surface ground motions … , as well as a regional tsunami and triggered major slow slip events" (Wotherspoon, Palermo, & Holden, 2017, p. i). Similar to the Christchurch events, over 8,000 aftershocks were recorded in the following five months (Wotherspoon et al., 2017). The event was felt across New Zealand, resulting in damage in the Kaikoura region, extending to Wellington on the North Island (Wotherspoon et al., 2017).

New Zealand continues to experience seismic activity on an ongoing basis. In fact, the research team experienced a magnitude 4.8 event in Christchurch on their first evening in Christchurch.

New Zealand's approach to building damage assessment evolved across these events. A modified version of the ATC 20 guidelines were in use following the initial 2010 Darfield event. These procedures were modified based on experience and the Ministry of Business, Innovation, and Employment (MBIE) now maintains a set of field guides for earthquakes and floods that incorporate a richer, more nuanced set of procedures.

The research team was thus able to meet with personnel who had been involved in building damage assessment in multiple events which occurred in different geographic settings, with different levels of building development and building structure. In addition, the team was able to interview personnel involved in the evolution of New Zealand's building damage assessment processes, procedures, and resources. In addition, the team was able to access a considerable amount of written documentation, both academic and professional, that described and analyzed New Zealand's response and provided direction for future development.

Data Collection Methods and Procedures

Data collection consisted of three strategies:

- Pre-trip document review
- Site visit, including small and large group presentations and interviews
- Stakeholder workshop

In preparation for the site visit, the team identified documentation from the literature review that was relevant to the New Zealand experience with building assessment. This included academic articles, professional documents (including the Ministry of Business, Innovation, and Employment [MBIE] processes, training, and documentation), and an extensive set of resources gathered by the Canterbury Earthquakes Royal Commission – Te Konihana Ruwhenua o Waitaha (http://canterbury.royalcommission.govt.nz/).

The research team met to review overall project goals and identify specific research objectives that should be the focus on the site visit. Team members then consulted with their staffs and contacts to identify agencies and specific personnel in New Zealand who could help address those research questions. Team members were able to identify personal contacts in each of the agencies on this list, and initial contact was made by email by individual team members (See *Deliverable 6.4 Needs Analysis: Site Visit Report,* Appendix 1: Initial Contact Message for New Zealand Site Visit). The project manager worked with team members and their contacts to develop an overall agenda, series of specific meetings and presentations, and personnel to meet and interview while in New Zealand. The research team developed a series of focused questions, a subset of the overall research questions, which were distributed to participating NZ agencies and organizations. Please see *Deliverable 6.4 Needs Analysis: Site Visit Report,* Appendices 1 – 4 for more detailed information.

The site visit included meetings with personnel in Auckland, Christchurch, Kaikoura, and Wellington. In addition to meeting with individuals, groups, and agencies/organizations, team members toured the Christchurch Earthquake City exhibit, multiple building sites in Christchurch, residential areas impacted by liquefaction in and around Christchurch, rural sites in Kaikoura, and damaged buildings in Wellington.

The third form of data collection was a workshop held in Wellington. The purpose of this stakeholder engagement workshop was to share information around the initial findings of the research team and to advance the research by collecting information from emergency management and building related personnel, around the development and implementation of post-disaster building safety assessment programs. Specifically, the workshop sought data on:

- Matching types of buildings with capabilities of inspectors
    - Credentialed and non-credentialed
- Fit of PDBA with overall emergency management
- Personnel
    - Who, credentials, training, recruitment, prep, liability
- PDBA Operations
    - Overall management, day-to-day decision-making
    - Logistics and team management
    - Data management and use of technology

The workshop consisted of a set of presentations, followed by group activities. Participants worked in small groups to answer questions targeted on each of the workshop research questions. The first activity explored the experiences of damage assessment teams, both at the operational and at the management level.

For the second set of activities a "carousel" method was employed, where five "stations" were set up, each focused on one of the following questions or topics:

- The Ad Hoc phase – what happened before formal damage assessment processes were in place?
- Credentials – where were credentialed and non-credentialed personnel used and why?
- Training – what types of training is available to support personnel before and during an event?
- Standards – what standards, processes, and guidelines support the PDBA process?
- Information Management – how was information gathered and managed?

Participants were divided into four groups, with one group assigned to explore each question. Responses were gathered by flip chart. After 20 minutes, the groups rotated to the next question. The new groups spent five minutes being briefed on the previous group's responses, then had fifteen minutes to respond, comment, and add new ideas. The groups continued to rotate until all groups had had an opportunity to respond to each topic. Each question was then debriefed in a plenary session, with additional analysis and commentary added to the data. The final plenary session explored unresolved issues through a set of open ended questions:

- What has not been written in a report that you would like to share?
- What has not been resolved?

- Blue Sky: what would you want DA to look like if you could start all over?

Data was collected through flip charts, photographs, and field notes taken by research team members.

The team met at the end of each day to review and compare notes. These sessions were informal, but helped to consolidate experience from each day's sessions and to help develop focus questions and strategies for the following days.

Findings and Recommendations

The site visit generated a substantial body of raw data, primarily in the form of text-based notes and files. Two members of the research team gathered running field notes on discussions and meetings. In addition, all team members kept personal notes. Team members collaborated in a summary review of the site visit (captured in additional field notes) and several submitted lists of comments and recommendations based on their notes and experiences. This data was consolidated and was used throughout the remainder of the project for analysis and to support development of the project deliverables.

The most important findings from the site visit were extracted in the form of recommendations and key points for consideration. These recommendations were consolidated, then coded against key research questions and topics. The results are presented in *Deliverable 6.4 Needs Analysis: Site Visit,* Appendix 5: Recommendations. These recommendations and key points served as critical elements for analysis in the Synthesis Phase of the project. While most recommendations applied to several research questions, the following emerged as primary themes:

- Guiding principles – key concepts, actions, and considerations for guiding development of the BC project
- Damage assessment as a complex system
- Implications from concept that earthquakes involve an ongoing series of events, not a single discrete event
- Damage assessment is one of a series of overlapping emergency management assessments and functions
- The concept of Building Status as a dynamic ongoing feature of buildings
- Importance of developing situational awareness
- Strategies for overall damage assessment
- Implications of changing goals of various building assessment processes over time
- Overall emergency management process
- Damage assessment operations
- Damage assessment process
- Placards and assessment outcome options
- Information flow
- Personnel
- Training
- Legal aspects
- Building and geohazard surveillance and intelligence (both pre- and post-event)
- Psychosocial impact
- Taxonomies and models to support a Damage Assessment process

6.9.1e TECHNICAL REPORT
DELIVERABLE 6.4: NEEDS ANALYSIS: SITE VISIT

Key findings from the site visit are available in Appendices 5: Site Visit Participating Organizations and Agencies, and Appendix 6: Recommendations based on Site Visit Analysis.

Please refer to *Deliverable 6.4 Needs Assessment: Site Visit Report* for additional information and data.

Interim Analysis and Core Concepts

Analysis was an ongoing and emergent process within this project. At all points, the team was concurrently collecting, considering, and making sense of data and findings with the goal of informing the development of the BC damage assessment process. The project took a "systems of systems" approach, and this is seen in the organization and presentation of data and analysis.

One of the challenges in this project has been to make sense and manage the volume of disparate information that the team has encountered. A second challenge has been keeping the focus on building assessment, as we have found that the process is inextricably linked a large and shifting set of other emergency management, recovery, and business-as-usual practices and processes.

In the earlier phases of the project, the team had developed a procedural framework that described the various processes and activities that are involved in damage assessment and in emergency management generally. This model was graphically represented using an "infomatic"/icon-based graphic style (Figure 3). The organization of the elements on the graphic could be organized horizontally in time (from pre- to post-event and on towards recovery) and vertically in complexity of organization (elements "lower" in the graphic were at the level of individual buildings, with successive elements arranged to local, regional, national, and international "levels." This approach allowed a graphic representation of significant "elements" in the system under study, including buildings, personnel, agencies, and processes and how these were related in organizational complexity across time.

Figure 3. Elements of a Generic Damage Assessment Program.

6.9.1e TECHNICAL REPORT
INTERIM ANALYSIS AND CORE CONCEPTS

The model was used in the Literature Review and Case Study phase to compare various building assessment processes (Figure 4. Infographic Style PDBA Program Summaries). The graphic also served as a conceptual model for organizing, conceptualizing and integrating data gathered during the site visit phase with that from previous phases in the project. However, the icon-based format was not useful for displaying processes, their elements, or the relationships between those elements. Thus, while the conceptual organization (horizontally in time, vertically in organizational complexity) was retained, the presentation and graphic style was changed to more of a process/flowchart presentation.

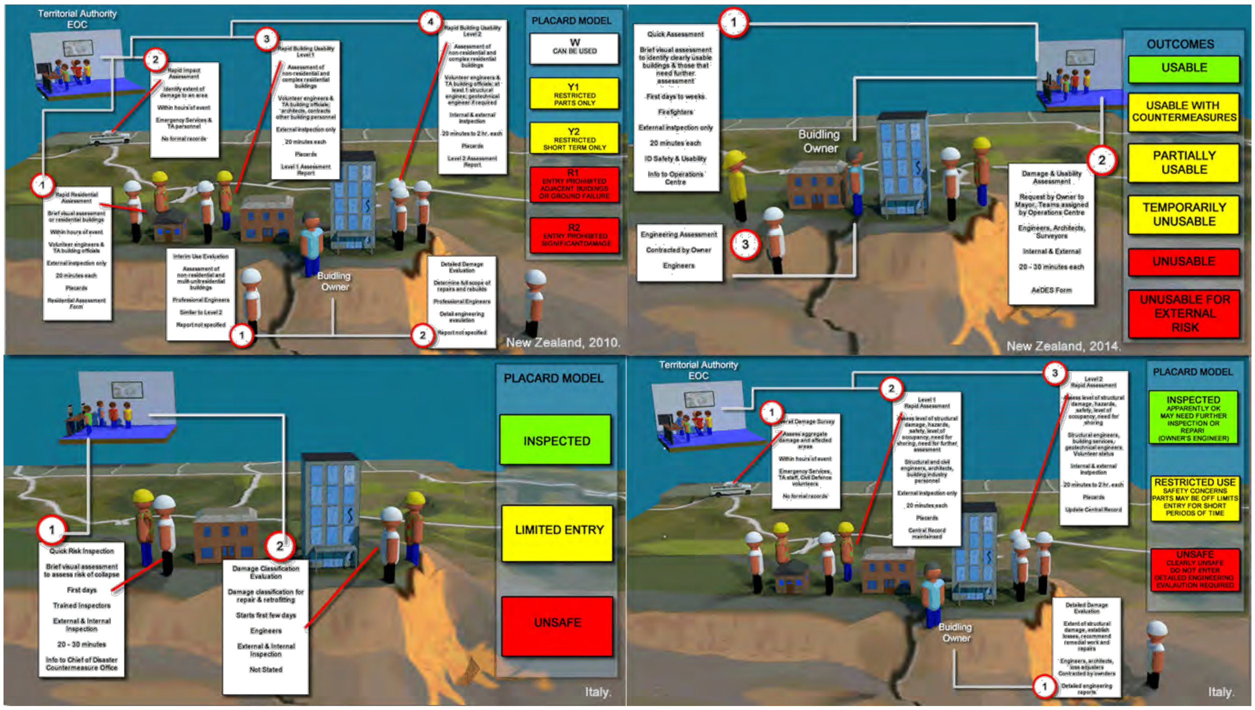


Figure 4. Infographic Style PDBA Program Summaries.

The core of the new conceptual model was a “flowchart” outlining a “generic” post-disaster building assessment process (see Figure 5. Generic Post-Disaster Building Assessment Process).

6.9.1e TECHNICAL REPORT
INTERIM ANALYSIS AND CORE CONCEPTS

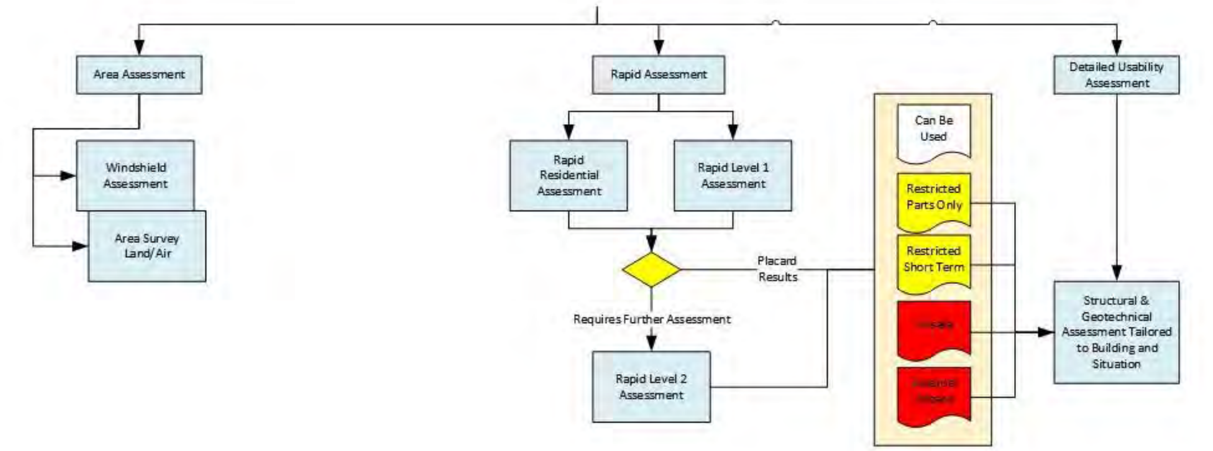


Figure 5. Generic Post-Disaster Building Assessment Process.

As the team gathered and assessed data throughout the site visit, this model was amended to add additional elements and processes. The graphic continued to grow in complexity, with new elements representing additional systems and sub-systems embedded within or of which building assessment is a part of. The resulting image (Figure 6. Systems-view of Post-disaster Building Assessment) serves as both a visual representation and an organizing framework for analysis and interpretation of data in this project. Figure 7 presents a systems-level version.

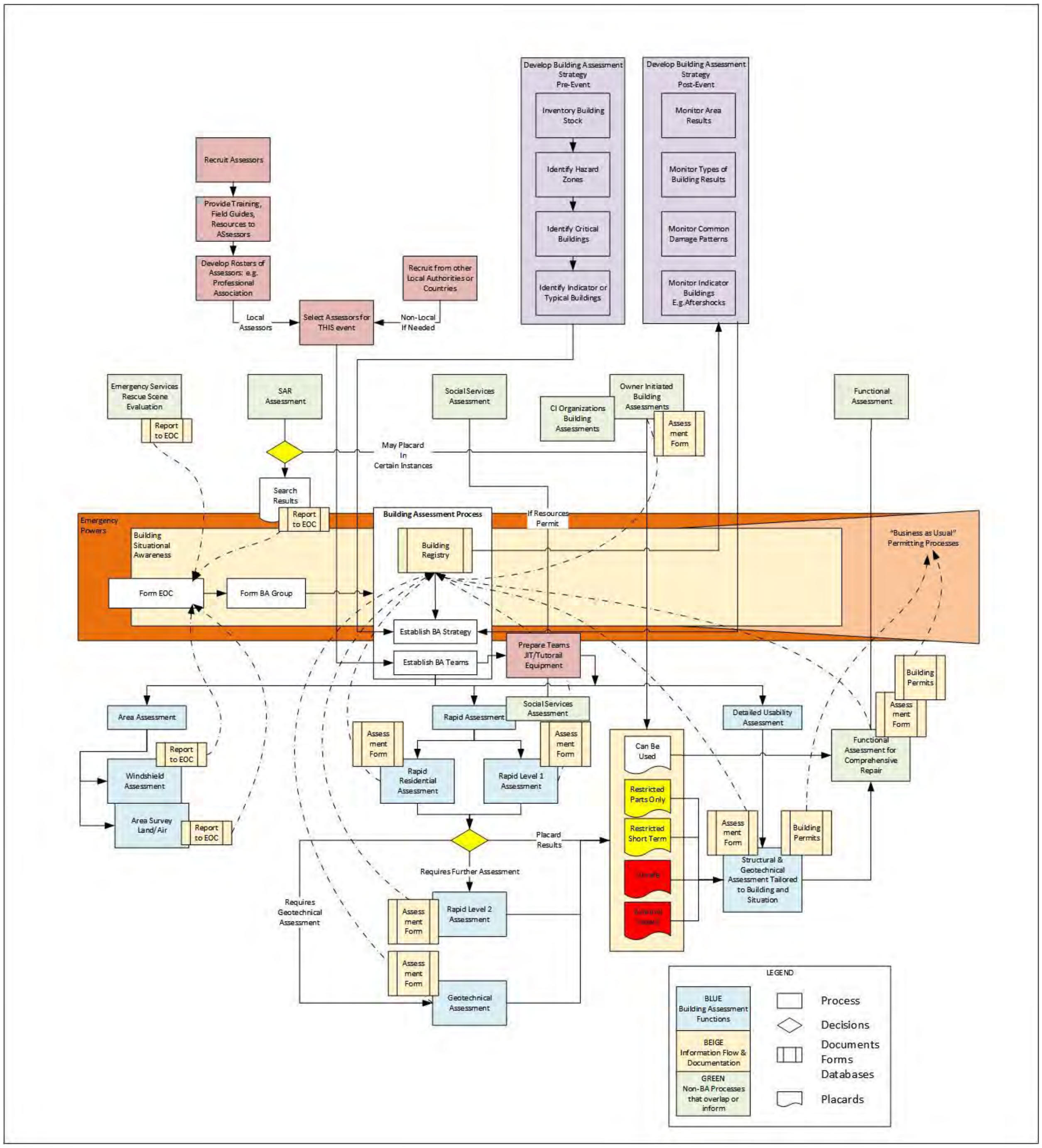


Figure 6. Systems-view of Post-disaster Building Assessment.

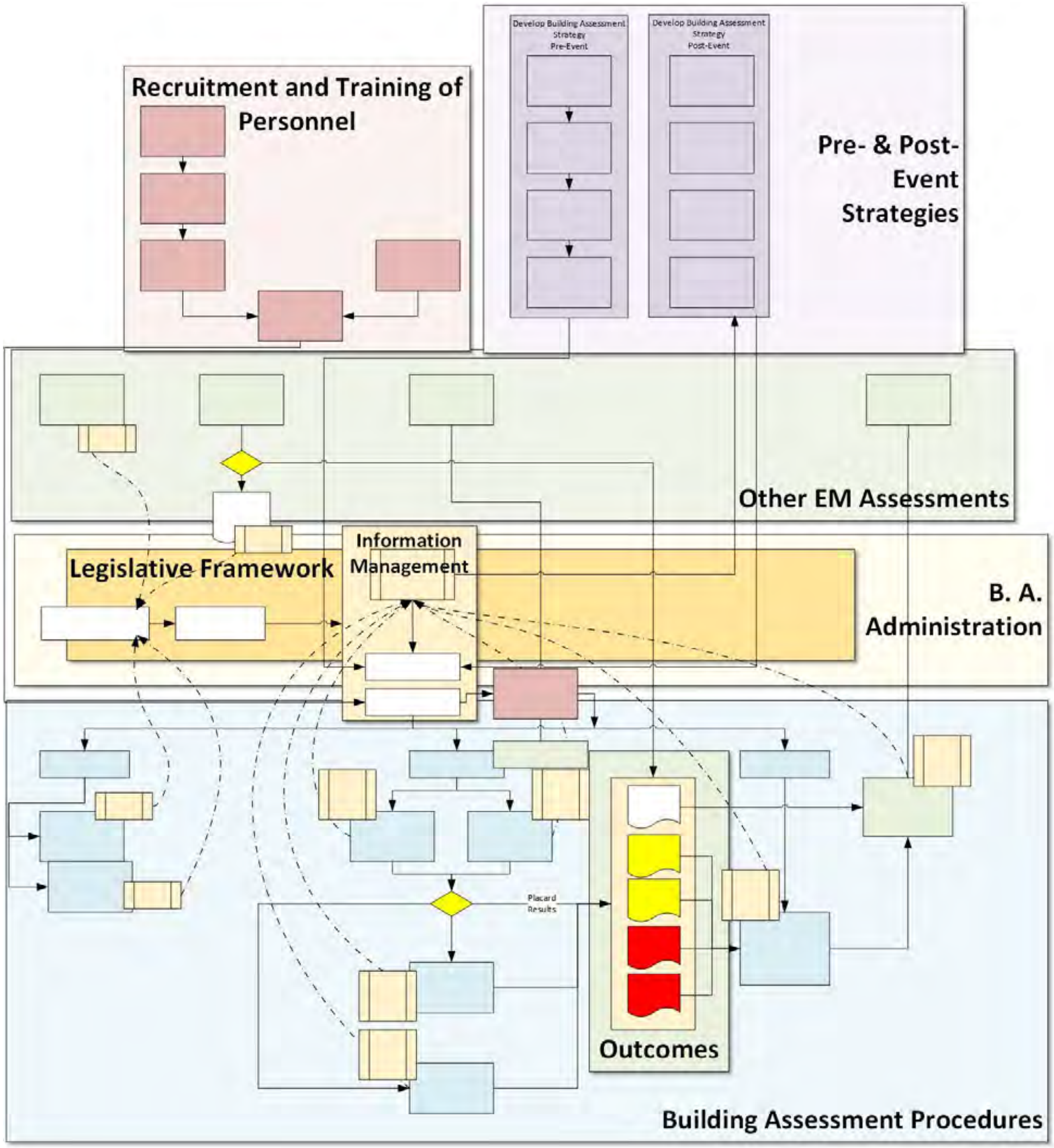


Figure 7. Systems-level model of Post-disaster Building Assessment.

The remainder of this section presents an initial analysis of data in the form of definitions of a selected set of systems involving overall post-disaster building assessment.

Basic Process

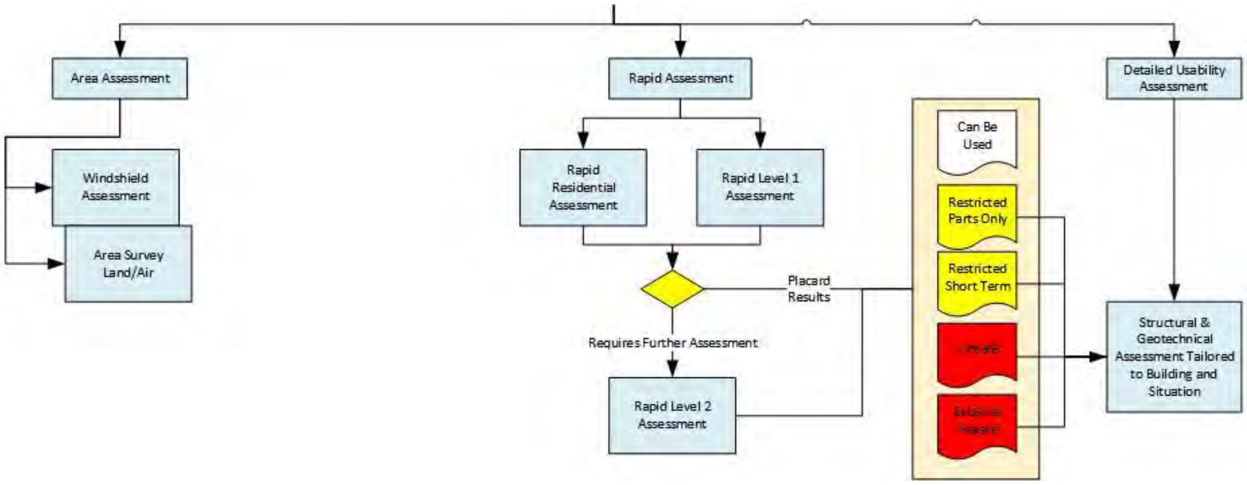


Figure 8. Basic Damage Assessment Process.

Damage assessment models vary, but in general there are three phases (Figure 8. Basic Damage Assessment Process):

- Area assessment, which typically consists of a "windshield assessment" and other information received by the EOC in the initial phases of a response. This phase focuses on gaining an understanding of the extent (what areas within the region) and severity (degree of damage) of the incident. This information is used both to determine what types of resources will be needed for building damage assessment and to begin initial prioritization.
- Rapid Assessment, which typically follows an algorithmic structure designed to triage buildings in terms of usability and requirement for further inspection. New Zealand distinguished between initial external assessment of simple residential and more complex buildings. Buildings with minor or no apparent damage ("white") and those deemed unsafe or unusable ("red") required no further immediate assessment. Those requiring further follow-up received a more detailed "Level 2" assessment involving structural engineers and/or internal inspection.
- A Detailed assessment, typically involving structural and/or geotechnical engineers to determine requirements for repair or demolition.

Note that the New Zealand model has evolved through several incidents. Participants described an initial process based closely on the ATC 20 guidelines that was subsequently modified and refined through use in Christchurch, Kaikoura, and Wellington. While each version has substantive changes in focus, goal, and procedure, the overall structure remains similar to the generic model described above.

Overall Administration

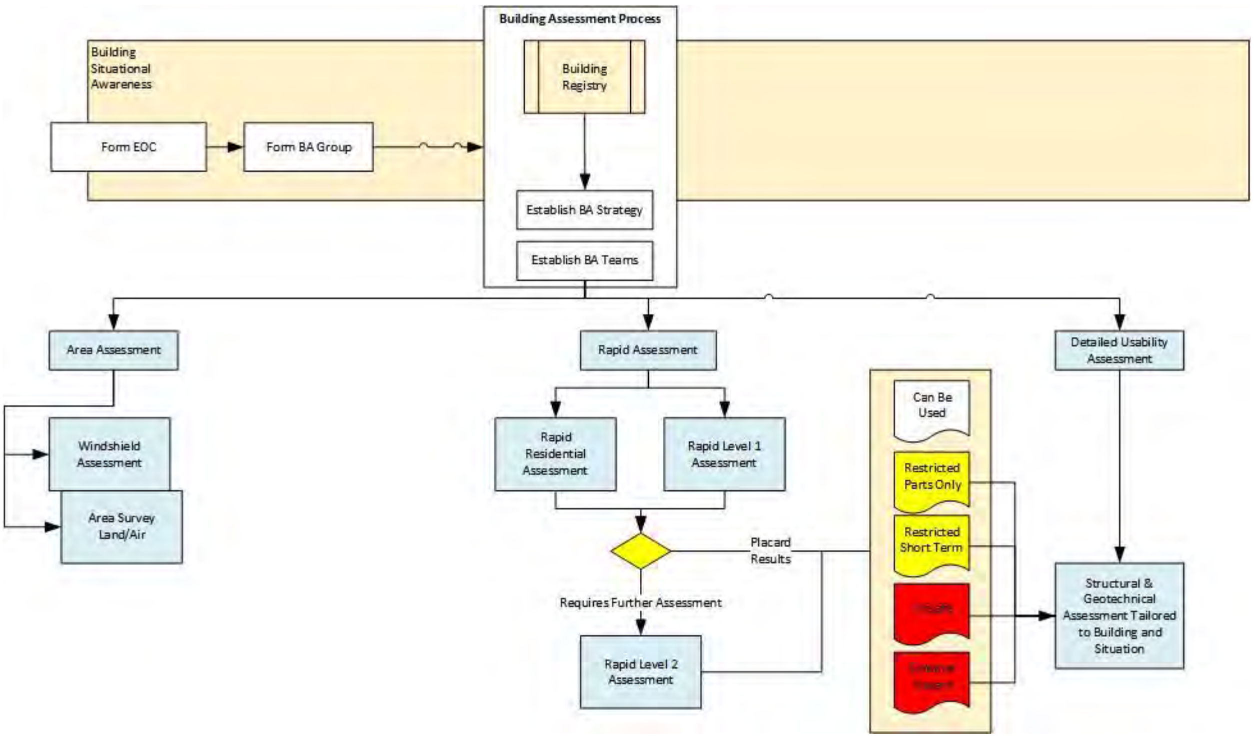


Figure 9. Overall Damage Assessment Administration.

The research team noted that much of the research literature, professional documentation, and manuals focus on the procedures of assessing individual buildings. Overall administration of damage assessment is an apparent gap in the literature and documentation. In general, DA is administered through the EOC (in the response phase) and devolves to local authorities' building inspection processes over time (Figure 9. Overall Damage Assessment Administration). This is an area that requires more detailed analysis and discussion.

Damage Assessment Strategy

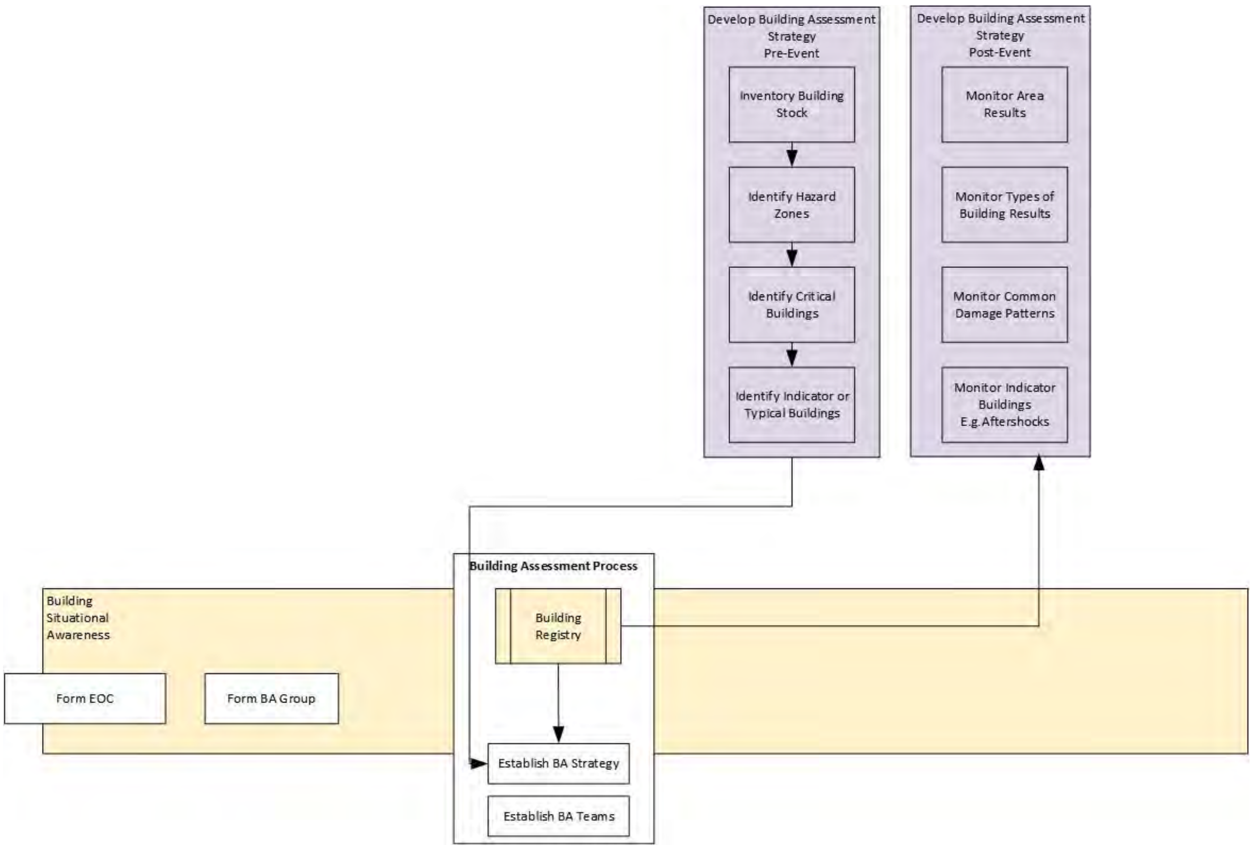


Figure 10. Damage Assessment Strategy.

The research team encountered a number of discussions on strategies involved in both the pre-event and post-event phases. Along with overall administration, this is a system or component of damage assessment that is underreported. A key element of discussions around strategy was the need for developing information and relationships with stakeholders prior to the event, and of the importance of information management and analysis to administration of the damage assessment process (Figure 10. Damage Assessment Strategy).

Overlapping Assessments

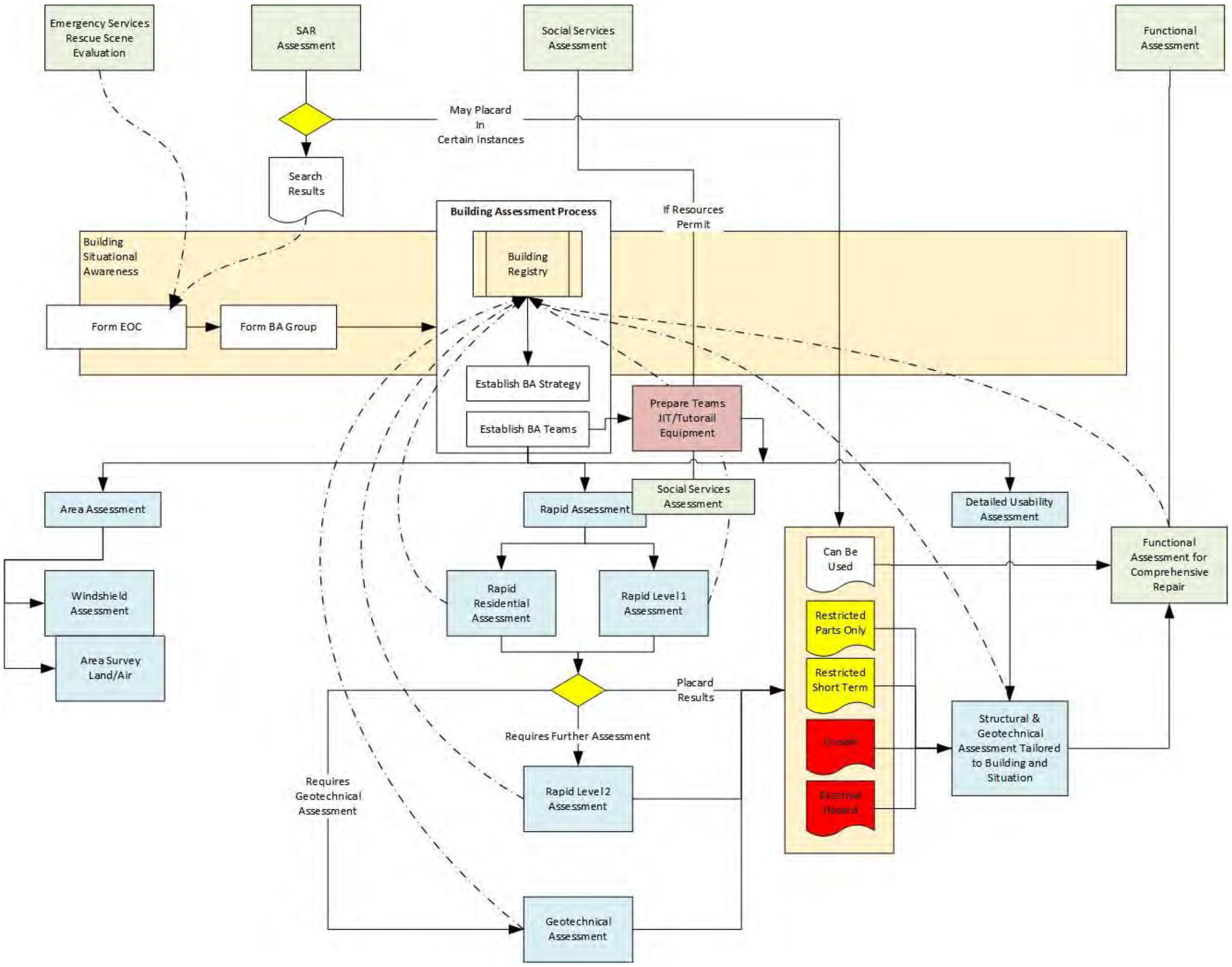


Figure 11. Overlapping Emergency Management Functions and Assessments.

One of the striking findings in this study is the degree to which building assessment is embedded within and related to other emergency management processes and assessments (Figure 11. Overlapping Emergency Management Functions and Assessments). The New Zealand context was intriguing in that participants were involved in damage assessment in three distinctly different events: the suburban and somewhat distributed urban landscape in Christchurch, the more rural experience in Kaikoura, and the dense, urban setting of Wellington. These experiences allowed the research team to hear how building assessment teams engaged with a variety of other groups and processes, including (but not limited to) initial search and rescue, USAR activities, geotechnical assessment, welfare/social services, critical infrastructure and building owner assessments. In different events, building assessment teams encountered buildings assessed by other groups (e.g., USAR and geotechnical engineers), were engaged as coordinated teams with other personnel (e.g., USAR personnel for short-term countermeasures such as pulling down chimneys or welfare personnel), and struggled to gain access to and incorporate results from building assessments done by private engineers.

Information Flow

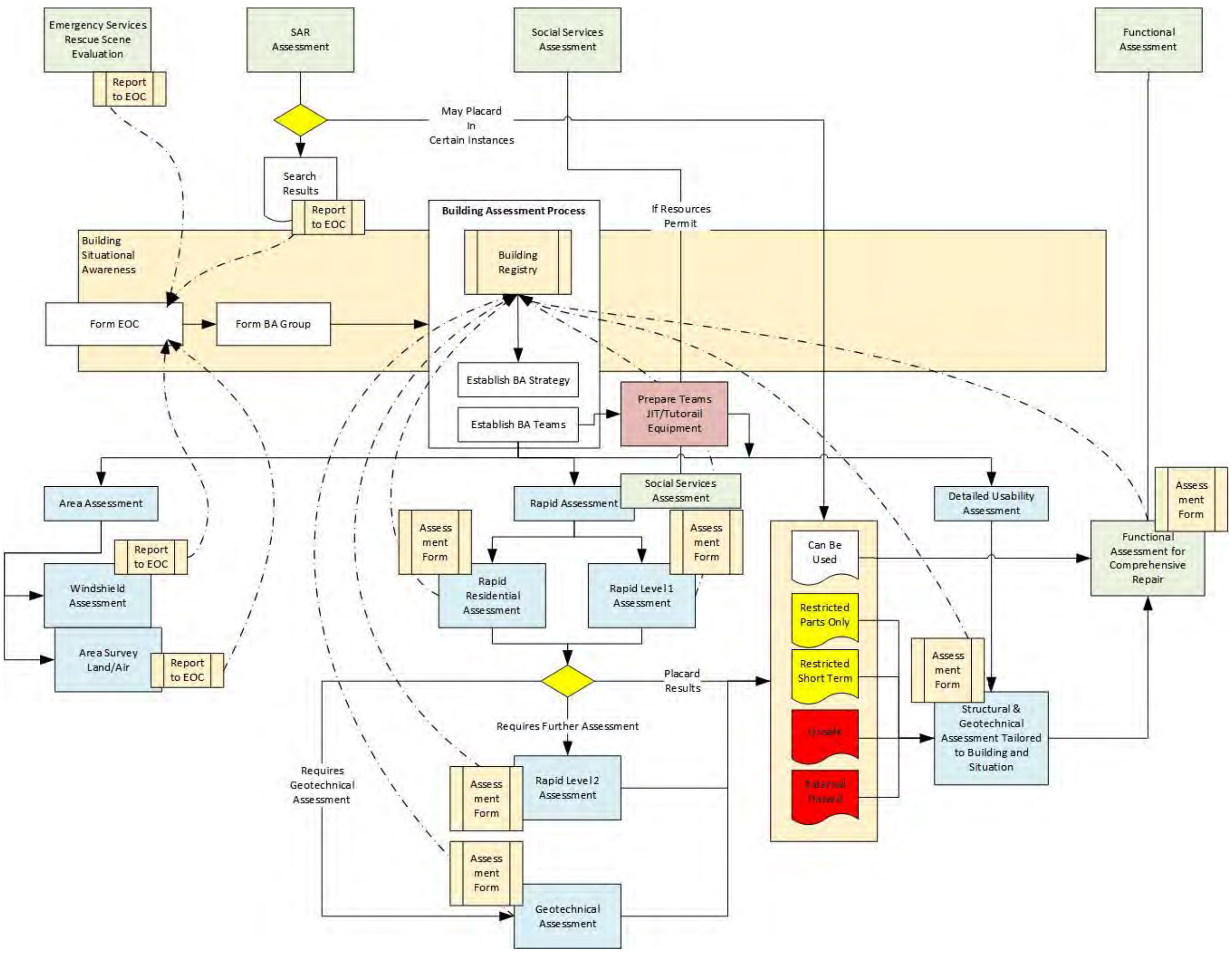


Figure 12. Information Flow.

Information gathering, management, and use emerged as one of the critical features of building assessment and one of the greater challenges in an event. Paper-based systems generated vast quantities of data that had to be collated, entered, and managed. Technology-based systems faced challenges due to limited network and communication systems, availability of power and integration with paper-based data. Multiple participants commented on the overwhelming volume of data generated by the building assessment process and the difficulty of timely data entry and analysis. Multiple participants described challenges in being able to manage data in a way that allowed for informed decision-making; and, indeed, much of the data gathered was not distributed to other elements of the emergency response. Another theme was the importance of integrating information from multiple assessments (e.g., USAR, later owner-led engineering assessments) with the information generated by the building assessment process itself. Elements of the information system included data collection forms, data collection technology, gathering and transmission of data to the overall DA administration, data entry, analysis, distribution, and decision-making (Figure 12. Information Flow).

Personnel

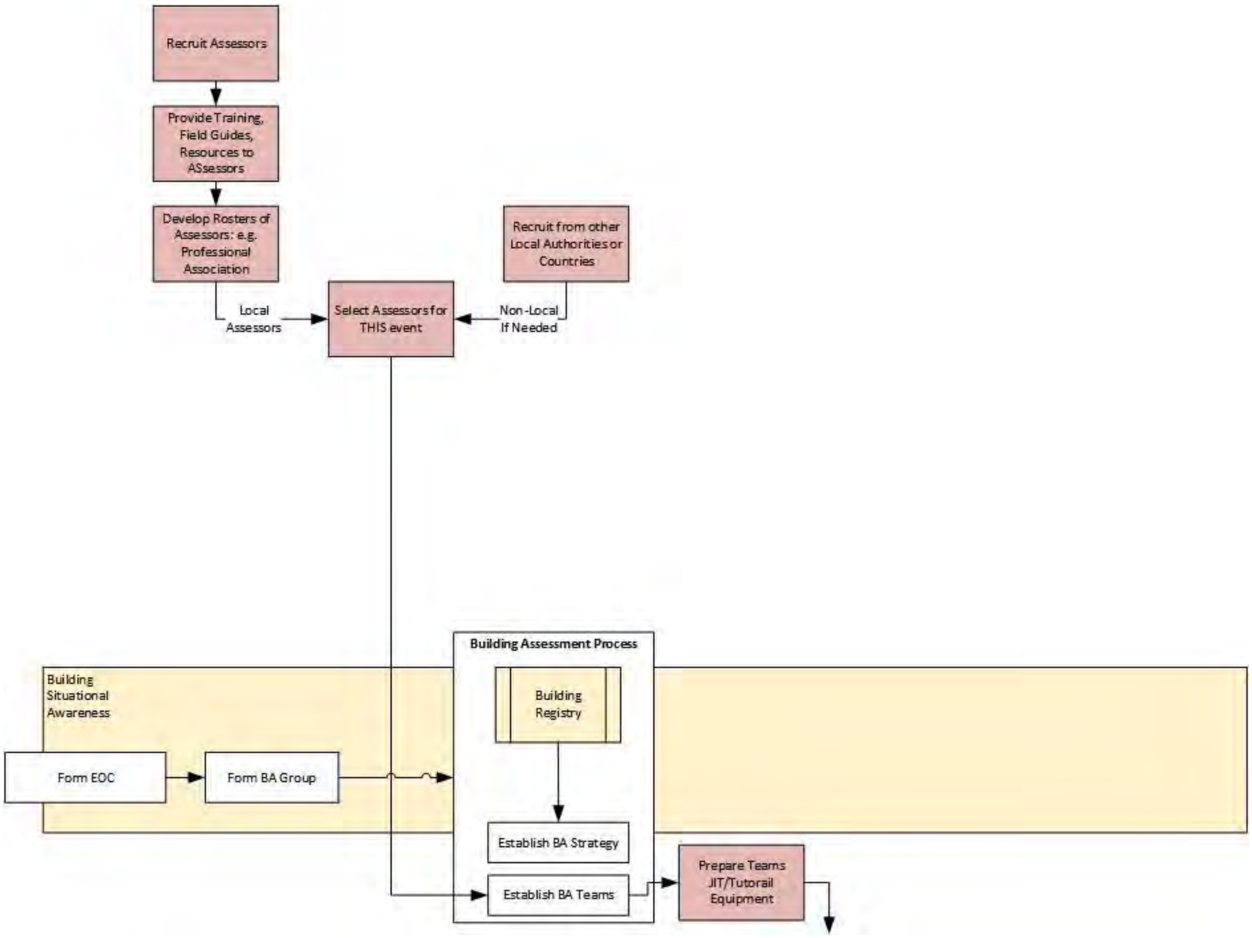


Figure 13. Personnel.

New Zealand's damage assessment program has evolved significantly since the initial 2010 Darfield (Christchurch) earthquake, with the development of a program for recruiting, training, and sustaining a cadre of experienced assessors and coordinators. The research team identified a number of elements to consider in developing the personnel aspects of PDBA (Figure 13. Personnel):

- types of personnel involved in building assessment
- matching background and experience to both building types and regional assessment strategies
- recruitment and deployment of local, regional, national, and international assessors
- team composition and deployment strategies
- management of volunteers
- rotation and support of assessors
- liability and legal issues
- establishment of a sustainable recruitment and training program

Events over Time

Another key concept that emerged from the site visit was the realization that post-disaster response and recovery is an ongoing process over time, and that many disasters involve multiple events rather than a single event. This is most evident in relation to earthquakes, where planners in Chirstchurch had to deal with at least three substantial earthquakes and a still-ongoing series of smaller aftershocks, but must be considered in other forms of disaster such as wild fire and flooding. Thus, the overall emergency management and building assessment processes must prepare for the possibility of re-evaluating buildings and/or complete areas due to follow-on events. A second implication of adding time as a consideration to building assessment planning is that the goals and processes of building assessment change over time. The research team noted the emphasis of building assessment processes change from life-safety and building entry, through questions of continued use, towards eventual remediation and repair. The third implication was that the legal and operational framework from which building assessment worked also evolved from the initial emergency response through ongoing assessment, towards a return to business-as-usual. Participants noted an uneasy transition in the legal foundations of using placards through emergency powers towards permitting as processes return to "business as usual."

Summary

These initial core concepts, along with the list of "gaps" and issues for further exploration formed the foundation for preparing for the BC Stakeholders Workshop and Expert Working Group meeting. These meetings, the final components of the Needs Assessment Phase, allowed the research team to consolidate their understanding of PDBA processes (in the form of the core concepts), to validate and extend their understanding through consultation with BC stakeholders and international experts, and, finally, to begin contextualizing these concepts to the BC perspective.

Deliverable 6.3.1: Stakeholder Workshop

Overview

The final activities in the Needs Analysis phase consisted of a two-day Stakeholder Input and Expert Working Group session held on June 26 and 27, 2017 in New Westminster, BC (For agenda, see Appendix 7: Stakeholder Input and Expert Working Group Participants' Worksheet).

In broad terms, the goal of the Stakeholder Input and Expert Working Group Workshop was to contextualize project outputs to date for analysis and use in British Columbia, to gather data on existing PDBA systems and their implementation in practice, to identify needs and expectations of BC PDBA stakeholders in relationship to a provincial PDBA program, and to establish relationships with both individuals and organizations in support of the development, implementation, and sustainability of the BC PDBA program.

The Stakeholder Workshop included participants from the Expert Working Group and from Stakeholders in BC's emergency management and PDBA environment. The workshop employed a series of experiential activities including scenarios, group discussion, focused question and answer sessions, presentations from experts, group activities, and debriefings. Members of the Expert Working Group provided expert presentation to the Stakeholder workshop, then participated in a half day debrief and discussion session focused on initial interpretation of the data from the workshop and uncovering additional data

Analysis of the data from the Stakeholder and Expert Working Group workshop was used to further extend and develop an understanding of how PDBA procedures, tools, and processes can best be established within a BC context.

Methods

The Stakeholder workshop consisted of two segments – *Learning from Others* and *Stakeholder Input*. The morning sessions included introductions and an expectation survey, an overview of the research project, and presentations from international experts on post-disaster damage assessment. The afternoon sessions consisted of findings from the research project to date, a carousel exercise to gather data from stakeholders on specific aspects of damage assessment, and a reflective summary exercise.

Participants were given a *Participants' Worksheet* which included prompt questions and fields for note taking for each segment of the workshop (See Appendix 7: Stakeholder Input and Expert Working Group Participants' Worksheet).

The lead researcher took field notes for each expert presentation. Slides from the presentations were collected as additional data.

The main form of data collection for the workshop consisted of a carousel activity. Members of the research team were each assigned a particular topic (Table 1. Carousel Activity Topics). Participants were broken into groups which then rotated through each station. The research team member would provide the topic of the station and a summary of previous comments. Each group would then add additional comments. Comments were captured on flip charts by another team member.

Table 2. Carousel Activity Topics.

- Goals of Building Assessment and its various assessments:
  - Safety, occupancy, usability
- Matching types of buildings with capabilities of inspectors
  - Credentialed and non-credentialed
- Outcomes and Placards
  - What are the outcomes of assessment, and who should be able to place, modify, remove placards
- Team Composition and Personnel
  - Who, credentials, training, recruitment, prep, liability
- Information Flow
  - Data management and use of technology

The final exercise of the day consisted of a reflective exercise where participants were invited to review all the flip charts and information provided through the day and identify three messages to pass along to the research team. This was documented in the Participant Worksheet.

The Expert Working Group session employed a “Wall Walk” activity, with participants reviewing the output from the previous day’s activities through a series of reflective prompts/questions, followed by a plenary session allowing participants to summarize their experience and reflections on the over workshop experience.

Participants

The Stakeholder Workshop ran from 0900 to 1630, attended by 44 participants on site and 2 who joined by teleconference and web. Participants included both the Expert Working Group (who met on Day 2, as well) and stakeholders in BC’s damage assessment and emergency management communities.

Appendix 8: Stakeholder Input and Expert Working Group Workshop Participants lists the participants’ organizational affiliations.

Table 3. lists stakeholder affiliations (by category) for participants in the Expert Working Group, BC Stakeholders group, and Research Team.

Table 3. Participant Affiliations (by category).

	Total	Academic	Critical Infrastructure	Local Authorities	Prof. Bodies	DA Programs	Govern	Military	Private Sector
EWG	11	3	0	2	1	2	1	1	1
Stakeholders	24	0	2	7	5	0	9	0	1
Team	14	5	0	0	4	0	4	0	1
Total	49	8	2	9	10	2	14	1	3

The Expert Working Group had three academic members, and one or two representatives each from Local Authorities, Indigenous communities, professional bodies, damage assessment programs, government, military and the private sector. The BC Stakeholder group had no academics and strong representation from government agencies (9), local authorities (5), and local professional bodies (5), along with two critical infrastructure owners and one private sector participant.

The Research Team itself consisted of five academics (JIBC), 4 from government (BC Housing), and four members from professional associations (Architectural Institute of BC and Association of Professional Engineers and Geoscientists of BC).

The distribution of members in the EWG ensures that we have representation from researchers, providers, operational DA groups, military and government. The Stakeholder group has stronger representation from organizations who will employ DA processes (local authorities and government agencies) and those who will be assessors (professional associations representing engineers, architects, engineering technologists, and building inspectors).

Findings

The data from the Stakeholder and Expert Working Group workshops was merged with data from other sources for comprehensive analysis, with the goal of informing the development of the BC Building Assessment process. The following section highlights several recurrent themes that emerged from the two days of the workshop.

Building assessment as a complex process.

This theme echoes data from research of the literature and particularly from the Site Visit. Several expert presenters emphasized that BA is a complex system that requires a solid foundation, but the ability to be flexible and adaptable. One presenter noted the need for national goals that can be modified to meet local needs and events. Others noted that a system that works in one country will not work for another – that damage assessment must adapt to meet local building practices, building stock, cultural, and social factors; the resulting process itself must then be adaptable to meet the unique requirements of specific events, personnel, resources, and experiences.

Goal of the program: Damage, Safety, Usability

A continuing conversation emerged around the goal or intent of the program. One of the recommendations from the Site Visit was to avoid using the terms “building safety assessment” or “building damage assessment” as the process neither ensured building occupants’ safety nor provided a comprehensive list of the damage to a structure. This sparked additional conversation in both the stakeholder and expert working group components of the workshop, with the conversation following similar lines. An additional conversation involved the concept of “usability” and whether or not usability was a short or long term goal of the program. If so, then the term “usability” requires careful definition. A subsequent discussion noted that Italy distinguishes between “peacetime” usability (the ability to occupy and use a building during normal times) and the “emergency” usability of a structure in the aftermath of a disaster. In the Italian context, the goal of building assessment, particularly in the early phases, is not to establish the long term usability and return to function of a building, but rather to identify whether it is safe enough to be used in the aftermath of the event. Even buildings identified as “usable” post-event may require an engineering assessment, and other assessments, to return to long term or “peacetime” functioning.

The Area Assessment

The Area Assessment was identified as an important part of the overall process that needs further consideration and development. Participants noted that the "ad hoc" phase is poorly understood, but that a key element of this phase is developing an initial sense of situational awareness that can then guide the establishment, implementation, and administration of an effective building assessment program. In addition to the archetypical windshield assessment, participants noted the potential use of drones, real time satellite images, aerial photography, "getting a couple people up in a helicopter right away), as well as novel concepts such as the aggregation of social media and pre-positioned building surveillance monitors.

Situational Awareness and the "Strategic" Level of Building Assessment

Participants noted the need for guidelines and, possibly tools/worksheets to help those who are setting up the building assessment process. Key decision may be required around what constitutes "usable" for this incident, what the community's risk tolerance will be for assessment (and hence potential modification of placarding categories and/or criteria). Factors to consider in the set up or strategic phase include administration, set up, logistics, and data/tracking systems.

Information

Both expert presenters and stakeholders noted that integrity and validity of information are issues that need to be considered, particularly if non-credentialed personnel will be conducting assessments. The system must also include technology for data collection, processes for data entry, mechanisms for distribution of information and information sharing, and identification of how information informs decision-making.

Team Composition

Team composition included discussions on how many personnel should be on teams, who has the authority to issue placards (e.g., should team leader be building inspector who has the legal authority?), and what skill sets are required for different roles or teams. Participants identified a minimum team as 3, particularly for teams doing any form of interior inspection (allowing one member to remain outside for safety reasons).

Overlapping Assessments

The discussion on Team Composition also lead to discussion on overlapping assessments, which in turn had two aspects: different types of building assessments and additional forms of assessment that overlapped with damage assessment. Participants noted that a variety of assessments are performed – some in the immediately post-event phase, some much later on, and that it makes sense, when appropriate to leverage the building assessment process. For example, the New Zealand example of including social welfare personnel in the building assessment teams was seen as a valuable addition, particularly in urban residential areas (less so in rural areas or commercial zones). Similarly, in Kaikoura, assessment teams included both building assessment and geotechnical assessment personnel. Other forms of assessment that may overlap include Search and Rescue, Emergency Social Services, humanitarian relief, etc.

Varied Forms of Building Assessment

One of the more intriguing discussions involved the overlap between Local Authorities, who have overall responsibility for building assessment, and the building assessment performed by building owners, particularly of large groups such as Critical Infrastructure organizations, provincial and federal government agencies, the military, and even private sector companies with multiple buildings. This lead to a discussion on who has the authority to issue placards, and how to reconcile/support assessment by different groups with the overall Local Authority efforts. In particular, the issue of information sharing was seen as critical, as was Local Authorities' ability to validate and ensure the integrity of assessments done by building owners.

Bias, Experience, and Conflict of Interest

The discussion above, in turn, informed another discussion on team composition specifically focused on the use of personnel such as facility managers and engineers who design, manage, or operate buildings. One aspect of the discussion focused on the importance of leveraging the knowledge of building personnel who know and have experience with a building. This was contrasted with the potential for a conflict of interest, particularly for commercial building owners. The challenge is to leverage experience of those with intimate knowledge of these buildings while ensuring integrity of the assessments and sharing of "proprietary" information.

Matching Building Types and Required Expertise

One of the more interesting and potentially interesting discussions was around ways of classifying building types and identifying the skill sets required to effectively assess them. Initial information was gathered in the workshop and this is one of the key areas for further data collection and analysis.

Additional Topics

Additional topics were flagged for more depth review and analysis when the Stakeholder Input data was merged with other data:

- Liability, volunteerism, and status of visiting personnel
- Cordoning of areas
- Importance of information on shoring and securing buildings
- Use of technology to support building assessment processes and data
- Training and credentialing of building assessment personnel
- Evolution or changing goals of assessment
- Legal aspects
- Operational Guidelines
- Integration of various assessments (e.g., geotechnical, roads/bridges, environment, etc.)

Identification of best practices

A key data gathering strategy throughout the two days of the workshop was the identification of best practice in post disaster building assessment through gathering "advice," "recommendations," or principles for developing and implementing PDBA programs. Several flip charts were set up to allow concepts that emerged during conversations to be collected. In addition, members of the research team took both contemporaneous notes and created field notes after the workshop. Finally, researchers reviewed all the artefacts (e.g., presentation slides, flip charts, field notes and debriefing notes) to further identify statements of “best practice.”

Recommendations

The research team acquired a substantial body of data from multiple sources from the workshop. The next steps in the process was to code this data against the research questions and in relationship to emerging themes and categories. A number of areas emerged as important or interesting to consider as the team moved towards analysis and synthesis, such as:

- Establishing the overall goal of the building assessment process
- Articulating the web of links that building assessment has with other facets of emergency management, governance of building, recruitment and training of professionals to assist in building management, etc.
- Identifying those aspects of the overall process which are in scope and addressable within this project
- Identifying those aspects and data which are beyond the scope of this project, but which should be articulated and considered for further study and/or development
- Choosing a conceptual model from which to design the BC Building Assessment provincial system and the community-level framework
- Articulating a set of guiding principles to guide the remainder of the project
- Determining the appropriate level of detail for development of processes, tools, and resources

Initial Analysis of Expert Working Group Session

Several themes emerged from the Expert Working Group’s analysis of the Stakeholder Input:

Building Assessment is a Dynamic Process that Changes over the Duration of an Event

Several discussions focused on the changing role and goal of BA in an event. At a strategic level, different countries have different political or overall goals for BA, as mirrored in the stakeholder discussions on damage, safety, and usability. The EWG noted that context is a critical factor in an event, and that the goals of building assessment in practice depend on the perceived role of government, the community’s risk tolerance (around safety of buildings that are damaged), and the extent and nature of damage. In addition, the goals of building assessment change throughout and after an event. Early efforts focus on rescue and life safety; initial rapid assessment focuses on identifying obviously unsafe and clearing obviously safe structures; as building assessment progresses the focus can change from short term usability towards identification of repairs required to ensure the safety of the building and/or return to “normal” use.

Building Assessment is Embedded in a Series of other Emergency Management Processes

One EWG member noted that ATC 20 is essentially an engineering assessment. However, overall PDBA overlaps and is influenced by a variety of factors and concerns (Figure 14. Factors Influencing PDBA Decision-making).

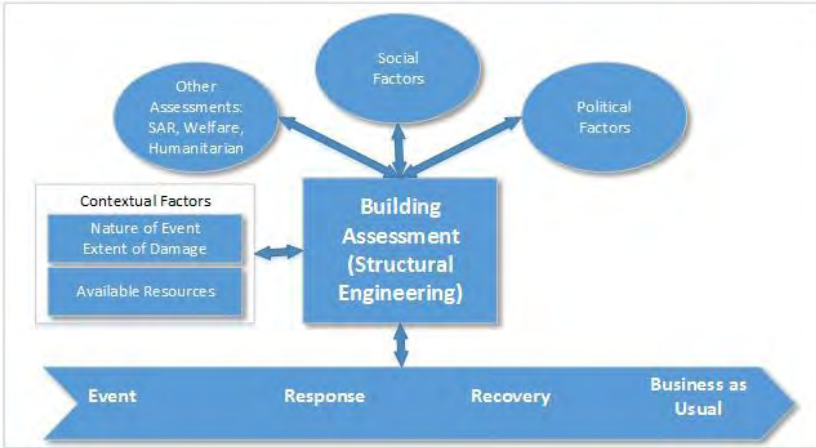


Figure 14. Factors Influencing PDBA Decision-making.

Designation of what constitutes “safe” or “usable” may be influenced by social and operational factors (e.g., need to reduce impact of displaced people who could “camp” in damaged but structurally safe buildings). As noted above, initial emphases on short term “usability” increasingly move towards long term rehabilitation and reoccupation, and assessment processes return to “business as usual.” Political factors may influence strategic decisions on distribution of teams, availability of external resources (regional, national, international), and prioritization of areas or types of buildings. And the implementation of a PDBA process is dependent on a number of contextual factor related to the incident itself, including the type and extent of the incident, the types and number of buildings affected, personnel and resources who are dedicated to PDBA, etc. Finally, PDBA itself overlaps with a number of other emergency management functions, including, but not limited to search and rescue, social/welfare concerns, building assessment by owners and agencies, etc.

The Need for Strong Recommendations on Personnel

The EWG noted that actual team composition is dependent on a variety of factors, not least of which includes the contextual factors noted above (for example, the nature and size of event, type of building stock, extent of damage, etc). However, there was general agreement on the need for a strong set of recommendations around core aspects of personnel and team management, including team size (minimum 3), safety considerations, matching composition to requirements of the assessment, recruitment, training, and ongoing support of teams during the event. The EWG did initial work on creating a matrix matching types of buildings with required expertise for assessors. This is seen as a critical aspect of the project.

Contextual Implementation

Many of the issues discussed in this section emphasize the need for a strong, well structured, and well supported foundation to the building assessment process that can be adapted for implementation for specific contexts and situations. EWG members noted that the early phases of an event can be chaotic, and that it may take several days to establish and implement an effective BA process. One of the keys to success is in effectively developing an understanding of “this” particular situation and being flexible in putting the BA process into effect.

Simple Core Process, Nuanced Strategies

Several participants noted the need to keep the essential building assessment process simple, with well-designed training, orientation, and support. It is important, particularly in the early, more chaotic phases of the event to keep the process simple enough to allow multiple teams to cover wide areas, yet effective and efficient enough to ensure consistent application and safe results. At the same time, the strategic level of the process must be nuanced and “open” enough to allow for contextual implementation and adaptation to changing conditions over time.

Please refer to *Deliverable 6.3.1 Stakeholder and Expert Working Group Workshop Synopsis* for further information, including:

- Workshop Agenda
- Participant Worksheets
- Stakeholder Workshop Participants

Deliverable 6.5.1: Analysis and Synthesis – Structured Conversations and Core Concepts

The researcher team collected considerable data from a number of sources (see Figure 2. Overall Research Project Components and Deliverables earlier in this document). The initial analysis of this data included categorization against the project research questions and a series of “recommendations” derived both from the data itself and by from analysis of the data by members of the research team. This data (both the categorized findings and the recommendations) formed the data “pool” from which the analysis and synthesis was drawn.

A second element of the initial analysis was creation of a Building Assessment “macro-map” (Figure 15. Post Disaster Building Assessment Process Macro-map) showing the various processes and strategies that the research team has identified. This map will serve as a conceptual framework for understanding the major elements, sub-systems, and relationships in a post-disaster building assessment (PDBA) process.

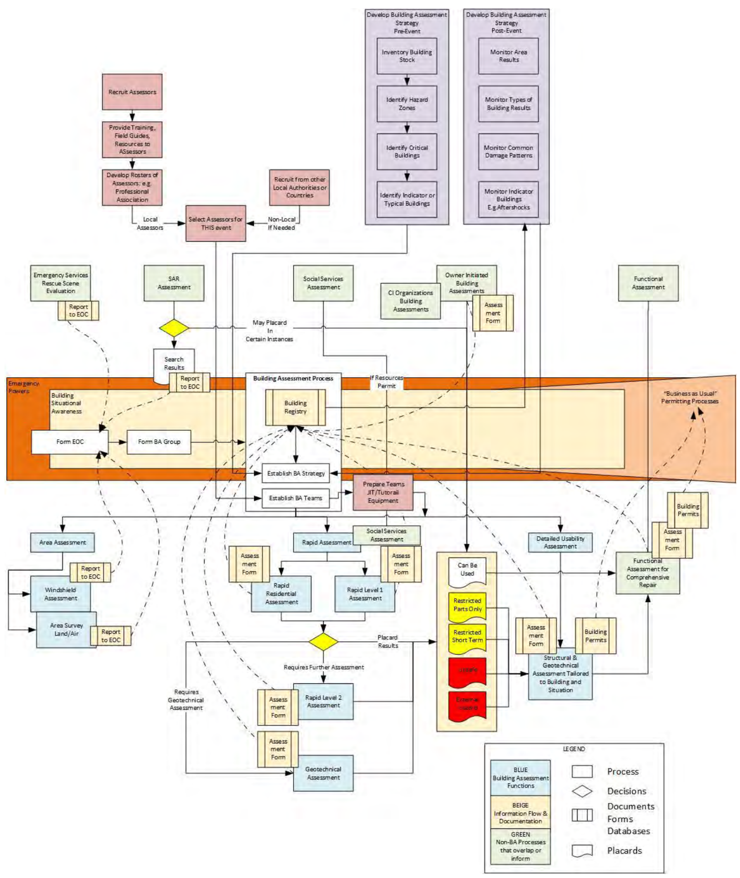


Figure 15. Post Disaster Building Assessment Process Macro-map.

(see Figure 6, earlier in this document for a full-size version and explanation).

Analytic Approach

The major analytic process in the Analysis and Synthesis phase consisted of a series of structured conversations (Figure 16. Structured Conversations) with the research team, each consisting of:

- Review of data, categorized against research questions relevant to the topic of the conversation
- Review of any preliminary thematic or content analysis of the data
- Facilitated discussion to develop working concepts
- Write up, including core concepts, implications for development, and areas for further exploration

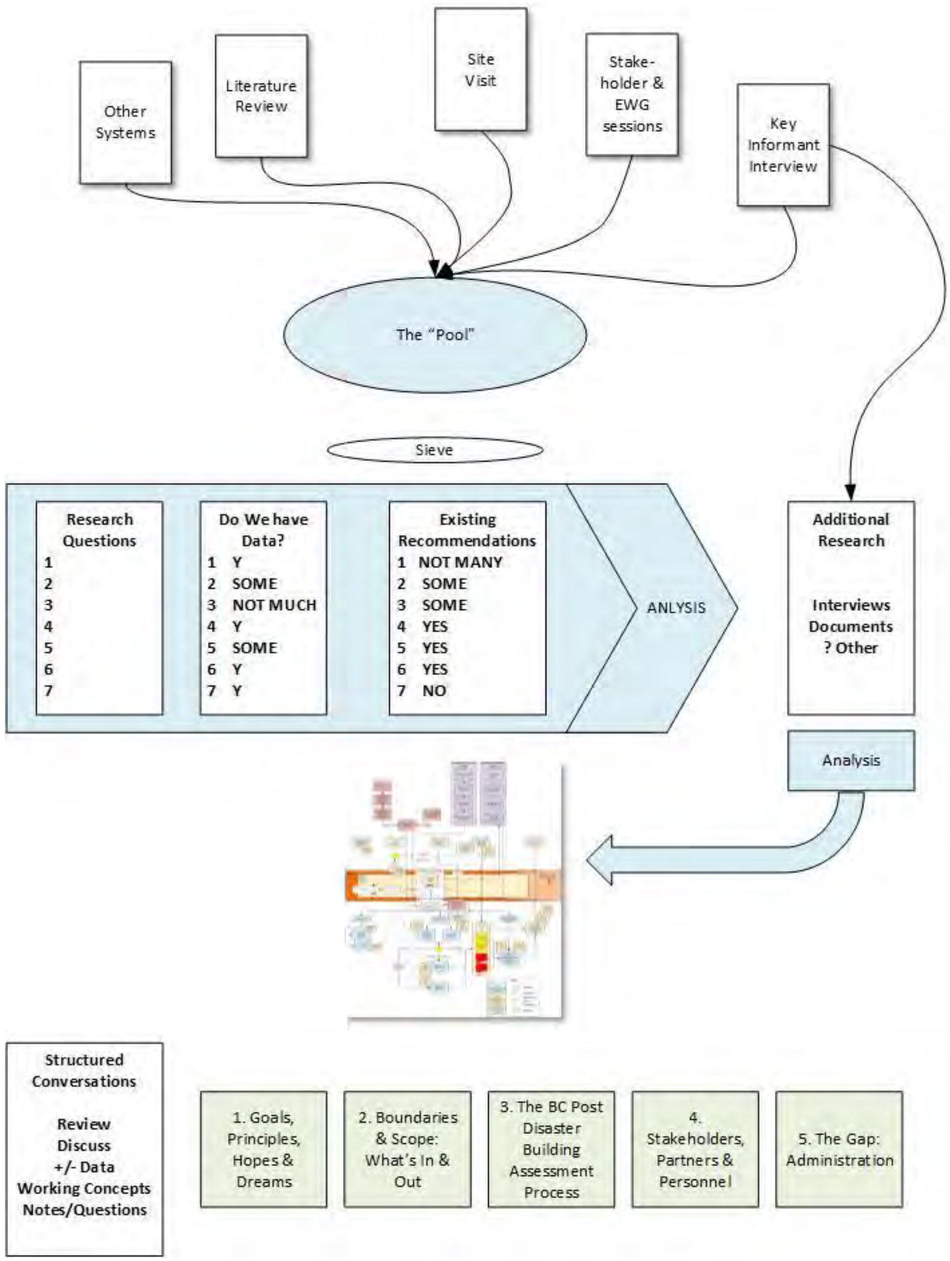


Figure 16. Structured Conversations.

6.9.1e TECHNICAL REPORT
DELIVERABLE 6.5.1: ANALYSIS & SYNTHESIS – STRUCTURED CONVERSATIONS & CORE CONCEPTS

Five Structured Conversations were conducted, covering:

- Goals and Principles
- Scope and Approach
- Needs and Requirements
- Models and Core Concepts
- Establish the Framework and Next Steps

Emerging from this process were a series of concepts, frameworks, tables, and commentary. These findings will guide the development of the draft BC PDBA Framework in the next phase of the project.

Structured Conversations

This section outlines the intent and process for each conversation, a summary or presentation of its results, and reference to findings and discussion when appropriate.

Structured Conversation 1: Goals and Principles

The goal of the first structured conversation was to revisit the project's goals, then reaffirm or revise these goals based on the unfolding of the project. The session also explored the team's current understanding of what the outputs of the project would be (in terms of form and structure), guiding principles for decision-making, and criteria for success of the project (see Appendix 9: Research Team Members' Goal Statements (Themed), Appendix 10: Research Team Members' Hopes and Dreams Statements (Themed), Appendix 11: Themes from Key Points and Principles Data Related to Goals and Principles, Appendix 12: Discussion notes on Principles).

Structured Conversation 2: Scope and approach

The session started with a general discussion on the scope and approach of the overall project. Team members noted that the project continues to collect a considerable amount of valuable data. Initial examination of this data has led to development of an overall "concept map" based on the functional components of a building assessment process (see Figure 4, above). A key finding to date is that the possibilities and opportunities available from analysis of this data far exceed the scope and expectations of this project. In a previous session, the team noted that project deliverables will have to be completed with an awareness of their "fit" within a layered series of emergency management processes and activities. At the same time, the project team must ensure that it remains focused on the core requirements of the project and does not attempt to reach too far.

The conversation reinforced the necessity of seeing Damage Assessment as part of a layered series of dynamic systems. Each element in the system both informs and is influenced by changes and activities within other systems and sub-systems. Thus, while remaining focused on the core requirements of the project, the team will identify overlaps with external systems, and make suggestions on future potential work within the broader context.

Drawing on the principles outlined in the first structured conversation, it was proposed that the core presentation of the overall PDBA process be based on a three-level structure. The framework will identify and describe specific ***aspects*** of PDBA, outline ***considerations*** associated with that aspect, and then provide ***guidance*** on addressing those considerations.

Structured Conversation 3: Requirements

This session focused on identifying the concepts, models, structures, and content that would be required to develop the BC PBDA process. The team started with the conceptual model, then identified four sets of "needs": guidelines and decisions (that were required), concepts and models, processes and procedures, and documents or forms. Sixty-eight items were identified. The elements were analyzed and themed to identify, for example, those elements that were part of a project deliverable, those associated with the overall PDBA framework, principles or guidelines to inform development, and elements addressing specific components of the project, such as governance, situational awareness, assessment, and information management. These were next categorized according to relationships (elements that were related to or similar to each other), dependencies (which elements could not be addressed until other elements were in place), and priorities (which elements were most critical to the project, based on relationships and dependencies).

Based on this analysis, three lists were developed: Prioritized requirements, Glossary Requirements, and Models/Matrices Requirements (see Appendix 13: Framework Needs and Requirements).

Structured Conversation 4: Models and Core Concepts

The fourth structured conversation used the priorities list from the previous session as a framework for further defining and describing key concepts and models emerging from the data. Several core concepts were extended or redeveloped and others were identified as requiring further analysis in the next phase of the project. The outputs from this session are presented in the Results sections of this report.

Structured Conversation 5: Establishing the Framework and Next Steps

In the final structured conversation, the team reviewed previous data and analysis, then developed the structure and approach to developing and populating the BC PDBA Framework (see Appendix 14: Framework Structure and Table of Contents). As noted above, the team developed a structure and approach based on that used by Engineers and Geoscientists of British Columbia to document its performance standards: aspects, considerations, and guidance. In addition, each section would include sections providing resources, tools, or artefacts (e.g. forms, job aids, etc.) as well as a section with examples (when appropriate). The "vertical" layout of the framework would be based on the "layers" model: buildings, assessment, assessors (individually and as teams), administration/operations (LA or EOC level), regional (PREOC in the BC context), and provincial. Information on national and international aspects may be included as well, either embedded within other sections or separately depending on volume and nature of the recommendations in these areas. Finally, each "layer" will address a common set of aspects: e.g., core concepts, definitions, guiding principles, and then sections related to the PDBA process. Not all aspects will be included in all levels.

Summary

The results of the Structured Conversations informed the overall analysis and synthesis that was the focus of Phase II of the project. The following section presents a summary of Phase II.

Deliverable 6.5.1: Summary of Phase II Analysis and Synthesis

The following sections summarize the findings from Phase II analysis and synthesis. These results formed the foundation for the development of the draft BC Post Disaster Building Assessment framework.

Goals and Principles

This section outlines the findings, analysis, and statement of the project goal and guiding principles for development. The intent of Phase II was to guide the further analysis of data and development of the project deliverables.

The process for this activity included:

- Inductive thematic analysis of existing data and identification of data elements and themes related to:
    - Key points describing the overall process of PDBA and its implementation
    - Goals of PDBA (overall and specific to particular types of assessment)
    - "Principle statements" – statements that implicitly or explicitly identified rationale, explanation, or principles for decisions related to overall PBDA and its processes
    - Strategies used in the implementation of PDBA
    - Recommendations related to overall PDBA
- Data included in this analysis included:
    - Field notes from NZ Site Visit, Stakeholder Workshop (NZ and JIBC), and Expert Working Group sessions (SB, RB, RF, JF, DU)
    - Artifacts and data collected from activities at the Stakeholder Workshops (NZ and JIBC) and Expert Working Group sessions ("wall charts," flip charts, and "stickies" from various data collection activities)
    - Summary notes and recommendations from team members (SB, RB, RF, DU)
- Selected, relevant data elements were identified and coded against a predetermined coding structure (Key Points, Principles, Strategy, Recommendations, and Overall Goal)
- Data elements within two categories (Key Points and Principles) were next analysed through open coding to identify themes and concepts. These themes formed the basis of the team discussion. This data is included in a separate document (*PDBA Structured Conversation 1 Data*)
- The full research team conducted an analysis workshop, employing a "structured conversation" to further develop the project goals and principles for further analysis and development. Activities included:
    - Review of formal project goals from the Project Charter
    - Brainstorming session on project goals, hopes, and dreams – members individually identified goals and aspirations for the project onto stickies, which were then grouped for discussion
    - Presentation of Principles data and themes
    - Focused discussion on principles in relation to the project goals, deliverables, and requirements
    - Open discussion on implication of these concepts

Goal Statements

Team members were asked to identify their goals for the project, explicitly considering their personal and professional backgrounds. These goals (Appendix 9: Research Members' Goal Statements – Themed) were then reviewed and discussed. Several trends were noted in the discussion:

- Framework/Strategy
- Process
- Characteristics
- Components

Implications for Development (Goals)

The goal of this project is to develop an operational post-disaster building assessment **framework/strategy** that:

- Harmonizes and supports local plans, programs, operations and community needs with regional, provincial, and national processes and resources
- Includes legislation, communications (information), and operational strategies at multiple levels of operation and governance

The **process** developed in this project must:

- Establish multiple levels of authority and control
- Extend from pre-disaster through differing levels of event (both declared and non-declared emergencies) to recovery and return to (the new) business as usual
- Create typologies and strategies matching event characteristics, types of buildings that are damaged, types of damage to those buildings, personnel that have the background and experience to assess them, and processes that are adaptable to the situation-at-hand

The framework must incorporate the following **characteristics**:

- Meet contractual obligations and be aware of potential scope creep
- Have core strategies, with principles that are simple, scalable, and adaptable to different levels of community, different types of event, and varied types and levels of resourcing
- Be sustainable, with mechanisms and support for ongoing review, revision, and adaptation

The **components** of the framework must include:

- Clear strategies and processes, including practice guidelines, criteria, and examples
- Models, tools, and resources that can be easily adapted and implemented by personnel on-the-ground
- Clear guidelines and processes for recruitment, education, just-in-time training, and ongoing training and preparation
- Recommendations, samples and examples of resources ranging from legislation to bylaws, operational strategies, manuals, field guides, forms/documents/electronic data gathering to support both systems-level implementation and use in an event

Success Criteria

Team members next identified "hopes and dreams" (success criteria) for the project – identifying potential success criteria to guide development. Again, the elements were themed and discussed (Appendix 10: Research Team Members' Hopes and Dreams Statements (Themed)). Five themes emerged from this discussion:

- Vision: an exemplar system that is scalable, adaptable and adopted in different jurisdictions and contexts
- Awareness, utility, and acceptance by stakeholders
- Implementation of a functional system at multiple levels
- Resolution of issues around liability and education
- Sustainability and enrichment

Implications for Development (Success Criteria)

The team identified the following as criteria by which the extended success of the project may be measured. Note that these criteria are NOT within scope of the currently funded project; rather they represent long term indicators for uptake of the project's outputs.

Three to Five Year Success Criteria

The following criteria represent markers that this project will have had a positive impact beyond meeting its project deliverables.

- Vision: an exemplar system that is scalable and adaptable in different jurisdictions/contexts
    - The project is trialed or piloted in two different communities, ideally within different jurisdictions
- Awareness, Utility, and Acceptance by Stakeholders
    - Usable and seen as usable by BC Stakeholders
    - Stakeholder both internal and external to local authority i.e. – EMBC, professional organizations etc.
    - Empowering local abilities to own/run their own DA programme
- Implementation of a Functional System at Multiple Levels
    - Pilot simulation
    - 3-5 year plan for implementation
    - That a local authority will adopt and validate that system / structure in practice
    - Community roll out
    - Emergency response incorporated into plans
- Resolution of Issues around Liability and Education
    - Liability issues are resolved with clarity
    - Consistent documentation and training standards are developed for various types of assessors
    - Provincial registration is changed to indemnify professionals acting in emergency response
    - Emergency response and damage assess is incorporated / required in professional training university

  - To embed the framework training within JIBC curriculum with appropriate responders
- Sustainability and Enrichment
  - Long Term Vision for enrichment / further development
  - All stakeholders support the framework so it can be implemented and maintained

Long-term Success Criteria

Long-term success of the project includes:

- Vision: an exemplar system that is scalable, adaptable and adopted in different jurisdictions/contexts
  - Provincial program expands to become a national standard. Supported and initiated by every province.
  - Seen as resources / experts
  - Exemplar system that other countries, regions draw upon
  - Multiple countries harmonize their D.A programs with Canada to create an international standard for PDBA
  - Supported by UN (UNDAC – United Nations Disaster Assessment and Coordination), including funding
- Implementation of a Functional System at Multiple Levels
  - Usable and seen as usable by BC Stakeholders
  - Stakeholder buy in / collaboration
  - Achieves buy-in from regional stakeholders to facilitate the implementation of a D.A. programme at local authority level
- Implementation of a Functional System at Multiple Levels
  - That a local authority will adapt and validate that system / structure in practice
  - This program is adopted by municipalities, large and small, and helps them be more prepared/resilient
  - Leads to rolling out framework across Canada
- Resolution of Issues around Liability and Education
  - Provincial registration is changed to indemnify professionals acting in emergency response
  - Emergency response and damage assess is incorporated / required in professional training university
  - To embed the framework training within JIBC and other institutions' curriculum with appropriate responders
- Sustainability and Enrichment
  - To explore further funding for important issues that arise that are outside of scope
  - Sustainability needs to be kept in mind
  - Connected to Phase II sustainability / continuation planning and funding
    - projects i.e.- building monitoring

Principles to Guide Development of the BC PDBA Framework

The themes that emerged from the project data provided the structure for outlining key principles to guide development of the PDBA process (Appendix 11. Themes from Key Points and Principles Data Related to Goals and Principles).

Discussion

The research team conducted and analysis of the key points and principles (see Appendix 12: Discussion Notes on Principles). Through this discussion, three sets of ideas emerged to guide further development of the project – a set of key principles, a series of tensions that must be considered and a series of core concepts which must be considered as the project progresses.

Key Principles

The following are key elements and/or principles that must be embedded throughout the project and its outputs:

- Layered – each element in the model has relationships and interactions with other elements and layers
- Pragmatic – must be as simple as possible, but as complex as required
- Scalable and adaptable – stated as strategies and principles that can be implemented within (varying) local (large or small) contexts
- RACI – A RACI model should be used to clarify roles and responsibilities between stakeholders in any PDBA program
- Information management is the foundational concept of the process
- Must inform and support decision-making, often with incomplete information and inadequate resources

Tensions

There are a number of tensions, which require ongoing consideration, both in development of the project and its outcome, processes and resources:

- Safety and usability – seen as ends of a continuum, occasionally at odds in terms of desired outcome, information required to determine, resources required to establish.
- This is also seen in a transition or tension between mandated processes at the government level (e.g., focusing on life safety) and market-driven decisions and outcomes at the level of the individual building owner (e.g., restoration and remediation).
- Local and global – processes should be stated as principles and guidelines at the global level which are scaled and adapted for use at the local level to meet the requirements of the current event, conditions, resources, etc.
- Efficiency and comprehensiveness – there is a tension between creating simplified processes which allow quick assessments/decisions versus more comprehensive processes that explore more complex aspects, or which incorporate other forms of assessment/process. This again calls for scalability and adaptability – individual decision-makers must constantly be aware of and incorporate this tension in developing and implementing their strategies and processes.

- Prescriptive vs performance-based approaches – some PDBA processes may be best articulated as prescriptive with little room for interpretation (e.g., life safety issues); however, following upon the concepts of scalability and usability, whenever possible, strategies and processes should be performance or outcome-based. Again, these two concepts will exist in tension with each other, and the balance between them may vary depending on the elements of the system being considered and/or the context in which that element is implemented in practice.

Structured Conversation Data and Analytic Themes

The data from the Structured Conversations are in the following appendices:

- Appendix 9: Research Team Members' Goal Statements (Themed)
- Appendix 10: Research Team Members' Hopes and Dreams Statements (Themed)
- Appendix 11: Themes from Key Points and Principles Data Related to Goals and Principles
- Table 1: Themes in Key Points related to Overall Goals and Functioning of PDBA
- Table 2: Themes in Principles related to Overall Goals and Functioning of PDBA
- Appendix 12: Discussion notes on Principles
- Appendix 13: Framework Needs and Requirements
- Appendix 14: Framework Structure and Table of Contents

Project Findings: Revised Core Concepts

Throughout this project, the research team worked to develop a conceptual model of how post disaster building assessment is structured, functions, and fits within broader emergency management planning and operations. At the end of Phase II, the initial Core Concepts were further refined and formed the foundation for the draft BC Post Disaster Building Assessment Framework and Recommendations.

The following Core Concepts are described within this section:

- PDBA as a layered construct
- Defining Characteristics of a PDBA System
    - Situational Awareness
    - Administrative Structure
    - Building Assessment Procedures
    - Outcomes
    - Information Management
    - Building Status
    - Strategies
    - Embedded in Multiple EM Processes and Assessments
    - Legal and Legislative Aspects
    - Multiple Levels of Organization
    - Goals of PDBA Change of Time
    - Contextual Factors
    - Critical Decisions for Communities

PDBA is a layered construct, best thought of as a dynamic system of interrelated sub-systems, which is itself part of larger emergency management, government, and private sector systems (Figure 17. PDBA as a complex, layered structure).

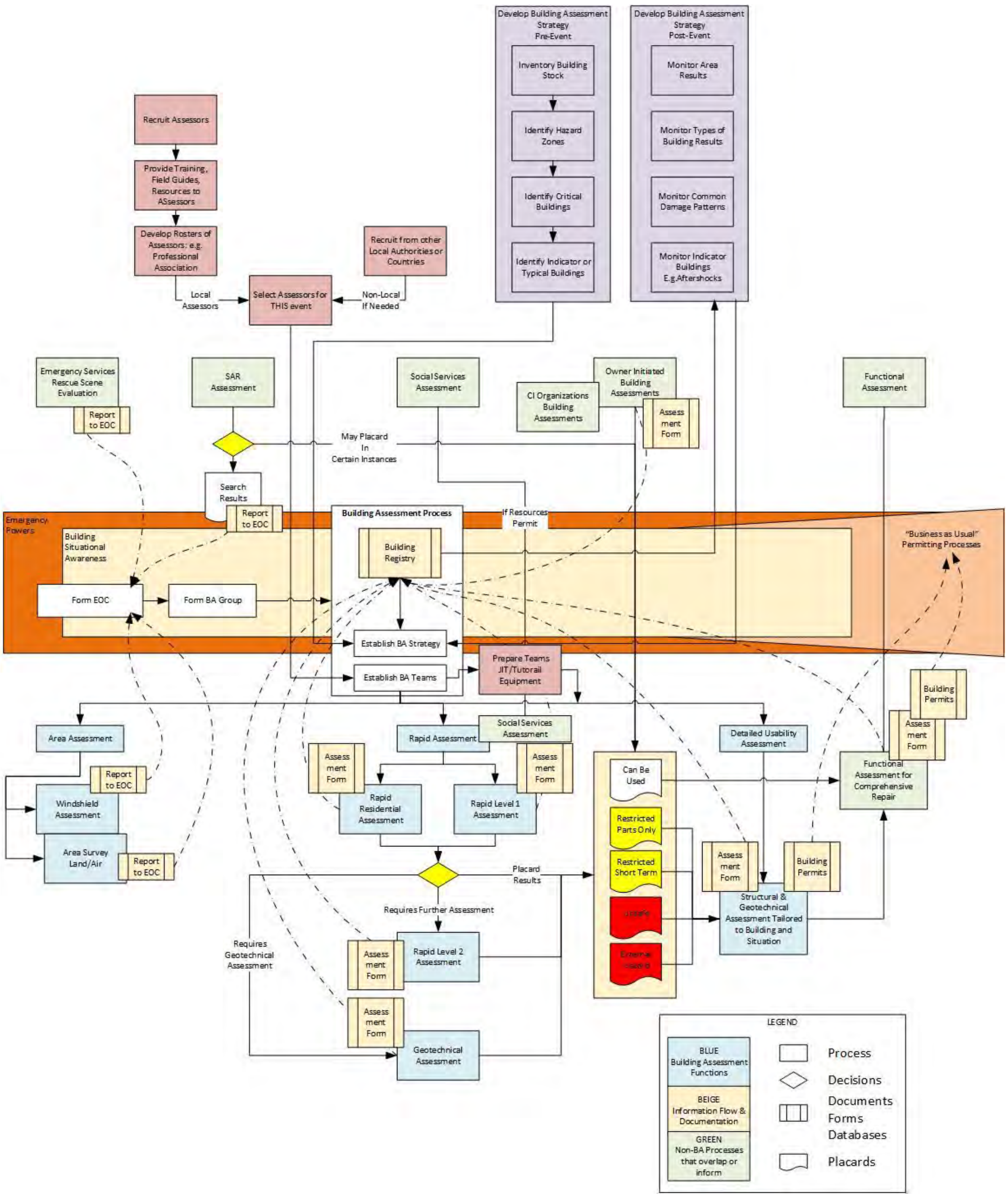


Figure 17. PDBA as a complex, layered structure.

These systems are overlapping, but share information and resources, and decisions/actions within one sub-system and have both obvious and covert (or unrecognized) impacts/effects on other sub-systems. Thus, both when describing elements and establishing principles, it is important to consider information, resources, decisions, and relationships of the element with both sub- and larger-systems.

The model in Figure 16 is “generic” – an abstraction of the various models that the team encountered. The model currently identifies a number of “systems”:

- The core Building Assessment procedure(s) (Blue elements)
- A series of outcomes (often identified through placards) (light brown box with red, yellow, and white elements)
- A number of overlapping Emergency Management functions and assessments (green elements)
- An information/data collection system (light brown elements)
- A legislative framework including both Emergency Powers and return to Business-as-Usual (orange elements)
- An administrative structure (including both logistics and strategy) (light beige elements)
- Personnel recruitment and training (light red elements)
- Building assessment and monitoring strategy (light purple elements)

Figure 18 represents the “system of systems” conception of PDBA.

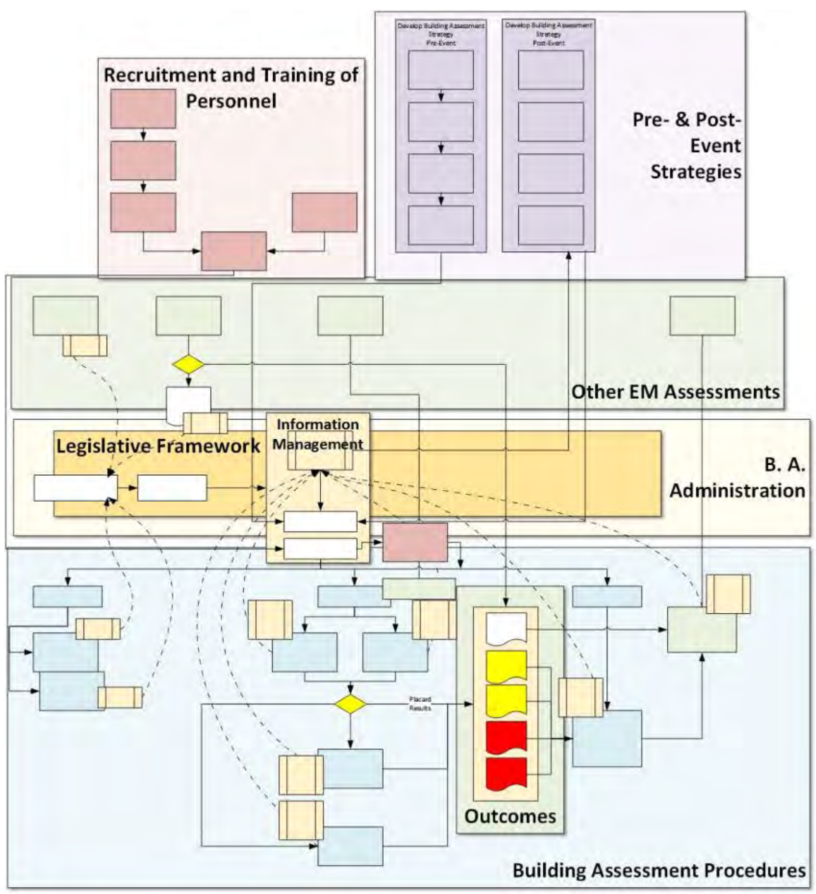


Figure 18. System of Systems.

Defining Characteristics of a PDBA System

Building assessment is a complex safety, scientific, and engineering process that overlaps with a number of emergency management processes. Different programs employ different terminology and have varied goals while sharing common overall frameworks and processes. One of the challenges in our research has been understanding how building assessment is integrated (or not) with other emergency management response and recovery functions such as search and rescue, managing the human aspects of a disaster, incorporating the science of buildings and earthquakes, and long-term repair and remediation of buildings in a community.

The overall goal of PDBA is the development of ***situational awareness*** of a community's buildings within a broader emergency management framework. A PDBA system consists of three essential functions: an ***administrative structure*** employing ***building assessment processes*** whose ***outcomes*** categorize the safety, usability, and/or damage to a community's buildings. Two key concepts underlie the PDBA process: **information management** which is used to identify, monitor, and update the ***building status*** of the structures in a community. The overall PDBA process is guided by pre- and post-event ***strategies***, many of which are currently undocumented. PDBA is ***embedded within***, and overlaps with multiple ***other emergency management assessments and processes***. The overall PDBA system exists within a ***formal legislative framework*** that transitions from business-as-usual through emergency powers and an eventual return to (the new) business-as-usual permitting and building inspection processes.

Several core concepts inform the development of specific PDBA processes within different jurisdictions and contexts. Functionally, PDBA occurs at ***multiple levels of organization***, ranging from the assessment of individual buildings to the overall response at the provincial and national/international levels. The ***goals of PDBA change over time*** from an initial focus on life safety to repair (or demolition) of buildings, and these changes have implications for PDBA practices and resources. A number of ***contextual factors*** influence the structure and functioning of specific PDBA systems, including legal frameworks, frequency of events, personnel and resources available and the experience of those personnel. And PDBA operations themselves are influenced by a number of ***critical decisions*** based on the nature of the event itself.

Situational Awareness

Building assessment occurs as part of an overall emergency management response to a disaster. While much of the documentation and processes describing building assessment focuses on assessment of individual buildings, the overall process of PDBA is both strategic and linked – or overlapping – with other emergency management processes (see Figure 19. Systems and Information Informing Situational Awareness).

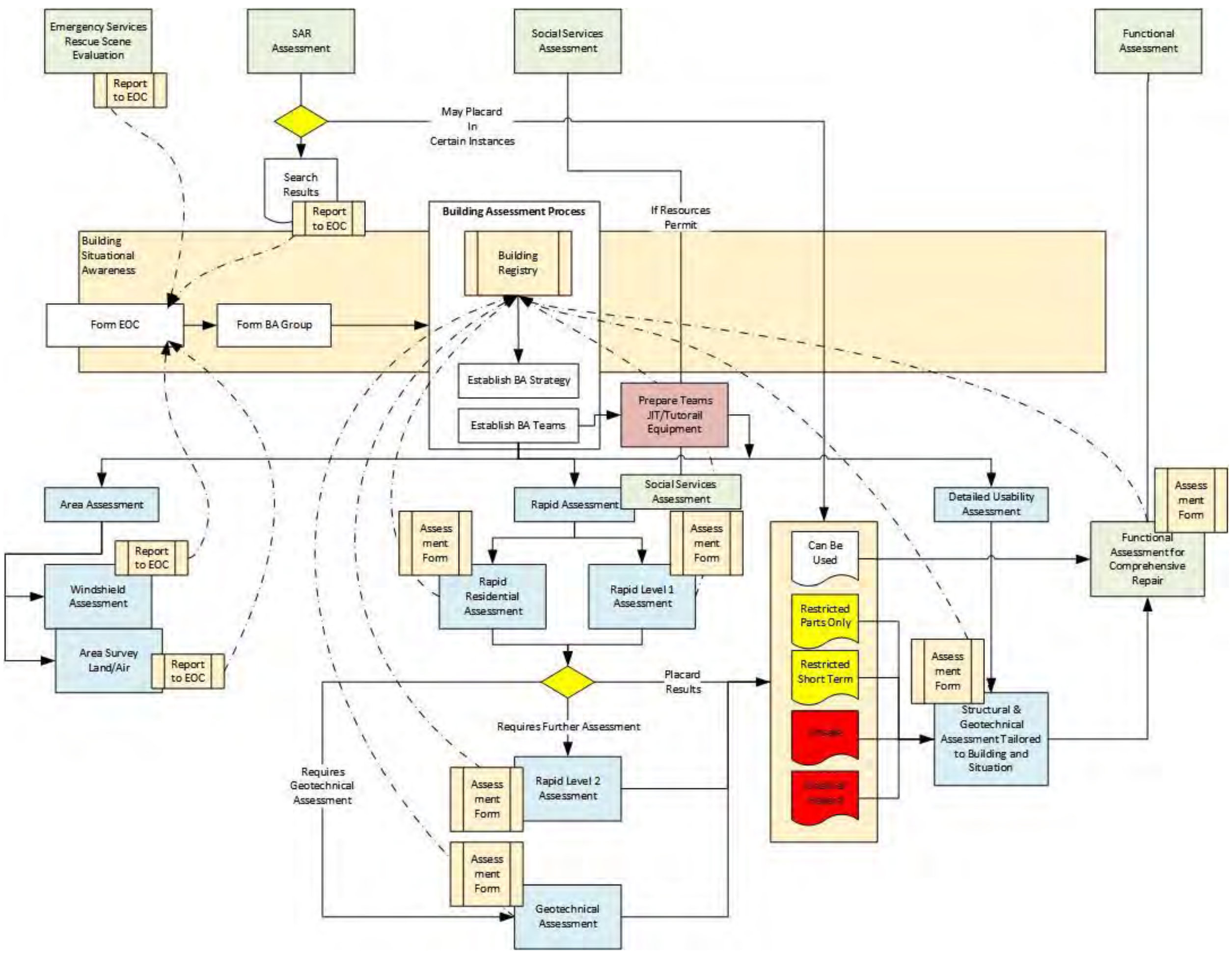


Figure 19. Systems and Information Informing Situational Awareness.

The larger goal of PDBA is to develop and maintain an overall awareness of the areas that are damaged, the types of buildings in those areas, the types of damage affecting different types of buildings, which buildings have been inspected and the results of those inspections. An effective PDBA process must consider the broader strategic functions of establishing and maintaining the overall PDBA process and how PDBA information informs and is impacted by other emergency management processes, such as search and rescue in the initial phases of an event and eventual recovery strategies.

Administrative Structure

An effective PDBA process must include the administrative functions as well as building assessment procedures (See Figure 20. PDBA Administration and Procedures). Administration of PDBA generally occurs at the local authority level – typically either municipal or regional. PDBA often is established within the Emergency Operations Centre, although operations may be moved to a separate location. Most often, Building Assessment occurs within the Operations component of an overall Incident Command System (or similar) process. The research team noted at least three phases in the administrative aspect of PDBA. In the initial response, administrative priorities include establishing a building assessment group, setting up information management and communication systems, and developing a strategy for forming and deploying teams. The second phase involves setting up and maintaining ongoing building assessment operations. Finally, the administrative process must have a strategy for transition from response to recovery and eventual return to standard building inspection processes.

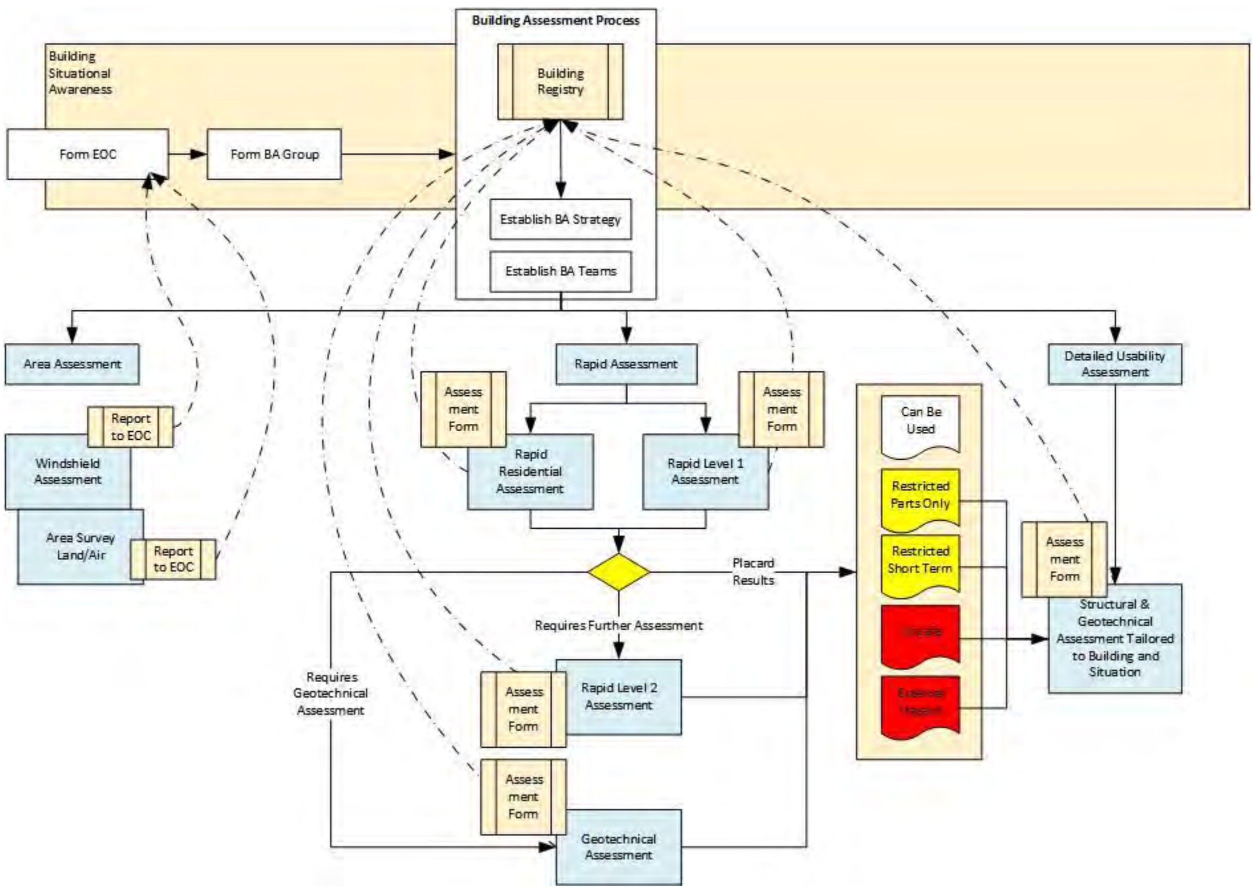


Figure 20. PDBA Administration and Procedures.

Building Assessment Procedures

The core of PDBA is the actual assessment procedures themselves (see the lower portion of Figure 20. PDBA Administration and Procedures, above). The research team noted that, while there are variations, the BA process generally consist of three phases: an initial area assessment, a rapid assessment, and a longer term detailed engineering/return-to-function assessment. The goal of the area assessment is to establish an initial estimate of what areas are damaged and what the level of damage is within those areas – key information that will guide initial response strategies. This typically includes windshield assessment by emergency responders and local authority personnel, supplemented by other forms of formal and informal reconnaissance. This process overlaps with initial search and rescue and emergency response activities. The rapid assessment phase involves of teams of assessors systematically conducting focused assessments (usually 20-30 minute visual inspections of the exterior) to categorize buildings. Several systems use a "triage" approach to categorize buildings as able to be used in the short term (sometimes with restrictions or conditions), those requiring more detailed assessment (including both interior **and** exterior inspection), or buildings which are unsafe (from internal or external hazards). The third level of assessment involves comprehensive structural and functional assessments of a building to identify requirements for demolition or repair and reoccupation of a building. Note that the goals of rapid assessment may vary from system to system or even over the duration of an event (see below).

Outcomes

Most PDBA systems employ three "levels" or categories of outcome. Most systems used a three-colour model: White or Green to indicate no restrictions; Yellow to indicate that parts of the building were usable or that the whole building is usable with restrictions (e.g. shoring or stabilization of debris); and, Red to indicate that buildings should not be used or entered (Figure 21. Varied Placard Systems).

Figure 21. Varied Placard Systems.

The language used by different PDBA models varies, with nuances related to the overall goal of the particular system. Green criteria included: "inspected," "usable," or "no restrictions on occupancy or use." New Zealand recently changed from using Green to White for this level of placard to emphasize that the outcome states only that a building could be used, but that the building may still require a detailed engineering assessment. Many systems had multiple levels of Yellow which allowed "temporary use," or "use after interventions or countermeasures" (e.g., shoring or tearing down unstable features such as chimneys), or allowed "restricted use" of only portions of a building. Red generally indicated that a building was unsafe, although some systems had multiple categories distinguishing when a building was unsafe due to significant damage or from external hazards (e.g. unstable adjacent buildings or geohazards such as unstable slopes).

Information Management

One of the key findings of this research has been the importance of information management to building assessment. This theme emerged both as a critical challenge and as an opportunity for innovation. Various countries have employed trial versions of electronic data capture, supplemented by paper-based backups. The challenges to electronic systems are availability of power, storage and transmission of data, availability of networks to link assessors and central administration, and the need for training of assessors. The challenges to paper-based systems included timely capture and collection of data, along with the need to collate and enter the data before it can be assessed and used. In addition, data may be available from multiple sources, including search and rescue, private building inspections, sensor data, etc. (See Figure 7. PDBA Administration and Procedures, above). A robust PDBA system should include a central building registry that allows for multiple forms of data collection (electronic, paper-based, data from other emergency management processes, social media, etc.), a process for validating or categorizing incoming data, the ability to collate and analyze data – ideally in real-time – and a process for monitoring the change in status in a building over the duration of response and recovery.

Building Status

The concept of "building status" emerged as a concept identifying what is known about the damage, safety, usability, and functionality of a building based on the information available at any given time. As noted elsewhere, there are multiple sources of information about the status of a building, including sensor data, early USAR/search and rescue assessments, building assessment by local authority teams, geotechnical hazard assessment, private building assessments, or assessments by social services (see Figure 7. PDBA Administration and Procedures, above). Each of these groups may use placards or other markings to indicate the status of a building from their own perspectives, which may sometimes conflict with outcomes or status identified through other processes. In addition, the status of a building may change based on subsequent events (e.g., aftershocks) or more detailed or focused assessments (such as Wellington's experience in identifying particular classes of building that were more likely to suffer damage, based on analysis of the event). As the event moves from response to recovery, owners may make repairs and the PDBA system must be able to note the change in status. We suggest that a PDBA system should employ the concept of building status as a way of recording, monitoring, and responding to these changes over time. In addition to the Outcomes and Placards noted earlier, two additional categories of building status were also reflected in the PDBA status of some jurisdictions that captured the changes over time. The first reflects those buildings which have "not yet been inspected", which are known or suspected to have sustained damage from the event. The second reflects those buildings which have been inspected and are considered "destroyed" beyond a state that they are likely to be reconstructed (e.g. from an extensive fire). Although these latter two conditions are not placarded as such, the buildings status is represented as part of the PDBA.

Strategies

Overall damage assessment is a strategic process that overlaps with other emergency management processes. Consistency in the assessment, categorization, and documentation of building assessment is important and requires well-designed processes and support resources, along with both initial and ongoing training.

However, local authorities require a flexible set of guidelines to deal with the unique needs of each incident, involving recruitment, preparation, deployment, communications, and information flow. These processes must also be able to accommodate additional events (e.g., aftershock or additional flooding) and changing conditions over time.

In addition, the strategic process should include both pre- and post-event strategies to better inform decision-making (See Figure 22. Pre- and Post-Event Strategies).

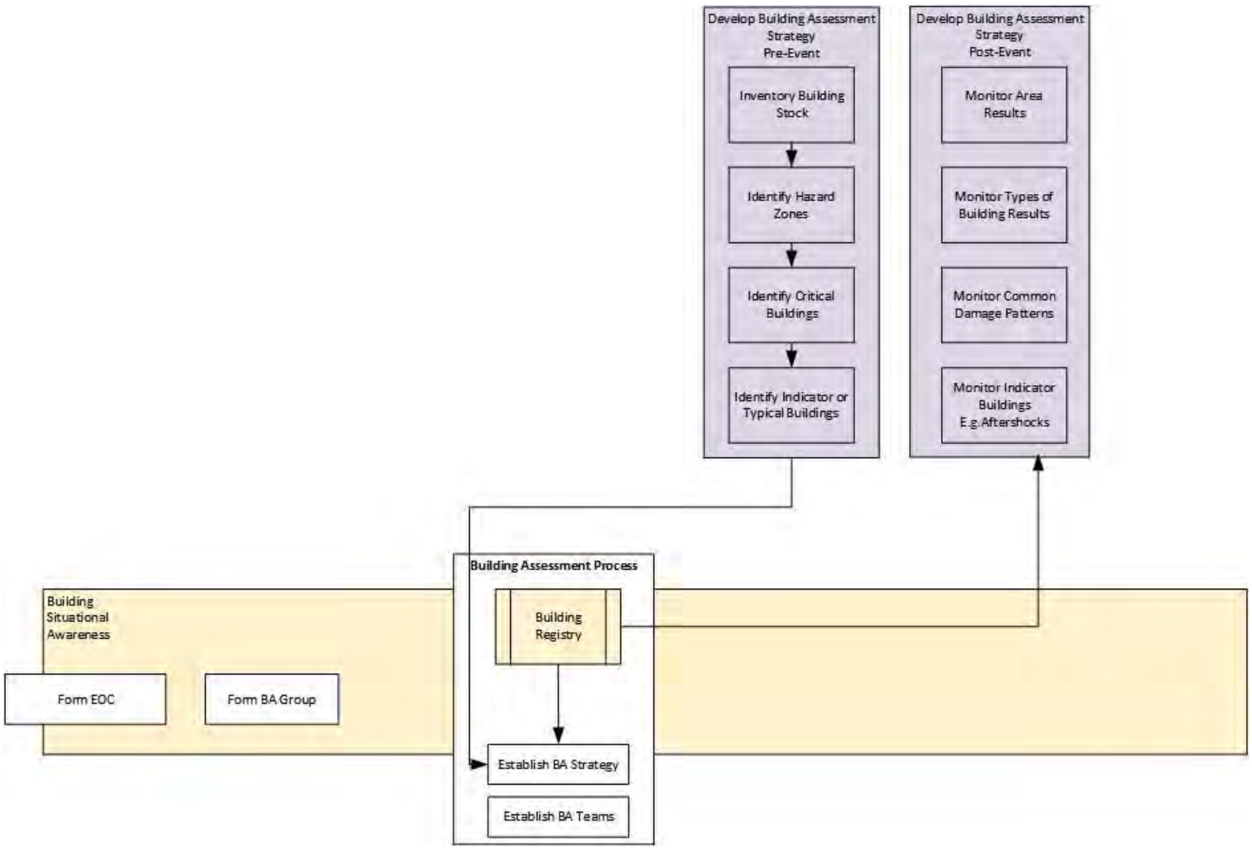


Figure 22. Pre- and Post-Event Strategies.

In the pre-event phase, local authorities should gather as much information as possible, including inventories of building stock, types of buildings in the area, identification of hazards and hazard zones (e.g., flood plains or soil maps), identify critical buildings requiring early assessment after an event, the use of “indicator buildings” to monitor the effect of the event on common types of buildings in the region and the use of technology and sensors to get real-time data during and after an event. Post-event strategies should include more than recording individual building status’, but also include ongoing monitoring and analysis of results within and across areas, noting the status across types of buildings, looking for common damage patterns, and the use of “indicator” buildings to guide assessment priorities.

Embedded in Multiple EM Processes and Assessments

PDBA is only one of a number of emergency management processes and assessments. These processes include assessments which can provide valuable information about the building status, or that would benefit from information gained from the PDBA assessments. In the early phases of an incident, windshield assessments and scene evaluations from first responders flag both individual buildings and general areas of damage. Several participants noted the value and importance of leveraging these processes whenever possible. Similarly, USAR assessments and documentation may provide critical information to guide both the assessment of individual buildings and to identify priority areas or buildings for assessment; examples include use of USAR personnel to provide short-term and ad hoc interventions that allowed partially damaged buildings to continue to be occupied, or including social services personnel with BA teams. At the systems level, PDBA information overlaps with, and can inform other assessments such as critical infrastructure, assessments of other aspects of the built environment, and overall emergency management functions. And the PDBA system must also be able to incorporate data from informal assessments and private assessments by building and critical infrastructure owners (Figure 23. Information Flow & Overlapping Processes).

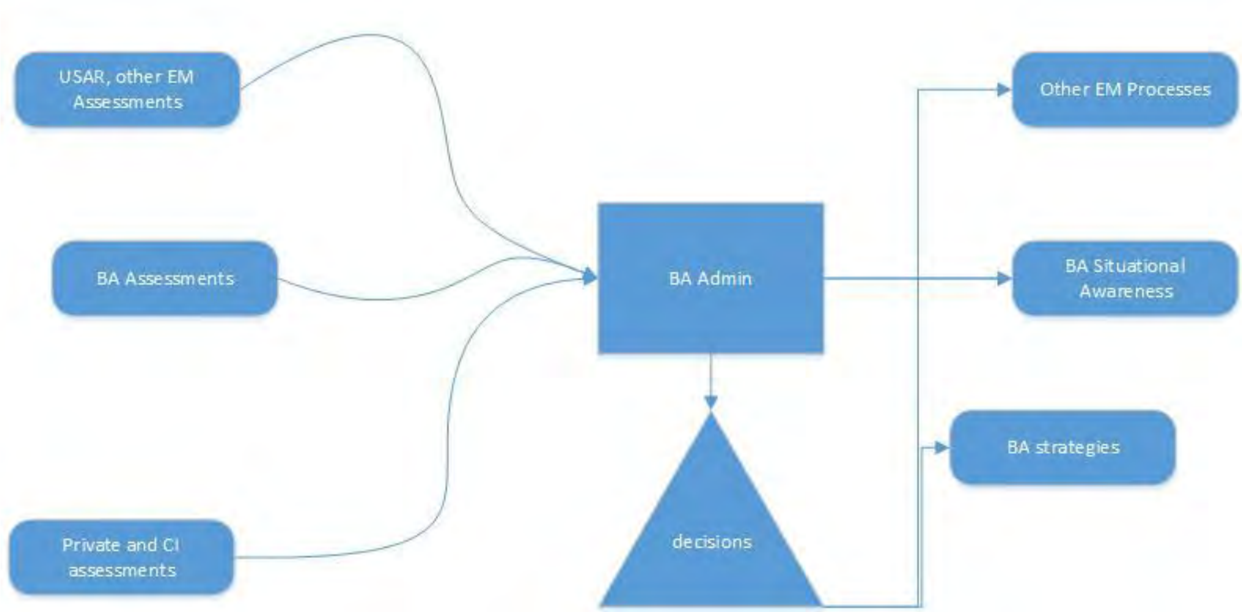


Figure 23. Information Flow & Overlapping Processes.

Legal and Legislative Aspects

PDBA is generally enabled by emergency powers granted by provincial or national legislation. However, as noted above, the process of PDBA should precede events and extends into recovery and return to business-as-usual (Figure 24. Legislative Aspects).

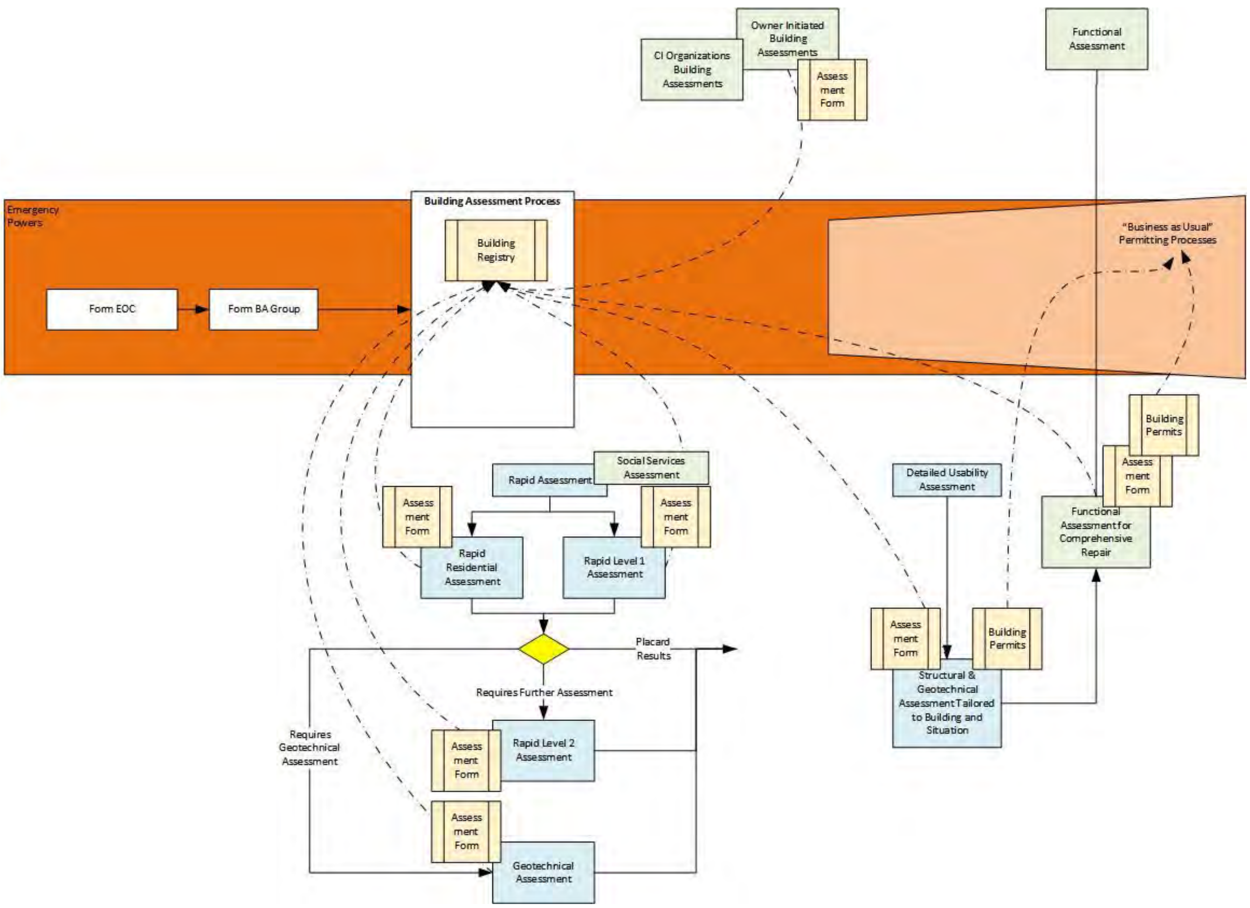


Figure 24. Legislative Aspects.

Ideally, legislation should allow and support pre-event gathering of key data on the existing building stock such as floor plans, structural engineering, and modifications. Processes or legal avenues should be in place to allow the local authority to obtain the results of assessments performed by critical infrastructure and building owners. Several participants noted challenges in having PDBA authority only within emergency powers legislation; a local authority must still have powers to enable its PDBA even if a state of emergency is not declared (e.g., the event is manageable by a local authority without exceptional powers). Second, there must be legal mechanisms in place to allow for transition from using placards during the state of emergency to the normal (or revised) permitting processes in a "business-as-usual" environment.

Multiple levels of organization

The research team noted that PDBA system operations function at multiple levels of organization. Much of the literature on PDBA focuses on the assessment of individual buildings by individual assessors (or teams of assessors). However, the framework will need to incorporate considerations and guidance ranging from operational aspects (use of an assessment framework) through EOC/Regional operations (e.g., recruitment and training of assessors pre-event) to provincial/national (e.g., legislative considerations regarding liability, authority to placard, etc.).

The team identified the need to structure the eventual framework as "layered" or "scalable" on several fronts, including the levels at which various building assessment processes occur (see Figure 25. Levels at which BA Processes Occur).

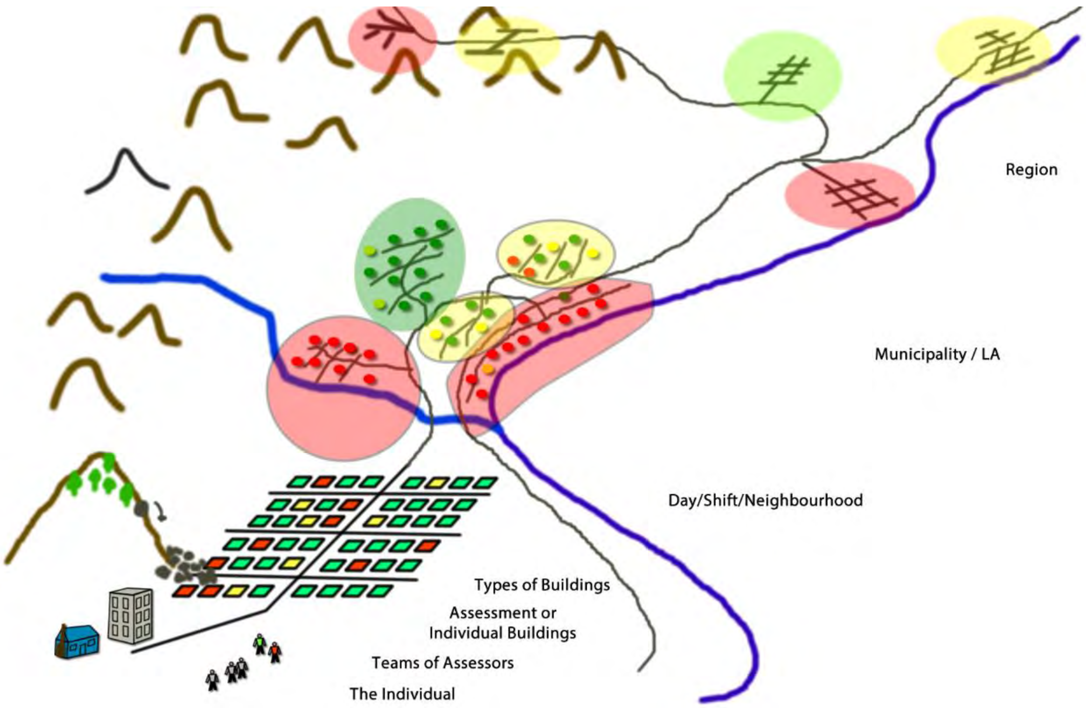


Figure 25. Levels at which BA Processes Occur.

Data elements spoke to assessment ranging from the equipment an individual assessor should carry through strategies for assigning assessors to an area, to how to manage the arrival of international teams. There are distinctive characteristics of the BA process that occur at each of these levels:

- The individual assessor
- Assessment teams
- Assessment of individual buildings
- Assessment of types of buildings
- Assessments of neighbourhoods or small areas
- Assessment across a municipality or Local Authority
- Assessment at the regional or provincial level

The following are suggested levels for the BC PDBA Framework:

- General (aspects related to overall PDBA and Emergency Management)
- System (aspects related to the PDBA process or system as a whole)
- Provincial (may include national/international considerations)
- Regional (may be combined with Provincial)

- Community (Local Authority or municipality, regional district or First Nations government)
    - NOTE: may consider Neighbourhood/Area if required
- Team/Assessors
- Building

Goals of PDBA Change over Time

The research team noted that various programs include assessment for immediate life safety and evacuation, determination of short-term use, long-term remediation and repair, identification of hazards internal to the building (risk of collapse, presence of hazardous materials) and external threats (potential collapse of neighbouring structures, geotechnical hazards, ongoing flooding or aftershocks, etc.). The research team noted considerable variation in the goals and intent of building assessment programs from different countries. In addition, the team documented an evolution in the New Zealand program over several major events (see Figure 26. Changing Goals over Time).

On analysis, the team noted that several goals were involved in building assessment:

- Area assessment, often including windshield assessments, to determine the location and extent of damage within the overall community. At this point, assessment focuses on general areas or neighbourhoods, rather than specific buildings.
- Initial life safety concerns, evaluation, and rescue – although generally handled by USAR and emergency response personnel, building assessors were occasionally involved in support roles during the initial and ad hoc phases of response.
- Safety/Entry – some systems assess whether or not buildings are safe for entry (e.g., to remove personal items). Several participants argued that building assessors cannot adequately determine the safety of buildings (particularly those with moderate damage) and that this should not be part of the explicit assessment process.
- Usability – Italy’s framework distinguishes between short term (emergency) usability and long-term usability, with the goal of allowing occupants to stay in buildings even when damaged, reducing the number of displaced persons that must be accommodated.
- Damage – the long-term goal of building assessment is to identify the extent of damage and repairs required. While this is usually conducted later in the response, there is considerable discussion on both the “goal posts” of this level of assessment (e.g., return to pre-event function, ability to sustain a subsequent similar event, update to current building codes and standards), and on whether this assessment should focus on structural assessment (all agree with this) or should include damage assessment of non-structural elements.

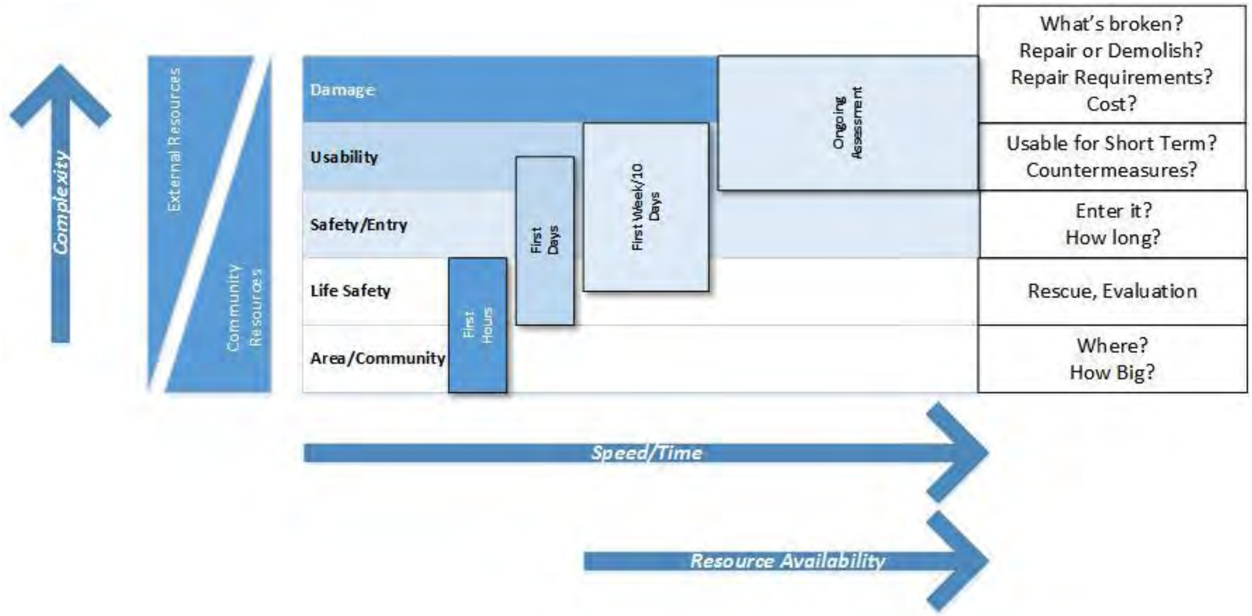


Figure 26. Changing Goals over Time.

The research team mapped these goals and noted that the intent and focus of building assessment changes over time in several ways. Figure 26. Changing Goals over Time, arranges the goals of building assessment from simple (lower on the vertical axis) to most complex (detailed structural damage assessment). The team noted that the goals near the bottom are the major focus early in an event, and that the overall goal and complexity of assessment increases over time. An initial focus on area assessment and life safety generally evolves into safety and usability assessment as the PDBA process is established. Early rapid assessment processes tend to be exterior, relatively quick (e.g. 20 minutes per ATC-20), and often employ a "triage" model – quickly identifying those that are obviously "green" or "red" and flagging "yellow" and more complex buildings for a more thorough secondary interior/exterior assessment. Finally, detailed engineering and return-to-function assessments tend to occur farther in time, although these may be initiated early in the response for critical infrastructure and private owner buildings. The team also noted that the early, shorter assessments tended to be simpler, more prescriptive (e.g. with explicit criteria and processes for categorizing buildings) that were mandated and conducted or supported through the Local Authorities, while detailed damage assessments tended to occur through private sector assessors using more outcome-based or context-specific assessment processes (the lack of criteria, consistency, and oversight of these assessments was noted by some participants as a potential area of concern).

Contextual Factors

Specific PDBA processes shared common elements, but varied across many facets. A number of contextual factors influence specific PDBA systems, including legal frameworks, frequency of events, personnel and resources available and the experience of those personnel (Figure 27. Contextual Factors Influencing PDBA).

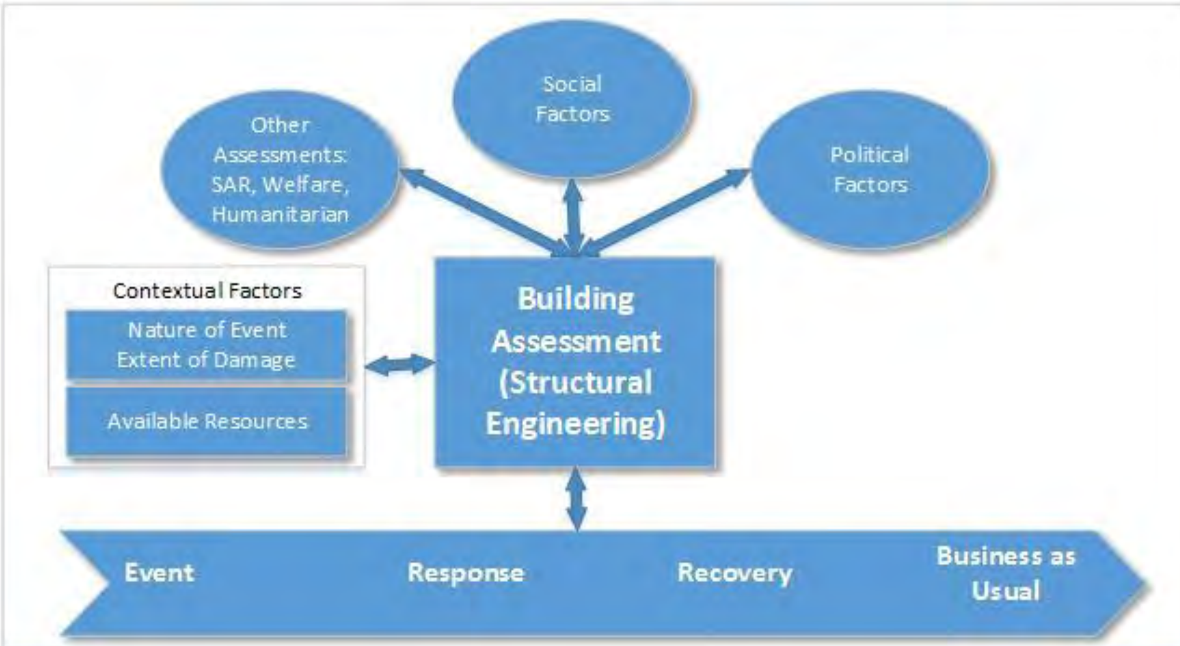


Figure 27. Contextual Factors Influencing PDBA.

Designation of what constitutes “safe” or “usable” may be influenced by social and operational factors (e.g., need to reduce impact of displaced people who could “camp” in damaged but structurally safe buildings). As noted above, initial emphases on short term “usability” increasingly move towards long term rehabilitation and reoccupation, and assessment processes return to “business as usual.” Political factors may influence strategic decisions on distribution of teams, availability of external resources (regional, national, international), and prioritization of areas or types of buildings. And the implementation of a PDBA process is dependent on a number of contextual factor related to the incident itself, including the type and extent of the incident, the types and number of buildings affected, personnel and resources who are dedicated to PDBA, etc. Finally, PDBA itself overlaps with a number of other emergency management functions, including, but not limited to search and rescue, social/welfare concerns, building assessment by owners and agencies, etc.

Critical Decisions for Communities

Communities responding to an event will have a series of critical decisions to make which will impact the implementation of PDBA processes. The project will present strategies to support communities in engaging in these decisions, which may include:

- Terminology – the project will include a data/terminology dictionary which provides the initial key terms used in the process (which will likely be BC specific terms), definitions and descriptions, and, when known, alternative names.
- Risk tolerance – communities will have to determine the extent to which life safety, building entry, short-term and long-term usability are to be considered in setting up and implementing the initial and ongoing PDBA processes. These decisions will be influenced by the nature of the

event, the extent and type of damage, local building stock and population characteristics, likelihood of further events, available (short- and long-term) resources, etc.

- Decision-making roles – consider using ICS-similar structures which identify scalable roles, which may be assumed in practice by different personnel, based on the local event and available resources
- One of the key missing elements, and potentially important value-added aspects of this project, is the articulation of processes and strategies to guide the overall PDBA process. Most systems and literature focus on individual assessment of specific types of buildings, and have only general discussion on establishing and maintaining the overall administration of PDBA.

Deliverable 6.6.1 and 6.6.2: Draft BC Post Disaster Building Assessment Framework

Developing the Draft PDBA Framework

Phase I and Phase II involved the gathering of data with the goal of identifying core concepts and recommendations to support development of BC post disaster building assessment framework. The research team gathered data from multiple sources, including academic and professional literature, descriptions and artefacts from operational PDBA systems, interviews and focus group sessions with key informants and stakeholders in PDBA, and observations and interviews obtained during a site visit to New Zealand. This data was used to develop an initial set of recommendations for development of a PDBA system for British Columbia.

The Analysis and Synthesis phase consisted of organization and analysis of the data, along with a series of structured conversations in which the team reviewed and synthesized a substantial amount of varied data. The structured conversations led to the development of the goals, guiding principles, and core concepts that the team employed in developing a draft Post Disaster Building Assessment Framework for British Columbia.

The central concept that emerged was that the BC PDBA Framework should consist of a series of recommendations (“guidance” and “considerations”) that would inform communities, organizations, and senior governments in developing PDBA programs. The framework would consists of a series of topics (or “aspects”) based on the research questions that guided this project. The considerations and guidance were to be derived primarily from analysis of the Recommendations (see *Deliverable 6.4 Needs Analysis Report*) which would be prioritized and developed through the lens of the Goals, Principles, and Core Concepts on this report (see Figure 28. Development of Framework Content).

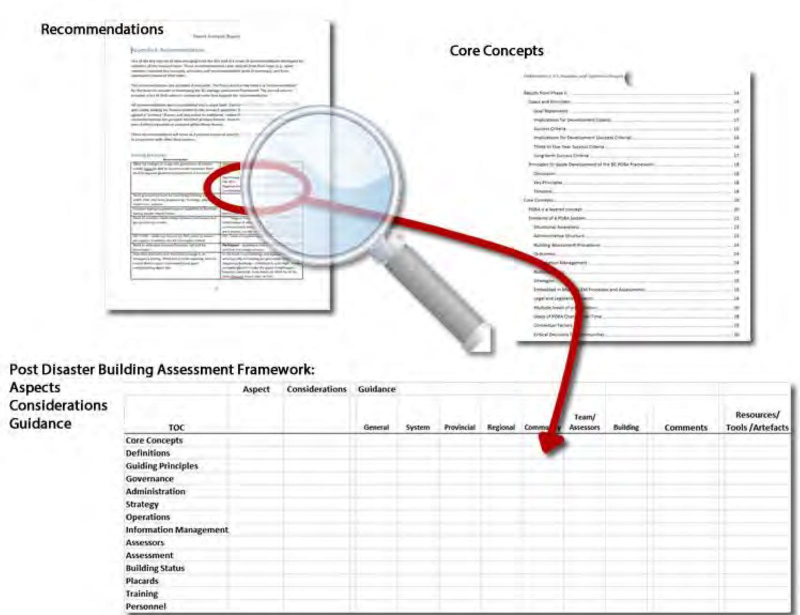


Figure 28. Development of Framework Content.

Synthesis and development of the draft framework consisted of a series of activities, including:

- Analysis of the core concepts to establish an initial overall structure or the topic areas for the framework (see Table 4. Framework Table of Contents and Structure)
    - For example, topics would include Governance, Administration, Assessment Procedures, etc.
- Identification of a series of "layers" or audiences to which specific content of the framework would speak
    - For example, each topic in the framework would have content or recommendations aimed at groups such as Provincial agencies or local government or to assessment teams
- Sorting of recommendations and data into the topic structure
- Within each topic, sorting of recommendations to form themes (the aspects or ideas to be presented for each topic)
    - For example, themes within the Operations topic included Logistics, Team Formation, Daily Deployment, etc.
- Further categorization of recommendation within a theme to the "layers" or "audiences" to which specific recommendations would speak
    - For example, within Operations, the theme of Equipment and Resources included recommendations at the Provincial level (identify resources for long-term PDBA operations), EOC/Local Government Level (pre-establish equipment supply sites or caches) and Assessment Teams (develop checklists of personal safety and assessment equipment)
- Restatement/development of the considerations (core concepts or content) and guidance (discussion and/or resources to support the readers) that would form the "content" or "recommendations" of the PDBA framework.

Table 4. Framework Table of Contents and Structure.

	Aspect	Considerations	Guidance								
TOC			General	System	Provincial	Regional	Community	Team/ Assessors	Building	Comments	Resources/ Tools /Artefacts
Core Concepts											
Definitions											
Guiding Principles											
Governance											
Administration											
Strategy											
Operations											
Information Management											
Assessors											
Assessment											
Building Status											
Placards											
Training											
Personnel											

Draft Post Disaster Building Assessment Framework Document

The resulting document, *Draft PDBA Framework and Recommendations*, included the deliverables described in the Project Charter for Milestone 6: Initial Damage Assessment Framework, incorporating both Deliverable 6.6.1 (provincial level DA framework) and Deliverable 6.6.2 (community-level DA framework for credentialed and non-credentialed personnel).

6.9.1e TECHNICAL REPORT
DELIVERABLE 6.2.1 & 6.2.2: DRAFT BC PDBA FRAMEWORK

These deliverables were initially conceived as two separate documents. However, as the project progressed, it became apparent that the two concepts are intertwined and are better presented as a single, “layered” document. A core element of the Draft Framework is the recommendations which include both provincial and local/community level recommendations throughout the document. In addition, a key element of the draft framework was an initial matrix matching the requirements of specific building types with the type of assessment required for post-disaster building assessment and the types of credentialed and/or non-credentialed personnel who could perform those assessments.

Components in Draft PDBA Framework

Table 5 lists the structure and contents of the Draft PDBA Framework and Recommendations.

Table 5. Framework Structure and Contents.

Section/Topic	Considerations and Guidance
Core Concepts	
Core Concepts	Defining Characteristics of a PDBA System PDBA is a layered construct Changing Goals over Time
The Recommendations	
Governance	Goal Elements of a Building Assessment program Legislation, Regulation, and Policy Authority for Post-Disaster Building Assessment Functions Leadership PDBA Processes and Field Guides Transition from Emergency Powers to Business-as-Usual Post-Event Legal Considerations
Administration	Operational Structure Relationship with Other Emergency Management Functions and Stakeholders (e.g. CI Owners) Administrative Structure Equipment and Resources Information Management Tracking and Monitoring PDBA
Situational Awareness	Developing an Overall Strategy Operational Decision-making and Interpretation of Information Leveraging other Emergency Management personnel and processes Establish Relationships in the Pre-event Phase Pre-Event Intelligence Indicator Buildings Pre-Planning Activation Logistics Equipment and Resources Team Formation and Personnel Management (General) Priority Setting Daily Briefings/Intelligence Reporting Daily Deployment Communications Linking with Other EM Functions Short Term Countermeasures End of Day Debriefs

Section/Topic	Considerations and Guidance
	Staff Rotation
Information Management	Information Management Systems Pre-Event Data Collection Data Management Data Collection and Forms Use of Technology Sources of Data Data Validation Sharing and Integration of Data with other Stakeholders
Assessment Teams	Pre-event Preparation Personal and Team Equipment Housing, Transportation, and Support Fitness to Practice Safety on the Ground Coordination with Other Teams Daily Briefings and Debriefings
Building Assessment Procedures	Goal of Building Assessment Procedures Building Assessment Algorithms Descriptions of Assessment Procedures Specific Assessments for Particular Building Types/Taxonomies
Building Status	Components of Building Status Changing Building Status over Time Placards Considerations and Guidance
Placard Systems	Categories and Definitions Format and Content of Placards Authority to Use Placards Overlap of Placards with Other Emergency Management Assessments
Assessment Personnel	Roles and Expectations Recruitment, Education, Background, Experience Registries and Rosters Legal and Liability Issues Personnel Requirements for Sustained Operations or Large Scale Events
Training	Goals of Training Core Curriculum Principles Responsibility for PDBA training Standards, Guidelines, Ownership/Responsibility for Curriculum Pre-Event Training Ongoing and Refresher Training PDBA Processes and Field Guides Orientation Training Just-in-time Training

Section/Topic	Considerations and Guidance
The Community-level PDBA Assessment Matrix	

Deliverable 6.7: Stakeholder Validation Workshop

The goal of the Stakeholder Validation workshop was to provide key stakeholders and end-users of the PDBA framework an opportunity to review the emerging framework and recommendations for post-disaster building assessment programs and to obtain their comments, input, and advice.

Prior to the workshop, participants received a copy of the draft framework along with an introductory letter and worksheet. Participants were asked to:

- Review the PDBA Draft Framework and Recommendations Document
- Provide general comments on the document, based on questions in the participant worksheet.
- Provide feedback, identify areas where participants did and did not agree with or support specific recommendations

The Stakeholder Workshop included participants from several members of the Expert Working Group, along with end users and key Stakeholders in BC's emergency management and PDBA communities. The workshop employed a series of experiential activities including scenarios, group discussion, focused question and answer sessions, group activities, and debriefings.

Analysis of the data from these sessions will be analysed with the goal of further extending and enriching the projects PDBA procedures, tools, and processes.

Workshop Overview

The workshop consisted of two segments: presentations on the background and findings-to-date of the project and a series of interactive work sessions focusing on specific segments of the overall framework (See Appendix 15: Validation Workshop Agenda).

The initial presentation included:

- Project overview:
  - Background
  - Funding and partners
  - Research goal and objectives
  - Design and data collection
  - Analysis
- Core Concepts:
  - PDBA as a complex system
  - PDBA as a system of systems
  - Changing goals of PDBA over time
  - Guiding Principles

The interactive component consisted of three blocks of activity:

- The PDBA Assessment Matrix:
  - Building taxonomy

  - Types of building assessments
  - Characteristics of assessors
- Operations:
  - Fit of findings with participants' context
  - Positioning of PDBA – EOC or separate department
  - Resources for PDBA
  - Requirements for establishing PDBA operations
- Documentation and Transitions:
  - Placards, forms, and documentation
  - Transitions from normal to emergency powers to return to business-as-usual

Participants

The Stakeholder Workshop ran from 0900 to 1600, attended by 33 participants on site and 2 who joined by teleconference and web. Participants included stakeholders and DA personnel from BC's damage assessment and emergency management communities.

Please refer to Appendix 16 for a list of participants' affiliations. Note that participant names have been removed per the research project's Informed Consent provisions.

Table 6 presents a summary of the affiliations for participants in the BC Stakeholders group, and Research Team.

	Total	Academic	Critical Infrastructure	Local Authorities	Prof. Bodies	Govern	Military	Other DA Stakeholders	DA Programs	Private Sector	Indigenous
Stakeholders	23	2	1	7	3	8	1	1	9	2	2
Team	10	3	0	0	3	4		0	1	0	0
Total	33	5	1	7	6	12	1	1	10	2	2

Table 6. Participant Affiliations.

The Research Team itself consisted of three academics (JIBC), four from government (BC Housing), and three members from professional associations (Architectural Institute of BC and Engineers and Geoscientists BC).

The Stakeholder group has strong representation from organizations who will employ DA processes (local authorities, Indigenous communities, government agencies, critical infrastructure owners, and private sector stakeholders) and those who will be assessors (professional associations representing engineers, architects, engineering technologists, and building inspectors).

Workshop Activities

PDBA Assessment Matrix

The PDBA Assessment Matrix was presented by Research Team members Peter Mitchell and Robyn Fenton (Appendix 17: Draft PDBA Assessment Matrix). The intent of the matrix is provide standardized definitions for building types and assessment types and a cross reference of these with the types of personnel who can perform the assessments. The table is intended as a starting point for local authorities or communities to adapt based on the types of building stock in their community and the availability and types of assessors who are available.

The matrix includes a Building Taxonomy, types of Building Assessment, and types of Assessors. The Building Taxonomy is based on work from UBC, NRCan, and North Vancouver. Four types of building assessment were identified (based on the recommendations of this project): Area, Rapid Exterior Only, Rapid Exterior and Interior, and Detailed. An initial set of three of assessors was presented: 1). (Non-credentialed) contractor, tradesperson, building manager; 2). Building official, architect, engineer or any kind; and 3). Structural engineer.

The matrix further identifies who is responsible for conducting building assessments (e.g., local authority, owner, and/or combination), and who has the authority having jurisdiction for conducting assessments (AHJ).

Participants worked in small groups to answer a series of questions:

- What is missing?
- Is this applicable to your organization?
- Can you see yourself/your organization using this?

Each group presented their responses and this formed the basis of a large group discussion. The findings for this activity are presented in Appendix 3: Findings.

PDBA Organization and Operations

This activity consisted of three sessions:

1. EOC/Support Structure, Roles & Responsibilities
2. Team Structures & Assignment Considerations
3. Deployment Considerations

Pete Learoyd presented key information on each topic, then groups were formed. Each group started at a station (based on the topics above) and answered a series of questions. A carousel technique was used to have each group rotate through three stations, review what other groups had contributed, then add their own comments. Finally, the groups reviewed their starting station to look at comments from all the other groups.

The discussion questions were:

- **ROTATION #1**

- What PDBA EOC/DOC organizational model (& communication/reporting lines) are you considering?
- What PDBA management/ support roles & primary responsibilities is your community/organization considering?

- **ROTATION #2**
  - What considerations are you using when determining the make-up of your individual teams?
  - What factors/considerations have you identified when determining initial & ongoing daily team assignments?
- **ROTATION #3**
  - What type of structure/ content would you include in a daily briefing for teams?
  - What measures has your community/organization considered around the health & safety of personnel when deployed?

The session concluded with a large group debrief and discussion. The findings from this activity are presented in Appendix 3: Findings.

Placards, Forms, & Documentation

Steven Bibby and Jim Forrest reviewed the draft framework recommendations and then lead a discussion exploring the use of placards, forms, & documentation. Questions considered were:

1. Do we allow white and green simultaneous? How will placards allow transition from EM to BAU?
2. Are the same placards sufficient for pre/post emergency?
3. Authority to post/remove?
4. Do we need a working group to manage these in future?

The findings from this activity are presented in Appendix 16: Findings.

Transitioning Between Pre-Event, Response, and Recovery

Steven Bibby and Jim Forrest lead a session exploring the various phases of PDBA. The questions explored in this session included:

1. Is there an existing or planned data management system?
2. Does the pre-event data collection adequately address the LA needs?
3. Does the framework work well with the way your organization functions?
4. Does the framework sufficiently address liability protection during and after the emergency?

The findings from this activity are presented in Appendix 16: Validation Workshop Data and Findings.

Proposal for BC Post-Disaster Building Assessment Advisory Committee

The final session of the workshop was an overview of the proposed BC PDBA Advisory Committee by Steven Bibby. Steven described the role and functions of the proposed committee. An initial meeting was scheduled for September, 2018. Participants were encouraged to consider membership and to contact Steven for further information.

Findings

The findings and notes from the Validation Workshop are available in Appendix 18: Validation Workshop Data and Findings.

Initial Analysis and Summary

Following the workshop, all data was gathered, collated and analysed to identify additional recommendations for inclusion in the PDBA Framework. This analysis is included in Appendix 19: Additional Recommendations.

Deliverable 6.8: BC Post-Disaster Building Assessment Advisory Committee

The formation of the BC Post-Disaster Building Assessment Advisory Committee meets the final objective of the BC PDBA project, namely to establish a network of stakeholder organizations to guide, deliver, and sustain the resulting suite of processes, approaches, and resources.

The goal of the PDBA Advisory Committee will be to adopt and advise on the provincial framework for establishing post-disaster building assessments. The concept of the committee emerged from the efforts of BC Housing (Steven Bibby) and as a result of the BC PDBA Validation Workshop. At the Validation Workshop, stakeholders reviewed the draft BC PDBA Framework and Recommendations which will serve as a guideline for communities and agencies who develop the resources and tools required to perform assessments in a post-disaster setting. Participants at the Validation workshop identified a series of recommendations to be introduced at an inaugural Advisory Committee meeting. After the Validation workshop BC Housing received overwhelming interest and support from multiple stakeholders to participate in the ongoing development of the provincial program.

Additional details were provided to participants in advance of the meeting, including the draft PBDA Framework and the draft Advisory Group Terms of Reference . It is anticipated that Advisory Group participants will commit to meeting two to three times per year.

An inaugural meeting of the BC Post-Disaster Building Assessment Advisory Committee was held in Burnaby on September, 2018. The Workshop included several members of the Expert Working Group, along with end users and key Stakeholders in BC’s emergency management and PDBA communities. The workshop employed a series of group discussion, focused question and answer sessions, group activities, and debriefings.

Workshop Overview

The workshop consisted of introductions, a project debrief, review and discussion of the committee draft terms of reference, working session on the potential development Streams/working groups: governance and administration, placards, forms, and information management, curriculum and training and a presentation from the BC Assessment Authority/Geo BC Presentation on Rapid Damage Assessment Mobile App and Dashboard (Appendix 20: Inaugural Consortium Meeting Agenda).

Participants

The Workshop ran from 0900 to 1400, attended by 22 participants. Participants included stakeholders and DA personnel from BC’s damage assessment and emergency management communities (Appendix 21: Inaugural Consortium Workshop Attendees’ Affiliations). Note that, per the research project Informed Consent provisions, names of individual participants have been removed.

Workshop Activities

Overview of PDBA project and framework

Ron Bowles presented and update and overview of the BC Post-Disaster Building Assessment (PDBA) project.

Committee Draft Terms of Reference

Steven Bibby walked through the purpose and mission of the BC Post-Disaster Building Assessment PDBA Inaugural Advisory Committee. There was discussion to rework the Terms of Reference to include the interests of the non-BC Housing, governmental groups. Committee members all agreed to the revised TOR, which was later distributed to all members with the revisions (Appendix 22: BC PDBA Advisory Committee Terms of Reference).

PDBA Development Streams/Potential Working Groups

Pete Learoyd presented the working group Development Streams. (See appendix 5 Development Stream Descriptions.) Participants were split into 3 groups and brainstormed focus areas for each stream.

Focus Areas

1. Governance and Administration
2. Placards, Forms, and Information Management
3. Curriculum and Training

Outcomes

Table 7 lists the areas identified

Building Assessment Matrix – who does what for which building – ID assessment expertise, building taxonomy type of assessments, assessment expertise, building type and what type of assessment
Liability of assessors – credentials, who owns it. Occupational health and safety,
Some community training residents vs experts to do assessments.
Teams: how many people/roles and responsibilities,
Information odul. for local authority – are hazardous materials being tracked
Worker care
Stakeholders – how do they fit in / insurance / role of stakeholders – associations
Governance liability, legal – need clarity on lines of authority, how do different acts play into this, (tenants and residential tenancy act – onus on building owners. – not just about the BA process itself but how it overlaps with different users, legal and regulatory)
Capacity and training and dealing with difference between volunteers – what are we tariing them on and what to do.
Information gathering – building inventory
Assessors and training – who what how
FN – governance / jurisdictions – play out – provincial/local.
Data – privacy, access, information.
Priorities == Liability/who – stakeholders (credentialing)/data – information odul., future funding
Legislation – FN

Table 7. Discussion Outcomes from PDBA Development Activity.

BC Emergency Management Common Operating Portal

Gurdeep Singh from Geo BC (FLNRO) presented on the BC Emergency Management Common Operating Portal and the Building Damage Assessment mobile App. It provides local and provincial authorities real time information. Assessors in the field enter assessment information into an app which goes directly into the BC Emergency Management Common Operating Portal. Local Authorities can view real time information on buildings in their area. Photos can be added and data reported.

Next Steps – Meeting frequency, location, dates

1. Steven Bibby discussed next steps and confirmed everyone's commitment to the TOR.
2. Notes, revised Terms of Reference will be sent out for approval.
3. Next Advisory Committee meeting will be held middle of March, 2019.
4. Development Stream meetings to be held before the end of December. Doodle meeting options will be sent out to forward and accept.
5. Revised framework will be sent out for review within the next 2 months.

See Deliverable 6.8 Inaugural Advisory / Consortium Committee Report for further information, including the Draft Terms of Reference and copies of the presentation slides.

Deliverable 6.7.3: Production Versions of the BC Post Disaster Building Assessment Framework and Recommendations and the Companion Manual: Recommendations and References.

The final activity in this project was development of the production versions of the Framework Manual and Companion Manual (Figure 29. BC Post-Disaster Building Assessment Framework and Recommendations: Manual and Companion Manual). These documents are available through both BC Housing and the Justice Institute of British Columbia websites.

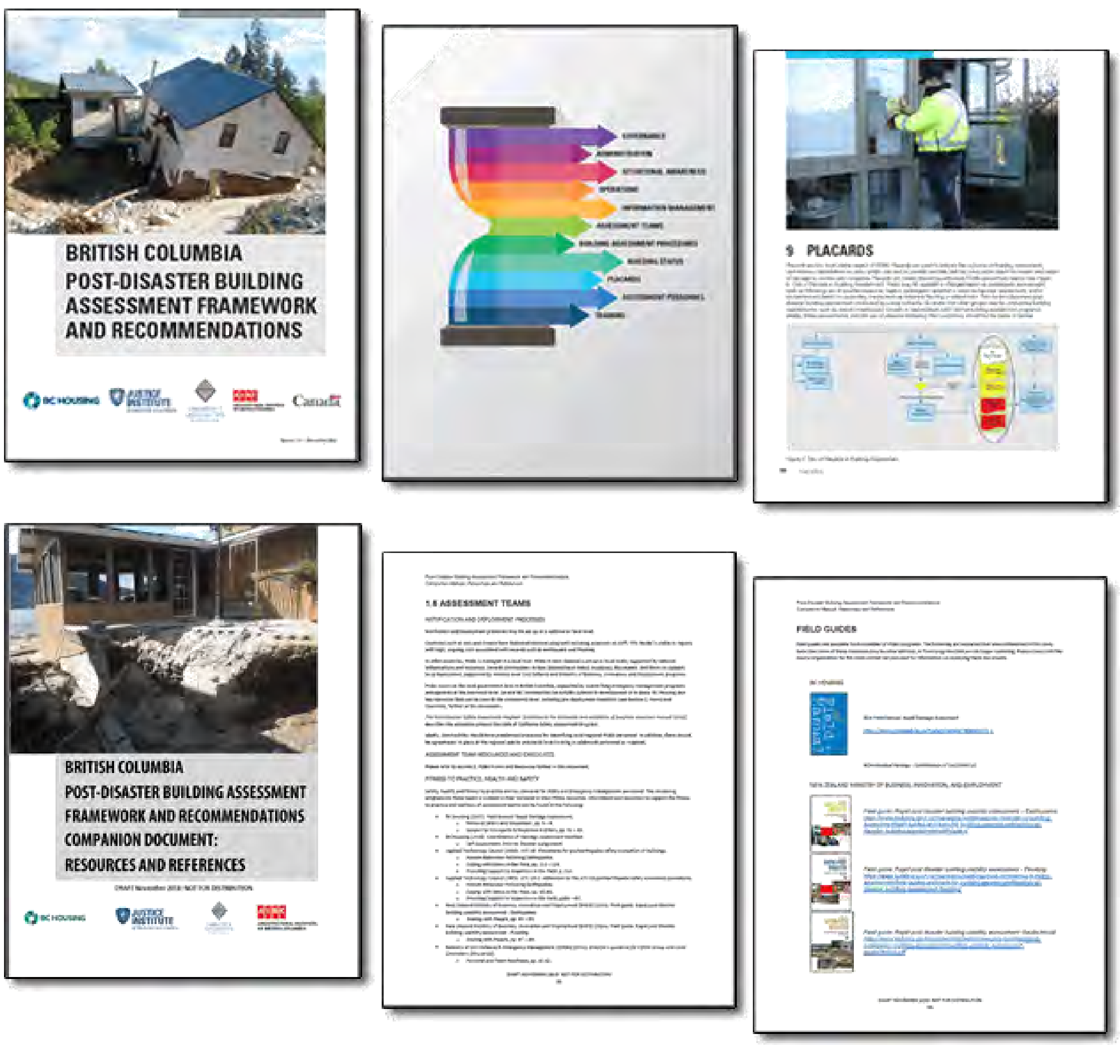


Figure 29. BC Post-Disaster Building Assessment Framework and Recommendations: Manual and Companion Manual.

Reach and Impact

The project has already had a reach and impact beyond its intended scope.

The project had three major goals: development of a provincial framework to support PDBA, a community-level framework for using credentialed and non-credential personnel to perform PDBA, and establishment of a provincial-level consortium or network of stakeholders who would help implement and sustain the PDBA framework. Thus, the k project outputs include a BC PDBA Framework and Recommendations, which support both the provincial- and community-level goals of the project, a PDBA Building Assessment Matrix which further supports communities in developing models for using credentialed and non-credential personnel, and the establishment of the BC PDBA Advisory Committee.

However, the project has had a substantial reach and impact beyond these goals, including supporting multiple agencies, stakeholders, and government agencies participating in PDBA across British Columbia, consulting and informing PDBA programs and initiatives nationally and internationally, and developing an extended international network of PDBA stakeholders, practitioners, and experts.

Reach

The BC PDBA Research Project has had local, national, and international reach in terms of individuals and agencies who participated in the project, knowledge dissemination activities, and development of ongoing relationships.

Figure 30. Reach and Impact. EWG: Expert Working Group Members; I: Interview Participants; P: Presentations.

6.9.1e TECHNICAL REPORT
REACH AND IMPACT

The following are individuals, agencies, and organizations who have participated in, or benefited from the project:

Research Team

- Steven Bibby, BC Housing
- Ron Bowles, Justice Institute of BC
- Robyn Fenton, Architectural Institute of BC (AIBC)
- Jim Forrest, BC Housing; City of Vancouver (from June, 2018)
- Marguerite Laquinte Francis, Architectural Institute of BC (AIBC)
- Pete Learoyd, Justice Institute of BC
- Peter Mitchel, Association of Professional Engineers & Geoscientists of BC
- Cindy Moran, BC Housing
- Dawn Ursuliak, Justice Institute of BC

Stakeholder Workshop

- Applied Science Technologists & Technicians of BC
- BC Housing
- BC Hydro: Generation Civil Design
- BC Liquor Distribution Branch
- Municipality of Bowen Island
- Building Officials Association of BC
- Coastal Health Authority
- Earthquake Engineering Research Institute
  British Columbia Chapter
- Emergency Management BC (EMBC)
- Hollyburn Properties
- Integrated Partnership for Regional Emergency
- City of Port Coquitlam
- Shared Services BC
- Structural Engineering Association of BC (SEABC)
- City of Vancouver
- Vancouver Airport Authority (YVR)

Expert Working Group:

British Columbia

- Mike Andrews, North Shore Emergency Management Office
- Dr. Carlos Estuardo Ventura, P.E., P.Eng., University of British Columbia
- Arnie van Hattem, BCR Properties
- Daniel Stevens, City of Vancouver

National

- Glenn Cooper, CFB Esquimalt USAR Team, Department of National Defence

International

- Agostino Goretti, C. Eng., Ph.D., Italy, Italian Civil Protection Department
- Ayse Hortacsu, California, Applied Technology Council
- David Swanson, PE, SE, LEED AP, F. SEI, Washington State
- Satoshi Tanaka, Japan, Fuji Tokoha University
- Fred Turner, California, California Office of Emergency Services; Safety Assessment Program

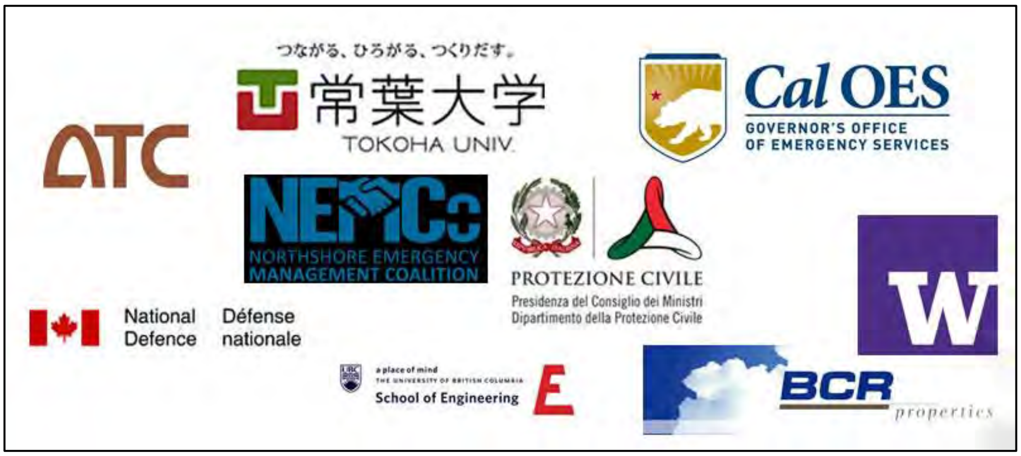


Figure 31. Expert Working Group Organizations and Agencies.

New Zealand Participant Organizations and Agencies:

- Auckland City Council
- University of Auckland
- Aurecon Group
- Canterbury Civil Defence Emergency Management
- Canterbury Earthquakes Royal Commission
- Christchurch City Council Building Consenting Unit
- Holmes Consulting
- Hong Kong Engineering Institute conference
- Housing New Zealand, Christchurch
- Housing New Zealand Corporation, Crown Agency
- Hurunui District Council
- Institute of Professional Engineers
- Kaikōura District Council
- NZ Ministry of Business, Innovation and Employment
- School of Architecture and Planning, Auckland
- Tonkin and Taylor
- Wellington City Council – Building Damage assessment

Figure 32. New Zealand Site Visit Organizations and Agencies.

MATILDA (MultinATIonal odule on Damage Assessment and countermeasures)

Final Event (Ron Bowles invited to attend), September, 2017

- Croatian National Protection and Rescue Directorate
- Eucentre Foundation, Italy
- Italian Civil Protection Department
- Italian Fire and Rescue Service
- Natural Disaster Rehabilitation Service, Greece
- National Institute for Research and Development in Construction, Urban Planning and Sustainable Spatial Development, Romania
- Administration of the Republic of Slovenia for Civil Protection and Disaster Relief

Meetings in Europe with Steven Bibby October, 2017

- Agostino Goretti, Civil Protection Department, Rome, Italy
- Kostas Ioannides, Earthquake Planning and Protection Organization, Athens, Greece

Validation Workshop Participating Organizations and Agencies

- Applied Science Technologists & Technicians of BC
- BC Housing
- Bowen Island Municipality
- Building Officials of BC
- CFB Esquimalt USAR Team
- Department of Civil Engineering, UBC

- Emergency Management BC (EMBC)
- Health Emergency Management BC
- Hollyburn Properties
- Indigenous Services Canada (ISC)
- Insurance Bureau of Canada
- Building and Safety Standards Branch Office of Housing and Construction Standards Ministry of Municipal Affairs and Housing
- North Shore Emergency Management Office
- City of Port Coquitlam
- Richmond School District No. 38
- Municipality of Saanich
- Soda Creek Band
- Vancouver Airport Authority (YVR)
- City of Vancouver

Figure 32. Validation Workshop Organizations and Agencies.

Inaugural Consortium/BC PDBA Advisory Committee Meetings

- Applied Science Technologists & Technicians of BC
- Architectural Institute of BC (AIBC)
- BC Assessment Authority
- BC Housing
- BC Hydro
- BC Safety Authority
- Building Officials Association of BC

6.9.1e TECHNICAL REPORT
REACH AND IMPACT

- Canadian Safety & Security Program, Department of National Defence
- Earthquake Engineering and Research Institute (EERI) – BC Chapter
- Emergency Management BC (EMBC)
- Engineers & Geoscientists BC
- Geo BC (FLNRO)
- Health Emergency Management BC
- Hollyburn Properties
- Indigenous Services Canada (ISC)
- Insurance Bureau of Canada
- Justice Institute of British Columbia
- Ministry of Municipal Affairs and Housing, Building and Safety Standards Branch Office of Housing and Construction Standards
- North Shore Emergency Management
- Provincial Health Services Assocaition
- Real Estate Services
- Richmond School District #38
- RJC
- District of Saanich
- Soda Creek Band
- Structural Engineering Association of BC
- BC Safety Authority, Technical Safety BC
- University of British Columbia, Department of Civil Engineering
- Vancouver Airport Authority (YVR)
- City of Vancouver, Building Review Branch

Impact

The BC PDBA Research Project had pragmatic and applied goals in developing tools and resources to support both community- and provincial/national-level post-disaster building assessment operations. These goals were met through publication of the BC PDBA Framework and Recommendations and Companion Manual, and through the inauguration on ongoing operations of the BC PDBA Advisory Committee.

However, the project has had impact beyond these formal goals, with impact at multiple levels from supporting local governments in British Columbia who are in the process of establishing their own PDBA systems, through consultation with multiple agencies and organizations involved in PDBA, and the development of an extended network of stakeholders and personnel who remain in contact with members of the research team and their organizations.

Operational

The project outputs (e.g. framework and recommendations) are actively informing work of British Columbia groups developing and implementing PDBA programs – e.g. Vancouver, North Shore, Delta, BC Housing, and the BC PDBA Advisory Group. Several participants noted that the timing of this project was extremely fortunate, as they are in the process of establishing and/or enriching their damage assessment programs and are incorporating the outputs of the project.

Knowledge Dissemination Activities

Members of the project attended and were invited to a variety of knowledge dissemination conferences, workshops, and meetings.

Activity	Date	Location	Notes
Site Visit	June, 2017	New Zealand	See notes above for attendees and participating organizations.
• Presentations		Auckland, NZ	Robyn Fenton & Dawn Ursuliak
• Presentations		Christchurch, NZ	Research Team
• Presentation		Canterbury University Christchurch, NZ	Robyn Fenton
• Presentations		Kaikoura, NZ	Pete Learoyd & Dawn Ursuliak
• Presentations		Wellington, NZ	Research Team
• New Zealand Stakeholder Engagement Workshop		Wellington, NZ	Research Team
New Zealand Housing	June, 2017	Christchurch	Steven Bibby
New Zealand Housing	June, 2017	Wellington	Steven Bibby
PDBA Stakeholder Input Workshop	June 26, 2017	New Westminster, BC	Research Team
PDBA Expert Working Group	June, 27 2017	New Westminster, BC	Research Team

6.9.1e TECHNICAL REPORT
REACH AND IMPACT

Activity	Date	Location	Notes
Architectural Institute of British Columbia	July 6, 2017	Vancouver, BC	Robyn Fenton – presentation on Site Visit
MATILDA Final Event (Italy, Slovenia, Croatian consortium on an international rapid damage assessment response team)	Sept., 2017	Rome, Italy	Dr. Ron Bowles was invited to attend and present at the MATILDA international conference
Meetings with international PDBA Experts	Oct., 2017	Rome, Italy & Athens, Greece	Steven Bibby
Emergency Preparedness & Business Continuity Conference	2017	Vancouver, BC	Dr. Ron Bowles presented on BC PDBA project.
World Congress on Disaster & Emergency Medicine	May, 2017	Toronto, ON	Dr. Ron Bowles presented on BC PDBA project.
BuildEx: Tradeshow and Conference for Western Canadian property management, interior design, architecture, renovation, construction, & real estate.	Feb 14, 2018	Vancouver, BC	Peter Mitchell & Dr. Ron Bowles presentation: POST-EARTHQUAKE BC: HOW DO WE STAND UP?
Regional Emergency Planning Committee (REPC) for the Lower Mainland	April 19, 2018	Vancouver, BC	Jim Forrest presented on the BC PDBA project.
Asset Management Conference	May, 2018	Victoria	Peter Mitchell, invited presentation the work being done under the BDSA as well as on resilient buildings at a Asset Management Conference schooled for Victoria
Emergency Preparedness for Industry and Commerce Council (EPICC)	Sept, 2018	Victoria, BC	Steven Bibby presented on the PDBA project.
National Committee of Structural Engineering Associations AGM	Oct. 2018	Chicago, IL	Steven Bibby & Peter Mitchell presented on PDBA project.
Emergency Preparedness & Business Continuity Conference	Nov., 2018	Vancouver, BC	Steven Bibby presented on the PDBA project.
Canadian Risk Hazard Network & Canadian Roundtable	Nov., 2018	Vancouver, BC	Pete Learoyd presented on the PDBA project.
Earthquake Engineering & Research Institute (EERI)	Mar 2019	Vancouver	Steven is one of 6 in a technical presentation describing the PDBA process in comparison to other international assessment protocols

6.9.1e TECHNICAL REPORT
REACH AND IMPACT

Consultation

The project has had international reach, with multiple stakeholders both informing and drawing on the expertise of our personnel through contact with various provincial and international groups.

Activity	Date	Location	Notes
UBC's Earthquake Engineering Research Facility	January 29, 2018	Vancouver, BC	Demonstration on the methodology and training developed to carry out post earthquake building assessments with the Minister of Education, DM EMBC and ADM EMBC in attendance.
George Abbott, Government of BC			Consulted with Peter Mitchell, APEG BC to provide feedback on the government's review of the 2017 fire and flood seasons and input on the planning, prevention, response and recovery aspects and any comments the association had based on their involvement.
City of Vancouver Seismic Policy Committee	Feb. 2, 2018	Vancouver, BC	Attended by two Research Team members.
BC Post Disaster Building Assessment Advisory Group	Sept. 13, 2018	Burnaby, BC	Inaugural meeting
National Council of Structural Engineering Associations (NCSEA)	Oct 2018	Chicago	Providing ongoing expertise and consultation to assist in the development of the BC PDBA Volunteer Registry
Earthquake Engineering & Research Institute (EERI)	Mar 2019	Vancouver	Steven moderating a panel of international experts to discuss PDBA processes for possible change to EERI deployment protocols
Applied Technology Council (ATC) and Federal Emergency Management Agency (FEMA)	In progress through Oct 2019	United States of America	Steven received a request to help ATC & FEMA develop US guidance for building experts to assess structures. Will be part of a project review panel.
BC Post Disaster Building Assessment Advisory Group – Working Groups	Dec 7, 17, 18, 2018	Burnaby, BC	Working group meetings on governance, outcomes/placarding, and curriculum
PDBA Volunteer Registry/Website	In progress	BC Housing	BC Housing is working on a PDBA Volunteer Registry/Website, with completion anticipated for Mar./Apr., 2019.
Emergency Management BC (EMBC)	In progress	British Columbia	EMBC has agreed to make Building Assessment a primary

Activity	Date	Location	Notes
			function to test during the provincial full scale operational exercise in 2021.
BC Ministry of Education, City of Vancouver, City of North Vancouver	In progress	British Columbia	Consulting with BC Housing to modify their PDBA processes to fit with the provincial PDBA framework
Emergency Management BC	In progress	British Columbia	Consulting with BC Housing on proposed changes to emergency legislation in BC to help facilitate the provincial PDBA framework

Appendices

Appendix 1. Project Gantt Chart

Milestone						FY 17/18												FY 18/19							
	JIBC	BCH	AIBC	APEG		A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N
6.1 Project Initiation																									
Project Plan	X					X	X																		
Research Protocol	X					X	X																		
Ethics	X					X	X																		
Deliverable:																									
6.1.1 Project plan	X						X																		
6.1.2 Research protocol/proposal	X						X																		
6.1.3 Research Ethics Approval	X						X																		
6.2 Needs Analysis Literature, Case Studies, and Professional Documents Review																									
Needs Analysis	X					X	X																		
Deliverable																									
6.2.1.1 Needs Analysis Report	X						X																		

6.9.1e TECHNICAL REPORT
APPENDIX 1: PROJECT GANTT CHART

Milestone						FY 17/18												FY 18/19							
	JIBC	BCH	AIBC	APEG		A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N
6.3 Needs Analysis: Stakeholder Engagement Workshop																									
Determine EWG vs participant list	X	X	X	X		X	X																		
Workshop booked June 26th and 27	X					X	X																		
Invitation list created	X	X	X	X		X	X																		
Invites created	X	X	X	X		X	X																		
Invites sent out	X	X	X	X		X	X																		
Workshop planning agenda and outline	X					X	X	X																	
Travel booked for invited guests	X					X	X	X																	
2 day workshop	X	X	X	X		X	X	X																	
Workshop data analysis/synthesis	X					X	X	X	X																
Deliverable																									
6.3.1.2 Workshop agenda, attendance list and the presentation material.	X								X																
6.3.1.2 Expert Working Group (EWG) Workshop synopsis report	X								X																
6.4 Needs Analysis: Stakeholder Interviews and Site Visit																									

6.9.1e TECHNICAL REPORT
APPENDIX 1: PROJECT GANTT CHART

Milestone					FY 17/18												FY 18/19							
	JIBC	BCH	AIBC	APEG	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N
Interviews: revise interview questions	X							X	X															
Interviews: Identify Key Informants & Stakeholders for interviews	X	X	X	X				X	X															
Interviews: set up interview times	X							X	X	X														
Interviews: transcribe and drop into analysis software	X								X	X														
Interviews: Analysis and Outcomes	X								X	X														
Interviews: Create report	X									X														
Site Visit Criteria Developed	X	X	X	X	X																			
Site Visit goals and outcomes	X	X	X	X	X																			
Site Visit Options	X	X	X	X	X																			
Site Visit Picked	X	X	X	X	X																			
Site visit preparations	X				X	X																		
Site Visit Establish Contacts	X	X	X	X		X																		
Site Visit Set Up Meetings and Schedule	X	X	X	X		X																		
Site Visit Book Travel / Hotel	X	X	X	X		X																		
Site Visit Create Canadian Presentation / Workshop	X					X																		
Site Visit Create Research Questions	X					X																		

6.9.1e TECHNICAL REPORT
APPENDIX 1: PROJECT GANTT CHART

Milestone						FY 17/18												FY 18/19							
	JIBC	BCH	AIBC	APEG		A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N
Site Visit 5 day Visit	X	X	X	X				X																	
Site Visit Analysis and Outcomes	X								X	X															
Site Visit: Create Report	X									X	X														
Review	X	X	X	X						X	X														
Deliverable																									
6.4.1 Needs Analysis Report	X										X														
6.4.2 Site Visit Report (MS Word electronically)	X										X														
6.5 Draft Framework: Analysis & Synthesis																									
Analysis/Synthesis	X										X	X	X												
Review	X	X	X	X								X	X												
Deliverable																									
6.5.1 Analysis and Synthesis Report	X												X												
Milestone 6.6 Initial Damage Assessment Framework																									
Initial Frameworks	X												X	X	X	X	X								
Review	X	X	X	X											X	X	X								

6.9.1e TECHNICAL REPORT
APPENDIX 1: PROJECT GANTT CHART

Milestone						FY 17/18												FY 18/19							
	JIBC	BCH	AIBC	APEG		A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N
Deliverable																									
6.6.1 Draft Provincial DA Framework	X																X								
6.6.2 Draft Community-level Framework	X																X								
6.7 Stakeholder Validation																									
Determine Workshop Validation Date	X	X	X	X									X	X	X										
Invite attendees	X	X	X	X									X	X	X										
Create agenda / outcomes/agenda	X												X	X	X										
Workshop	X															X									
Workshop data analysis/synthesis	X															X	X								
Revisions to Frameworks	X																								
Deliverables																									
6.7.1 Workshop agenda, attendance list and the presentation material	X																	X							
6.7.1.1 Draft Validation Review Report .	X																	X							
6.7.2 Draft of the Provincial and Community-level frameworks and resources	X																	X							

6.9.1e TECHNICAL REPORT
APPENDIX 1: PROJECT GANTT CHART

Milestone					FY 17/18												FY 18/19							
	JIBC	BCH	AIBC	APEG	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N
6.7.3 Final distribution versions of the Provincial and Community-level Damage Assessment Frameworks and Resources.	X																X							
6.8 Establish Consortium																								
Establish Consortium	X	X	X	X															X	X	X	X		
Knowledge Dissemination	X	X	X	X															X	X	X	X		
Deliverables																								
6.8.1 foundational administrative document for the Consortium	X	X	X	X																		X		
6.8.2 Final agenda and attendance list	X																					X		
6.8.3 Knowledge dissemination documents: (a) A white paper on the DA frameworks (b) A draft presentation for a EWG peer-level conference for the TA's approval no later than two weeks prior to the conference and a final copy following the conference	X																				X	X		
Milestone 6.9 Project Close Out																								

6.9.1e TECHNICAL REPORT
APPENDIX 1: PROJECT GANTT CHART

Milestone						FY 17/18												FY 18/19							
	JIBC	BCH	AIBC	APEG		A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N
Project Reporting	X	X																							
Ongoing Project Reporting (verbal and written CSSP Progress Reports, in the format provided by the TA)	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Financial Reporting (YE Financial Reports)	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PRC meetings, reports, and Record of Decision (as per the CSSP project implementation guide)	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Project Completion Report and Presentation	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Project Technical Report	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Table A1. Project Gantt Chart.

Appendix 2: Research Protocol

Research Questions

The research questions focus on two areas: gathering data on existing building damage safety assessment programs and exploring the experience of those who have used them.

Part I: Building Damage Safety Assessment (BDSA) Framework

How does Building Damage Safety Assessment fit within the overall Emergency Management planning and response structure?

- Who has the overall (e.g., legislative) responsibility for BDSA?
- Who are the stakeholders groups involving in developing, implementing and sustaining BDSA processes and infrastructure?
- What are the roles and relationships between stakeholders in BDSA?

Describe the elements/structure of your BDSA programs.

- What is the overall goal of BDSA?
- What types of BDSA are performed, by whom, with what goals/outcomes, and following what procedures or processes?
- How is BDSA information gathered, recorded, transferred, and employed? How
- What are the credentials, background, &/or experience required to perform each type of BDSA?
- What training and/or education is available to support personnel performing BDSA?
- Is there a performance standard identified for how BDSA is carried out and is there a different standard used for BDSA's carried out by credentialed and non-credentialed individuals?
- Are credentialed and non-credentialed individuals carrying out BDSA's fully indemnified against any liability or from claims being made against them

Describe the administration and control of BDSA.

- Who has operational control or administration of BDSA?
- How are BDSA teams and personnel recruited, selected, operationalized, and supported?

Describe the context for BDSA in your jurisdiction: history, evolution, and current state.

- How have BDSA processes evolved to incorporate experience, best and emerging practices?
- What are the key assumptions or principles upon which your BDSA program is based?
- Why has it developed the way it has (e.g., political considerations, experience, etc)?

Part II: Participants' Experience in Building Damage Safety Assessment

6.9.1e TECHNICAL REPORT
APPENDIX 2: RESEARCH PROTOCOL

Please describe your recent experience in using BDSA.

- Describe the event: location, timing, extent of damage, etc.
- Describe the operational functioning of BDSA: who managed/administered the overall process, who identified indicator buildings (and what process was used to identify these buildings), who set operational priorities, what were the operational principles on which decisions were based?
- Describe recruitment, deployment and use of BDSA teams.
- Describe extent of BDSA: # teams, composition, selection, logistics, timeline, # buildings assessed, outcomes of assessment.
- Were BDSA's carried out in order to confirm that buildings actually met a certain performance level?
- What types of information were collected, how was information recorded, where did information "go," and what types of decisions did information influence?
- Describe the actual performance of BDSA in comparison to your planned response: what worked, what didn't, what would you change?

The "Blue Sky" question: what would an ideal BDSA program "look like"?

- Based on your experience, what would an ideal BDSA program "look like?"
- What are the strengths and challenges with your current BDSA program?
- What changes are you currently making in BDSA processes and infrastructure?
- What changes would you like to make? What keeps you from making these changes?
- What advice would you give us regarding development of a BDSA process for the British Columbia context?

Research Personnel

Principal Investigators

- Dr. Ron Bowles, Associate Dean, Centre for Applied Research, JIBC (primary contact)
- Pete Learoyd, Program Director, Emergency Management Division, JIBC
- Steven Bibby, BC Housing
- Peter Mitchell, Association of Professional Engineers and Geoscientists of BC
- Paul Becker, Architectural Institute of BC
- Robyn Fenton, Architectural Institute of BC
- Marguerite Laquinte Francis, Architectural Institute of BC

Researcher and Research Project Manager

- Dawn Ursuliak, Justice Institute of BC

Research Design and Methodology

Approach and Methodology

This mixed methods study consists of three phases over approximately 18 months.

Phase 1: Needs Analysis, employing five concurrent data collection streams:

- Literature review
- Stakeholder Workshop
- Key Informant Interviews
- Visit to Exemplar Site
- Consultation with Expert Working Group members

Phase 2: Analysis and Synthesis using content analysis and thematic analysis to develop a draft framework, process, and tools

Phase 3: Stakeholder Validation, through consultation and a stakeholder validation workshop

Site

The primary site for this research will be the Justice Institute of British Columbia. Additional team meetings may occur at partners' corporate locations. In addition, data will be gathered through interviews (both face-to-face and via tele/video conference) and a site visit (currently scheduled for Christchurch, Wellington, and Auckland, New Zealand).

Participants

Four sets of participants will be engaged in this study:

Expert Working Group, consisting of approximately 12 national and international experts with insight and experience in the development, delivery, and/or research into building damage assessment. These participants will be purposively selected with the goal of engaging recognized experts with a history of publication, operational experts from exemplar systems, both locally and internationally, and key stakeholders in BC's emergency management community who have insight and responsibility for conducting building damage safety assessment after an emergency.

Broad Stakeholder Group, consisting of up to 20 participants recruited from BC local authorities, critical infrastructure organizations, provincial and federal government agencies. Participants will be purposively selected, using convenience and snowball strategies. An initial list of potential participants (both individuals and organizations) will be developed by the research team, seeking individuals known to background, expertise, and interest in emergency management and building damage safety assessment or who hold positions involving damage safety assessment in key organizations and stakeholder groups. In addition, the research team will engage personal and professional contacts within key stakeholder organizations to identify other potential participants (snowball strategy). Potential participants will be contacted via email and given information about the study and invited to participate (convenience strategy). In addition, these potential participants will be asked for names of additional potential members. The research team will continue to recruit until the Stakeholder Group membership covers key stakeholders in BC emergency management and damage safety assessment.

Site Visit Group, consisting of an unknown number of personnel encountered when the research team visits an exemplar site. Participants will be recruited by key organizations involved in the exemplar program.

The research team will recruit up to 12 key informants to engage in in-depth semi-structured interviews. The goal of these interviews will be to fill in gaps from the literature review, stakeholder workshop, and site visit, and the explore in greater depth initial findings from data collection. We anticipate that the key informants will be drawn from the Expert Working Group, Stakeholder group, or participants met on the Exemplar Site Visit, although some participants may be identified from outside these groups.

Inclusion/Exclusion

There are no a priori exclusion criteria for participants.

Inclusion criteria include personnel who have interest, expertise, experience and/or insight into emergency management with a particular focus on building damage safety assessment.

Recruitment

Members of the Expert Working Group and Stakeholder Groups will be contacted informally by email. Those that express an interest in participation will receive an introductory information letter. The research team will identify one or more lead organizations in the site visit to assist with recruitment of participants. An information letter will be sent to the assisting organizations which will be forwarded to potential participants. All participants will receive an information letter and informed consent form at the beginning of their interactions with the research team.

Data Collection

The study will collect several forms of data:

- Text and images from existing professional, academic, and grey literature
- Audio recordings, and subsequent transcripts of interviews, workshops, presentations, and other interactions with the research team
- Field notes, both handwritten and typed, gathered by researchers at interviews, workshops, presentations, and other interactions with the research team
- Hard copy artifacts and photos of flip charts, whiteboard/blackboard notes and activities from interviews, workshops, presentations and other interactions with the research team
- Physical artifacts including texts, manuals, placards from exemplar damage safety assessment programs

Data Collection procedures

Initial data on existing BDSA procedures and case examples will be gathered from a review of relevant academic, professional, and gray literature. This data will populate a template based on the research questions. The first table, developed using an emergent strategy, will develop key characteristics and elements of damage safety assessment processes. At least four existing BDSA programs will be analysed using this structure. The second table consolidates consistent data from at least 3 case studies of BDSA in practice. Analysis will identify common elements and procedures, as well as gaps in existing literature describing BDSA. Both content and thematic analysis will be employed with case study data to identify best practices, gaps, strengths, and challenges with existing systems.

The Stakeholder Workshop will include participants from the Expert Working Group and from Stakeholders in BC's emergency management and BDSA environment. The workshop will consist of a series of experiential activities including scenarios, group discussion, focused question and answer sessions, presentations from experts, group activities, and debriefings. Activities directed towards the Expert Working Group will focus on uncovering additional data to supplement findings from the literature review and solicitation of advice on adaptation of BDSA procedures to the BC context. Activities focused on the Stakeholder group will focus on development of common terminology, understandings of core concepts related to BDSA and emergency management more broadly, gaining an understanding of the operational context and BDSA needs and expectations of different user groups (e.g., Local Authorities, Critical Infrastructure organizations, responder agencies, professional associations). Analysis will focus on further extending and developing an understanding of how BDSA procedures, tools, and processes can best be established within a BC context.

The site visit will consist of a series of formal and informal presentations from both the research team and the exemplar site, focused "workshop" sessions where the research team will employ interactive sessions to obtain specific information related to the research questions, one-on-one discussions, and question and answer sessions. This data will be analyzed using content and thematic analysis strategies with a particular focus on implementation of BDSA procedures, best practices, and suggestions for adaptation.

Semi-structured interviews with key informants will supplement and extend the data gathered through the literature review and Stakeholder Workshop. While the Research Questions will form the foundation of the interview, the interviews will employ an emergent strategy with the goal of filling specific gaps and extending findings.

Confidentiality

The researchers do not anticipate a need for anonymity of data. The research questions focus on organizational structures, procedures, tools, and resources, primarily through information sources that are publically available. While individual participants will be asked about their experiences in performing BDSA, the focus, again, is on characterizing and evaluating the effectiveness of BDSA processes, not on personal experiences or personal opinions.

However, the researchers will employ strategies to ensure confidentiality, such as de-identifying data at collection. Participants will only be identified by pseudonym or code, and comments and quotes will not be identified with specific participants. In instances where quotes or data might be attributable to specific individuals (for example, quotes from a manager of a civil defence organization from the site visit), researchers will provide those individuals the opportunity to review, and if desired, ask that the quotes be removed from the report or publication.

Disclosure

The researchers do not anticipate the collection of any data that the researchers might be legally required to disclose.

Participant Review

Initial research reports will be posted online and available for participant review and comment prior to completion of the study.

Data Linking and Secondary Use

The researchers do not anticipate secondary use of data or data linking from this study.

Risks and Benefits

Individuals will not directly benefit from this research. However, the findings of the study may result in recommendations or suggestions for practice that may inform participants' professional practice.

The findings in this study will directly benefit those in British Columbia who are impacted by disaster. The findings will inform the development and implementation of building damage safety procedures that have the goal of effectively assessing buildings damaged in a disaster and allowing people and businesses to more quickly reoccupy their buildings.

This research will inform BC practice directly and contribute to national and international dialogue and practice on building damage safety assessment and emergency management more broadly.

Improving building damage safety assessment procedures may have social, psychosocial, economic, and life safety impact for communities suffering a disaster.

The researchers do not anticipate social, behavioural, psychological, economic harm to participants. The researchers do not anticipate any potential injury to reputation or privacy nor potential breach of law.

Analysis and Synthesis

The research team will employ a concurrent and iterative process of data collection, analysis, and synthesis with the goal of developing and continuing to enrich its understanding of BDSA processes and drafting a framework, tools, and processes for BC Building Damage Safety Assessment.

The research questions form a basis for analysing both existing BDSA programs and their use in practice. A process of content analysis and thematic analysis will be used to identify and extract relevant data. Data from the literature review, site visit, stakeholder workshop, and interviews will be used to populate a template based on the research questions. Thematic analysis will be used to identify best practices, strengths, challenges, factors to consider in adaptation to the BC context.

Synthesis will involve multiple meetings of the research team to develop an overall concept of the elements in the framework and to determine the desired level of depth or detail for resources and tools. Development will be iterative, following a “rapid prototyping” approach, with initial specification of high level outputs, which are reviewed with stakeholders and users and refined towards final form.

A draft set of deliverables will be presented and/or piloted with a stakeholder group in a workshop in 2018, from which recommendations will guide refinement of the final project outputs.

Appendix 3: Ethics Certificate

JUSTICE INSTITUTE of BRITISH COLUMBIA

NOTICE OF APPROVAL – ETHICAL REVIEW

Contact Person & Position	Institution	Protocol #:
Ron Bowles, Associate Dean	Justice Institute of BC	JIBCER-2017-08-BDSA

Student or Co-Investigators & Position: Pete Learoyd, Steven Bibby, Peter Mitchell, Paul Becker, Robyn Fenton, Marguerite Laquinte Francis

Title of Project: *BC Building Damage Safety Assessment Research Project*

Sponsoring/Funding Agency: Canadian Safety & Security Program, Department of National Defence.

Institution(s) where research activities will be carried out: JIBC

Approval Date:	Term/Year:
May 29, 2017	May 28, 2018

Certification: The above named project has been reviewed by the Research Ethics Board and has been approved as described or has been approved subject to the following modifications.

Darren Blackburn, Chair, JIBC Research Ethics Board

Note: This Certificate of Approval is valid for the above term provided there is no change in the procedures or criteria given.

Appendix 4: Literature Review Data

The Literature Review generated a series of data tables and case studies:

New Zealand

Appendix 4.1: New Zealand Article Review Data Extraction

Appendix 4.2: New Zealand BDSA Processes (2010/11 and 2014)

Appendix 4.3: New Zealand Case Study

Italy

Appendix 4.4: Italy Article Review Data Extraction

Appendix 4.5: Italy Zealand BDSA Processes (2010/11 and 2014)

Appendix 4.6: Italy Zealand Case Study

Japan

Appendix 4.7: Japan Article Review Data Extraction

Appendix 4.8: Japan BDSA Processes (2010/11 and 2014)

ATC

Appendix 4.9: ATC 20 and ATC 20-2

Appendix 4.1: New Zealand Article Review Data Extraction

This appendix provides an annotated list of key and useful documents uncovered in the literature review. Many of these documents provide similar information, though sometimes from different perspectives. Due to saturation of themes, not all documents are fully reviewed. Note that many of the documents reference each other and there is substantial overlap, particularly in regards to case history, BDSA procedures, issues, and recommendations. The articles listed here as KEY or USEFUL should be further assessed as the project moves from data collection to analysis and synthesis.

Readers are directed to the following KEY Documents as essential reading on the Canterbury Earthquakes:

- Canterbury Earthquakes Royal Commission (2011). Discussion paper: Building management after earthquakes. CERC Christchurch, NZ.
- New Zealand Society for Earthquake Engineering. (2012). *Building Management After Earthquakes: Submission to Canterbury Earthquakes Royal Commission*. Wellington, NZ: NZSEE.
- Gallagher, R., Lizundia, B., & Barnes, J. C. (2011). Building Safety Evaluation after the February 22, 2011 Christchurch, New Zealand Earthquake: Observations by the ATC Reconnaissance Team. Redwood City, CA: Applied Technology Council.

For Current Procedures:

- Ministry of Business, Innovation, and Employment. (2014). *Field Guide: Rapid Post Disaster Buildings Usability Assessment – Earthquakes.* Wellington, NZ: MBIE.
- Ministry of Business, Innovation, and Employment. (2014). *Field Guide: Rapid Post Disaster Buildings Usability Assessment – Flooding.* Wellington, NZ: MBIE.

Citation	Canterbury Earthquakes Royal Commission Document Library for Building Assessments http://canterbury.royalcommission.govt.nz/document-library?SearchView&Query=(Field+Subjects=%22Building+assessments+after+earthquakes%22)&Subject=Building+assessments+after+earthquakes	

Inline Ref	CERC Document Library	
Description	Documents from the Canterbury Earthquakes Royal Commission related to Building Damage Assessment.	
Informs	All aspects	
Commentary	Comprehensive set of documents that explores all facets of the Canterbury Earthquakes. Many of the documents listed in this review are taken from the site. Note that there are many documents that are not reviewed, even though there is relevance due to saturation – many of the reports reference each other, particularly in regards to case history, BDSA procedures, issues, and recommendations.	
Status	KEY	KEY USEFUL LIMITED NOT USEFUL

Citation	Canterbury Earthquakes Royal Commission (2011). Discussion paper: Building management after earthquakes. CERC Christchurch, NZ.	
Inline Ref	CERC 0004.01	
Description	Discussion paper exploring “implementation and effectiveness of the building management process used after the 4 September and 26 December 2010 earthquakes.” (p. 1). The intent of the paper was to generate discussion, identify lessons, and present some options for addressing issues raised in the paper.	
Informs	BDSA processes generally NZ BDSA during CCC incidents Recommendations for changes to BDSA.	
Commentary	This is a key document for understanding BDSA in the NZ context. The source has a substantial amount of core content, both on process, case, and recommendations. The recommendations are a KEY RESOURCE for the BC BDSA project.	
Status	KEY	KEY

		USEFUL LIMITED NOT USEFUL

Citation	New Zealand Society for Earthquake Engineering. (2012). *Building Management After Earthquakes: Submission to Canterbury Earthquakes Royal Commission*. Wellington, NZ: NZSEE.	
Inline Ref	NZSEE 2012	
Description	Submission of the NZSEE to the Royal Commission. p. 2: This submission is focussed largely on item b. above, i.e. the assessment of post earthquake building vulnerability: b. The vulnerability to damage of the buildings in the affected region may have been increased by earthquake effects,	
Informs	Case Understanding decision-making rationale	
Commentary	This is a key document. Many of the issues and recommendations are documented elsewhere. The discussion paper from p. 8 on discusses potential changes and rationale and is particularly useful for the next phases of this project.	
Status	KEY	KEY USEFUL LIMITED NOT USEFUL

Citation	Wilkinson, S., Grant, D., Williams, E., Paganoni, S., Fraser, S., Boon, D., Mason, A., & Free, M. (2013). Observations and implications of damage from the magnitude M_W 6.3 Christchurch,	

	New Zealand earthquake of 22 February, 2011. *Bulletin of Earthquake Engineering, 23*(11). 107-140.	
Inline Ref	Wilkinson	
Description	Report of a reconnaissance team from UK-based Earthquake Engineering Field Investigation Team over 5 days following the 22 February 2011 incident. Article provides limited information on the case itself or BDSA procedures. Good discussion on the types of damage associated with specific types of buildings.	
Informs	Building types taxonomy Examples of damage associated with specific types of buildings.	
Commentary		
Status	LIMITED Although good background for damage and types of buildings.	KEY USEFUL LIMITED NOT USEFUL
	Responses to the Independent Review to the response to the Canterbury earthquake, 4 September, 2010.	

Citation	Gallagher, R., Lizundia, B., & Barnes, J. C. (2011). Building Safety Evaluation after the February 22, 2011 Christchurch, New Zealand Earthquake: Observations by the ATC Reconnaissance Team. Redwood City, CA: Applied Technology Council.	
Inline Ref	Gallagher et al. 2011	
Description	The Applied Technology Council (ATC) sent a small reconnaissance team to Christchurch, New Zealand to observe the building safety evaluation process following the Magnitude 6.2 February 22, 2011 earthquake.This report summarizes the reconnaissance team's observations, findings, and recommendations regarding postearthquake building safety evaluation. P. 1	
Informs	Background on case Comparison of programs BDSA processes Indicator buildings Examples of building damage Recommendations	
Commentary	Excellent comparison of then NZ procedures in comparison with ATC 20. Good discussion on BDSA processes. Excellent discussion on use of indicator buildings.	
Status	KEY Multiple fronts: Case BDSA Indicator buildings Recommendations	KEY USEFUL LIMITED NOT USEFUL

Citation	Ministry of Business, Innovation, and Employment. (2014). *Field Guide: Rapid Post Disaster Buildings Usability Assessment – Earthquakes.* Wellington, NZ: MBIE.	

Inline Ref	MBIE, 2014a	
Description	This guide replaces the document 'Building Safety Evaluation During a State of Emergency', published by the New Zealand Society for Earthquake Engineering (NZSEE) in August 2009. The experiences from the 2007 Gisborne earthquake, 2009 Padang earthquake, and 2010-2011 Canterbury earthquake sequence have also greatly assisted in updating this document.	
Informs	BDSA Information Flow Specific assessments	
Commentary	Key document. This is the revised version of NZ procedures based on the Canterbury experience. The level of detail is very useful and should be a good model for user-level stakeholders in the BC framework.	
Status	KEY	KEY USEFUL LIMITED NOT USEFUL

Citation	Ministry of Business, Innovation, and Employment. (2014). *Field Guide: Rapid Post Disaster Buildings Usability Assessment – Flooding.* Wellington, NZ: MBIE.	
Inline Ref	MBIE, 2014b	
Description	This Field Guide has been produced to assist building control officials, engineers, architects, property managers and other building professionals to carry out Rapid Building Usability Assessments during a State of Emergency. At the discretion of a territorial authority (TA) the Field Guide may be used outside a State of Emergency. This Field Guide is one of a suite of documents developed to promote a nationally consistent approach to rapid building usability assessments after the recommendations of the Canterbury Earthquakes Royal Commission.	
Informs	BDSA Information Flow Specific assessments	
Commentary	Key document. Companion to Earthquake guide – analyze for adaptation to flooding context.	
Status	KEY	KEY USEFUL LIMITED NOT USEFUL

Citation	McLean, I., Oughton, D., Ellis, S., Wakelin, B., & Rubin, C. B. (2012). *Review of the Civil Defence Emergency Management Response to the 22 February Canterbury Earthquake.* Wellington, NZ: Civil Defence and Emergency Management.	
Inline Ref		
Description	This review deals with the Civil Defence Emergency Management (CDEM) Response to the 22 February 2011 Canterbury earthquake, from the date of the earthquake until 30 April 2011. On that date the response phase officially ended and recovery process was taken over by the Canterbury Earthquake Recovery Authority (CERA). The purpose of the review is: _ from an emergency management perspective identify the practices that should be reinforced and identify the processes and policies that warrant improvements. P. 1	

6.9.1e TECHNICAL REPORT
APPENDIX 4.1: NEW ZEALAND ARTICLE REVIEW DATA EXTRACTION

Informs	Narrative of the event from a political and organizational perspective. Good discussion on interplay between stakeholders.	
Commentary	There is a lot of background in here. The recommendations are key, and there is lots of information on the decision-making and organizational processes involved in operationalizing BDSA. The list of documents on p. 133 requires follow up. The list on p. 134 is a succinct summary of challenges from the NZSSE.	
Status	KEY p. 134, p. 136 – number of teams, personnel 138 - recommendations	KEY USEFUL LIMITED NOT USEFUL

Citation	GEN.MCDEM.0004	
Inline Ref	Each document referred to separately.	
Description	Package of documents that appear to respond to the independent review.	
Informs		
Commentary		
Status		KEY USEFUL LIMITED NOT USEFUL
Citation	Middleton, D. & Westlake, R. (2011). Independent Review of the response to the Canterbury earthquake, 4 September, 2010. Wellington, NZ: Ministry of Civil Defence & Emergency Management.	
Inline Ref	GEN.MCDEM.0004.32 Middleton & Westlake (2011).	
Description	Review of CDEM response to initial Sept earthquake. Note that report was not completed as review overtaken by subsequent aftershocks and events.	
Informs		
Commentary	Review itself has useful information, but not a lot that is new. Good description of response from CDEM perspective. Recommendations may be useful.	
Status	USEFUL	KEY USEFUL LIMITED NOT USEFUL
Citation	Canterbury District Health Board (2011). Canterbury Health System response to the independent review of the response to the Canterbury Earthquake, 4 September, 2010. Wellington, NZ: Canterbury District Health Board.	
Inline Ref	GEN.MCDEM.0004.11 CDHB 2011	
Description	Report from BDHB in response to the independent report. Responds to particular elements of the initial report.	
Informs		
Commentary	Some information from perspective of CI – in this case health. Some information on multiple EOCs.	

	Some information on information flow Some information on managing volunteers (need to). Recommendations are useful Section on information pp. 50 - is USEFUL	
Status	LIMITED for general information Recommendations are USEFUL Information flow is USEFUL	KEY USEFUL LIMITED NOT USEFUL

Citation	Baird, A., Palermo, A., & Pampanin, S. (2011). Facade damage assessment of multi-storey buildings in the 2011 Christchurch earthquake. *Bulletin of the New Zealand Society for earthquake engineering*, *44*(4), 368-376.	
Inline Ref	Baird et al. 2011	
Description	This paper presents the damage assessment of the façade systems of these RC buildings. A survey of 173 RC buildings in the Christchurch CBD is conducted here, focusing on the damage to the façade systems of the buildings.	
Informs	Types of buildings Operational performance level	
Commentary	Article deals with specific type of damage to specific structures in reinforced concrete buildings and is of limited value overall. However, there is some good general information on types of damage with reinforced concrete buildings. Section on operational performance level as a taxonomy of interest.	
Status	USEFUL	KEY USEFUL LIMITED NOT USEFUL

Citation	Lochhead, I. (2011). Christchurch architecture and the earthquakes of 4 September 2010 and 22 February 2011. *Fabrications*, *20*(1), 120-127.	
Inline Ref	Lochhead 2011	
Description		
Informs	N/A	
Commentary	Good description of types of buildings in Christchurch and damage to specific buildings. However, very little that is directly related to BDSA. Good narrative of the earthquake events.	
Status	NOT USEFUL	KEY USEFUL LIMITED NOT USEFUL

APPENDIX 4.1: NEW ZEALAND ARTICLE REVIEW DATA EXTRACTION

Citation	Palermo, A., Wotherspoon, L., Hogan, L., Le Heux, M., & Camnasio, E. (2012). Seismic performance of concrete bridges during Canterbury earthquakes. *Structural Concrete*, *13*(1), 14-26.	
Inline Ref	Palemo et al 2012	
Description	The authors aim to give a detailed overview of the damage assessment and seismic performance of the Canterbury bridges during these two earthquakes, emphasizing unexpected issues that are still not properly detailed in New Zealand and overseas standards.	
Informs	N/A	
Commentary	Background information on events, but focused entirely on bridges. Very little of use to BDSA.	
Status	NOT USEFUL	KEY USEFUL LIMITED NOT USEFUL

Citation	Kam, W. Y., Pampanin, S., & Elwood, K. (2011). Seismic performance of reinforced concrete buildings in the 22 February Christchurch (Lyttleton) earthquake.	
Inline Ref	Kam et al 2011	
Description	This paper describes observations of damage to reinforced concrete buildings from the September 2010 Darfield (Canterbury) earthquakes. Data was collated from first-hand earthquake reconnaissance observations by the authors, post-earthquake surveys, and communications and meetings with structural engineers in Christchurch. The paper discusses the general performance of several reinforced concrete building classes: pre-1976 low-rise, pre-1976 medium rise, modern low- and mid-rise, modern high-rise, industrial tilt-up buildings, advanced seismic systems and ground-failure induced damaged and retrofitted RC buildings.	
Informs	Types of buildings damage to specific types of buildings	
Commentary	May be useful for taxonomy of building types and examples of types of damage to specific buildings.	
Status	NOT USEFUL for BDSA MAY BE USEFUL for analysis of building types, damage to specific types of buildings, etc.	KEY USEFUL LIMITED NOT USEFUL

Citation	Lizundia, B., Hortacsu, A., & Gallagher, R. (2017) Improvements in Postearthquake Building Safety Evaluations: Lessons Learned From Recent Earthquakes	
Inline Ref	Lizundia et al. 2017	
Description	This paper will reflect on lessons learned during recent development exercises, such as the development of an adaptation of the ATC-20-1 methodology for Bhutan which considered the country's vernacular buildings, made adjustments for its cultural and governmental context, and provided an extensive set of images of varying degrees and types of building damage with the recommended posting category.	
Informs	Comparison of systems	
Commentary	NOTE ANALYZED ONLY FOR NZ CONTENT - will be listed again in comparison articles section. Very little information included and nothing new or different.	
Status	LIMITED in this context – very little information included.	KEY USEFUL LIMITED NOT USEFUL

Appendix 4.2: New Zealand BDSA Processes

This section contains key data extracted from documents describing both the 2014 NZ Rapid Post Disaster Building Usability Assessment process and the Building Damage Assessment process in place during the 2010/2011 Canterbury Earthquakes.

Appendix 4.2.1: New Zealand Building Damage Safety Assessment Process 2010

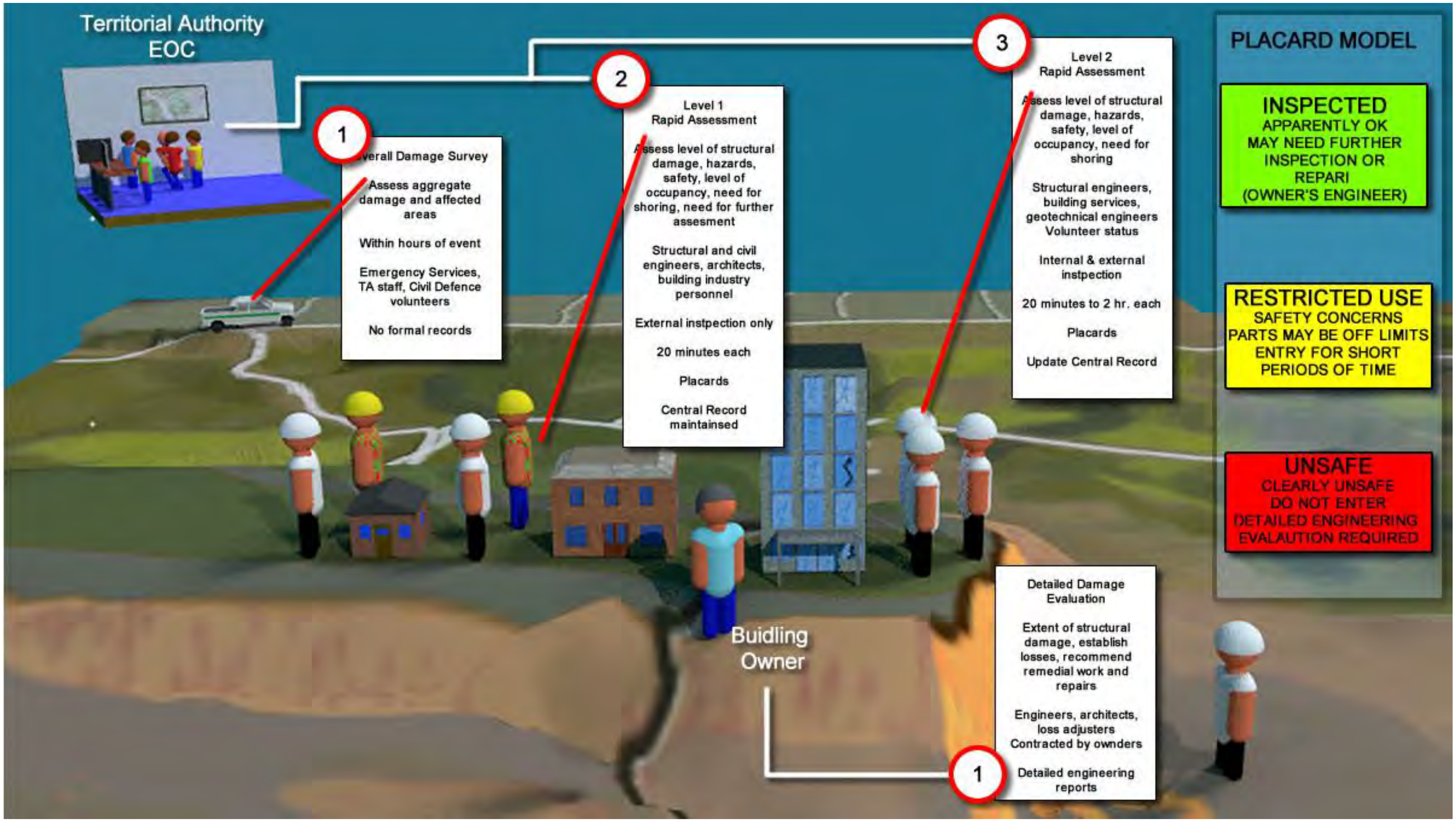


Figure A1. New Zealand DSA Process, 2010.

6.9.1e TECHNICAL REPORT
APPENDIX 4.2.1: NEW ZEALAND BDSA PROCESSES 2010

DSA Overview

RQ #	Topic	Comments	References
AB_001	Elements		
AF_001	Overall Goal	The main aim of New Zealand's building safety evaluation process is to ensure public safety following a disaster.	CERC 0004.1, p. 6
Af_007	Overall Authority	Authority of a Civil Defence Local Controller, under local or national state of emergency	CERC 0004.1, p. 6
AF_008	Legal Basis	Civil Defence and Emergency Management Act, 2002	CERC 0004.1, p. 6
AF_010	General Liability		
AF_003	Types of BDSA Assessment	Overall Damage Survey Rapid Assessment, Level 1. Rapid Assessment, Level 2. Detailed Engineering	CERN 0004.1 p. 7
AF_012	Building Taxonomies	None Described	
AF_012b	Specific Assessments for Building Types	None Described	
AF_007a	Relationship of various assessments		
AF_013	Type of Placard System		
AF_014	Placard Colours	Green Yellow Red	CERC 0004.1, p. 8
AF_015	Potential Outcomes	Green – Inspected; apparently okay Yellow – Restricted Use; Safety concerns, parts may be off limits; entry for short periods of time only Red – Unsafe; Clearly unsafe; do not enter; Engineering Evaluation required before any use.	CERC 0004.1, p. 8
AF_016	Changing Placards	During state of emergency, placards/status can only be changed by civil defence and emergency management. After the state of emergency, only local authorities can change placards.	CERC 0004.1 p. 10
AF_016	Removing Placards	Cannot be removed during State of Emergency; may be re-classified After State of Emergency, become Warning Notices, per Building Act 2004. Can only be removed by person authorised by Territorial Authority.	CERC 0004.1 p. 10

6.9.1e TECHNICAL REPORT
APPENDIX 4.2.1: NEW ZEALAND BDSA PROCESSES 2010

RQ #	Topic	Comments	References
AF_018 – AF_024	Reporting and Information	All assessment reports must be entered into a building register, which may be computer-based or paper-based (varies by TA). Completed forms are given to TA.	CERC 0004.1 p. 10
AF_017	Other markings		

6.9.1e TECHNICAL REPORT
APPENDIX 4.2.1: NEW ZEALAND BDSA PROCESSES 2010

Personnel

RQ #	Topic	Comments	References
		Personnel	
AU_001	Types of Personnel	Note Process above. Most comprehensive description of personnel found yet. • Emergency services and TA personnel involved in Overall Damage Survey. • Structural and civil engineers along with other personnel from building industry engage in Level 1 assessments as volunteers. • Structural and geotechnical engineers along with building services personnel engage in Level 2 assessments as volunteers. • Engineers, architects, and loss adjusters are engaged in Detailed Engineering Evaluation.	CERN 0004.1 p. 7

RQ #	Topic	Comments	References
	Category	Engineer	
AU_004	Professional Certification		
AU_007	Pre-Event Training		
AU_011	JIT/Event Preparation		
AU_012	Relationship		
AU_013	Liability		
AU_014	Capabilities		
AU_015	Types of Assessments performed		

	Category	Building officials	
AU_004	Professional Certification		
AU_007	Pre-Event Training		
AU_011	JIT/Event Preparation		
AU_012	Relationship	1.	
AU_013	Liability		

AU_014	Capabilities		
AU_015	Types of Assessments performed		

Building Damage Assessment

RQ #	Topic	Comments	References
	BDSA Type:	**Area Assessment, Windshield Assessment**	
	Local Name	**Overall Damage Survey**	
AG_001	Goal	Assess aggregate damage and identify affected areas. "…quick stocktake of the extent of the damage caused by the disaster." P.8	CERC 0004.1, p. 7
AG_003	Description	Emphasis on extent of damage, areas of high impact, identifying rescue tasks, identifying areas of priority for rapid assessment, estimating manpower and skills base needs, etc.	CERC 0004.1, p. 7
AG_015	Types of Buildings Teams Can Assess	Area assessment	CERC 0004.1, p. 7
AG_037	Legal Authority	Emergency service action plans, territorial authorities action plans	CERC 0004.1, p. 7
AG_005	Dispatched By	Civil Defence staff	CERC 0004.1, p. 7
AG_038	Implementation	Within hours after event	CERC 0004.1, p. 7
AG_006	Team Members	Emergency services, Territorial Authority staff, Civil Defence volunteers	CERC 0004.1, p. 7
AG_009	Team Size		
AG_010	How Selected		
AG_016	Interior/Exterior Check?	No entry to premises	CERC 0004.1, p. 7
AG_018	Assessment Outcomes	See description	CERC 0004.1, p. 7
AG_020	Info Gathering Tools	No formal records	CERC 0004.1, p. 7
AG_028	Assessment Time		
AG_030	Destination for Info Collected		

RQ #	Topic	Comments	References
	BDSA Type:	**Rapid Damage Assessment**	
	Local Name	**Rapid Assessment, Level 1.**	

6.9.1e TECHNICAL REPORT
APPENDIX 4.2.1: NEW ZEALAND BDSA PROCESSES 2010

RQ #	Topic	Comments	References
AG_001	Goal	Ascertain level of structural damage to individual buildings and note other hazards; assess building safety and decide appropriate level of occupancy; recommend security and shoring requirements.	CERC 0004.1, p. 7
AG_003	Description	Building safety assessment	CERC 0004.1, p. 7
AG_015	Legal Authority	During a period of a state of emergency declared under the Civil Defence Emergency Management Act.	CERC 0004.1, p. 7
AG_037	Types of Buildings Teams Can Assess	Up to 3 or 4 stories high	CERC 0004.1, p. 8
AG_005	Dispatched By	Controller, Building Safety Evaluation Leader	CERC 0004.1, p. 7
AG_038	Implementation		
AG_006	Team Members	Structural and Civil Engineers, architects, other personnel from building industry; note volunteer status	CERC 0004.1, p. 7
AG_009	Team Size		
AG_010	How Selected		
AG_016	Interior/Exterior Check?	Typically exterior only	CERC 0004.1, p. 7
AG_018	Assessment Outcomes	Placards posted on buildings, note made of sites requiring further inspection, unsafe areas cordoned off	CERC 0004.1, p. 7
AG_020	Info Gathering Tools	Formal system, not specified	CERC 0004.1, p. 7
AG_028	Type of Placard System		
AG_030	Assessment Time	10 – 20 minute	CERC 0004.1, p. 8
AG_030	Destination for Info Collected	Central record maintained	CERC 0004.1, p. 7

6.9.1e TECHNICAL REPORT
APPENDIX 4.2.1: NEW ZEALAND BDSA PROCESSES 2010

RQ #	Topic	Comments	References
	BDSA Type:	**Detailed Building Damage Assessment – Simple Buildings**	
	Local Name	**Rapid Building Usability Assessment, Level 2.**	
AG_001	Goal	Ascertain level of structural damage to individual buildings and note other hazards; assess building safety and decide appropriate level of occupancy; recommend security and shoring requirements.	CERC 0004.1, p. 7
AG_003	Description	Building safety assessment Typically for priority inspection of critical facilities (for situations where facilities operators do not have contract engineers) or where further information that raises concerns is received	CERC 0004.1, p. 7
AG_015	Types of Buildings Teams Can Assess	Larger and more complex buildings (more than 3 or 4 stories), along with critical facilities	CERC 0004.1, p. 7, 8
AG_037	Legal Authority	During a period of a state of emergency declared under the Civil Defence Emergency Management Act.	
AG_005	Dispatched By	Controller, Building Safety Evaluation Leader	CERC 0004.1, p. 7
AG_038	Implementation		
AG_006	Team Members	Structural Engineers, building services, and geotechnical engineers; note volunteer status	CERC 0004.1, p. 7
AG_009	Team Size		
AG_010	How Selected		
AG_016	Interior/Exterior Check?	Interior and exterior inspection, plus reference to available drawings. Calculations may not be envisioned.	CERC 0004.1, p. 7
AG_018	Assessment Outcomes	May result in revised placards, central records updated, unsafe areas cordoned off, urgent work recommendations	CERC 0004.1, p. 7
AG_020	Info Gathering Tools	Formal system, not specified	CERC 0004.1, p. 7
AG_028	Assessment Time	1 – 4 hours	CERC 0004.1, p. 8
AG_030	Destination for Info Collected		
		Central record maintained	CERC 0004.1, p. 7

6.9.1e TECHNICAL REPORT
APPENDIX 4.2.1: NEW ZEALAND BDSA PROCESSES 2010

RQ #	Topic	Comments	References
	BDSA Type:	**Engineering Assessment**	
	Local Name	**Detailed Engineering Evaluation**	CERC 0004.1, p. 7
AG_001	Goal	To determine the full scope of repairs and rebuilds, and resource requirements. Provides confidence in the remaining building stock to assist the recovery.	CERC 0004.1, p. 7
AG_003	Description	Detailed review and specification of repairs and/or strengthening required.	CERC 0004.1, p. 7
AG_015	Dispatched By	Building owners, insurance companies, Territorial Authorities.	CERC 0004.1, p. 7
AG_037	Implementation	Typically longer term, but may be immediate for critical structures.	CERC 0004.1, p. 7
AG_005	Team Members	Engineers, architects and loss adjusters.	CERC 0004.1, p. 7
AG_038	Team Size		
AG_006	How Selected	Contracted by building owners.	CERC 0004.1, p. 7
AG_009	Types of Buildings Teams Can Assess		
AG_010	Interior/Exterior Check?	• Detailed review of existing documentation • Evaluation of capacity • Identification of weaknesses • Observation of damage	CERC 0004.1, p. 7
AG_016	Assessment Outcomes	Ascertain extent of structural damage, establish losses for insurance purposes, and recommend remedial work to restore functionality and compliance with the Building Code.	CERC 0004.1, p. 7
AG_018	Info Gathering Tools	These evaluations are likely to involve review of construction documentation and the preparation of detailed engineering reports.	CERC 0004.1, p. 7

Appendix 4.2.2: New Zealand Building Damage Safety Assessment Process 2014

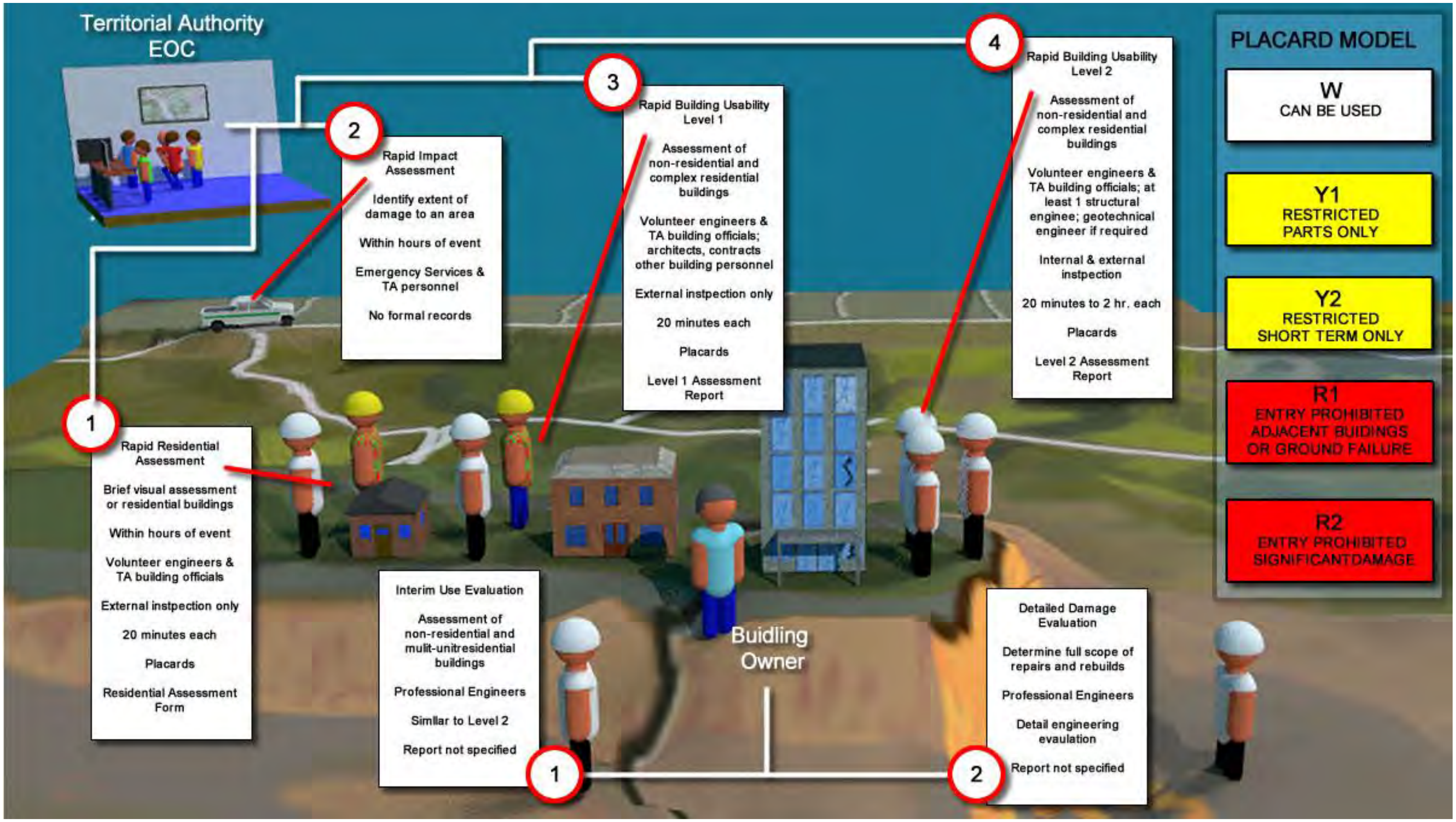


Figure A2. New Zealand DSA Process, 2014.

DSA Overview

RQ #	Topic	Comments	References
AB_001	Elements		
AF_001	Overall Goal	The objective of the rapid building assessment is to quickly establish the usability of buildings and associated infrastructure where functions may be compromised by a hazard event. Hazard events include earthquake, flood, landslide, rock-fall, volcanic eruption, storm surge, tsunami, explosion, or other event with life safety, residential or business consequences. The focus of the rapid building assessment process is on immediate public safety, not the provision of an engineering assessment service to building owners. Quantified assessment of building damage is necessary to determine reconstruction programmes and resource requirements for repair, and to assess how long recovery may take.	Field Guide 2014
Af_007	Overall Authority	Led by Territorial Authority (TA, similar to Local Authority) under control of a Civil Defence Emergency Management Controller (Local or Group Controller).	Field Guide 2014
AF_008	Legal Basis	Civil Defence Emergency Management Act 2002 (CDEM Act) and the associated regulation, the CDEM Plan, provide for TAs to issue and control the use of signs. In case no State of Emergency is declared, the Building Act 2004 allows authorised officers of a TA to enter premises to determine whether a building is dangerous, earthquake-prone, or insanitary.	Field Guide 2014
AF_010	General Liability	The CDEM Act provides protection from liability for any act or omission of the Crown, CDEM Groups (including officers, employees or members of those groups), or other persons, except in cases of bad faith or gross negligence.	Field Guide 2014
AF_003	Types of BDSA Assessment	Rapid Impact Assessment Residential Rapid Assessment Rapid Building Usability Assessment, Level 1. Rapid Building Usability Assessment, Level 2. Detailed Building Damage Assessment – Simple Buildings Detailed Building Damage Assessment – Complex Buildings	Field Guide 2014
AF_012	Building Taxonomies	Simple Residential Complex Residential Non-residential and complex residential buildings Essential Buildings	Field Guide 2014

APPENDIX 4.2.2 NEW ZEALAND BUILDING DAMAGE SAFETY ASSESSMENT PROCESS 2014

RQ #	Topic	Comments	References
AF_012b	Specific Assessments for Building Types	Timber framed structures Reinforced concrete or masonry wall construction Reinforced concrete frame construction Precast concrete tilt-up structures Suspended concrete floors Steel frame structures Unreinforced masonry (URM) structures	Field Guide 2014
AF_007a	Relationship of various assessments	Rapid Building Usability Assessments are undertaken by the territorial authorities to provide a rapid indication of the usability and safety of affected buildings and adjacent public spaces. Irrespective of the result and recommendations of the rapid building assessment, it is the building owner's responsibility to ensure that their building is safe before it is reoccupied. It is also the owner's responsibility to ensure that the building does not pose any danger to neighbouring buildings or public spaces.	Field Guide 2014
AF_013	Type of Placard System		
AF_014	Placard Colours	White Yellow Red	Field Guide 2014
AF_015	Potential Outcomes	W Can be used (white) Restricted access (yellow) Y1 Restricted access to parts of the building only Y2 Restricted access – short term use only Entry Prohibited (red) R1 Entry Prohibited – Risk from External Factors, e.g. adjacent buildings or ground failure R2 Entry Prohibited – Significant Damage	Field Guide 2014
AF_016	Changing Placards	Only by building assessor authorized by the Controller	Field Guide 2014
AF_016	Removing Placards	Cannot be removed during State of Emergency; may be re-classified After State of Emergency, become Warning Notices, per Building Act 2004. Can only be removed by person authorised by Territorial Authority.	Field Guide 2014
AF_018 – AF_024	Reporting and Information	All assessment reports must be entered into a building register, which may be computer-based or paper-based (varies by TA). Completed forms are given to TA.	Field Guide 2014
AF_017	Other markings	Urban Search and Rescue Markings	Field Guide 2014, p. 13

RQ #	Topic	Comments	References
		Collapsed or partly collapsed buildings may already have been marked by Urban Search and Rescue (USAR) teams. The marking would usually be located on the exterior of the collapsed structure near the point of entry that offers the best visibility. Consider these markings when deciding whether it is safe to enter a building. USAR markings are always orange spray paint. The marking consists of a 1 x 1 meter square box with the following details: *Inside the box:* • "Go" or "G" if deemed safe to enter; "No Go" or "NG" if it is deemed unsafe to enter • Team identification • Date and time start • Date and time finish. *Outside the box:* • Hazard information (top) • Missing persons (bottom) • Live victims rescued (left) • Dead victims extricated (right). When the USAR team has completed work on the structure to its capacity, a circle is drawn around the entire marking. After all work on the structure is completed and it is confirmed there are no more victims, a horizontal line is drawn through the entire marking.	

RQ #	Topic	Comments	References
		An example of a USAR marking is shown below:  *Figure 1: USAR marking*	Field Guide 2014. P. 14

Personnel

RQ #	Topic	Comments	References
		Personnel	
AU_001	Types of Personnel	Rapid Building Usability Assessments: • Professional Engineers • Building Officials Detailed (Engineering) Assessment: • Professional Engineers	Field Guide 2014

RQ #	Topic	Comments	References
	Category	**Engineer**	
AU_004	Professional Certification		
AU_007	Pre-Event Training		
AU_011	JIT/Event Preparation		
AU_012	Relationship	1. Each event has a Memorandum of Understanding for engineers such as the IPENZ "Memorandum of Understanding for Engineers Volunteering to Assist territorial authorities in a State of Emergency" 2. Professional Volunteer (Rapid Damage Assessment) 3. Hired by building owner or occupant (Detailed/Engineering Assessment)	Field Guide 2014
AU_013	Liability	Professional volunteers sign in on a list of assessors, to ensure that they are authorised to undertake Rapid Building Usability Assessments for a particular event. This protects their liability exposure.	Field Guide 2014
AU_014	Capabilities		Field Guide 2014
AU_015	Types of Assessments performed		Field Guide 2014

RQ #	Topic	Comments	References
	Category	Building officials	
AU_004	Professional Certification		
AU_007	Pre-Event Training		
AU_011	JIT/Event Preparation		

RQ #	Topic	Comments	References
AU_012	Relationship	2. Employed by TA (local authority) 3. Seconded to TA for a particular event	Field Guide 2014
AU_013	Liability	Professional volunteers sign in on a list of assessors, to ensure that they are authorised to undertake Rapid Building Assessments for a particular event. This protects their liability exposure.	Field Guide 2014
AU_014	Capabilities		Field Guide 2014
AU_015	Types of Assessments performed		Field Guide 2014

Building Damage Assessments

RQ #	Topic	Comments	References
	BDSA Type:	**Area Assessment, Windshield Assessment**	
	Local Name	**Rapid Impact Assessment**	Field Guide 2014
AG_001	Goal	To understand the overall impact and extent of affected areas.	Field Guide 2014
AG_003	Description	Brief drive-by or aerial assessment of overall damage to areas. Emphasis on identifying extent of damage, priorities for rescue, areas of high impact and resources required.	Field Guide 2014
AG_015	Types of Buildings Teams Can Assess	Area assessment, not of specific buildings.	
AG_037	Legal Authority	Leads to a decision on whether to declare a State of Emergency.	Field Guide 2014
AG_005	Dispatched By		
AG_038	Implementation	Undertaken within hours of the event by emergency services and the territorial authority.	Field Guide 2014
AG_006	Team Members		
AG_009	Team Size		
AG_010	How Selected		
AG_016	Interior/Exterior Check?		
AG_018	Assessment Outcomes		
AG_020	Info Gathering Tools	No formal records kept.	Field Guide 2014
AG_028	Assessment Time		
AG_030	Destination for Info Collected		

	BDSA Type:	**Rapid Damage Assessment**	
	Local Name	**Residential Rapid Assessment.**	Field Guide 2014
AG_001	Goal	To quickly assess the impact of damage observed on the continued use of a building or adjacent property. The emphasis is on public safety.	Field Guide 2014

		The objective of a rapid assessment is to assess the impact of damage observed on the continued use of a building or adjacent property.	
AG_003	Description	Brief visual assessments of damage to individual buildings.	Field Guide 2014
AG_015	Types of Buildings Teams Can Assess	Simple residential buildings.	Field Guide 2014
AG_037	Legal Authority	Carried out during a declared State of Emergency acting under the authority of the Civil Defence Controller.	Field Guide 2014
AG_005	Dispatched By	Building Assessment Manager (EOC)	Field Guide 2014
AG_038	Implementation		
AG_006	Team Members	Volunteer engineers and building officials	Field Guide 2014
AG_009	Team Size		
AG_010	How Selected		
AG_016	Interior/Exterior Check?	external inspection only; internal inspection (if required) may consist of looking through windows for internal damage.	Field Guide 2014
AG_018	Assessment Outcomes	See overview	
AG_020	Info Gathering Tools	formal records. Information Sheet (to occupant) Residential Assessment Report (to Territorial Authority) (p. 44) Photos	Field Guide 2014
AG_028	Assessment Time	Around 20 minutes each.	Field Guide 2014
AG_030	Destination for Info Collected	Discussion with building owner/occupant Provide Information Sheet	Field Guide 2014

RQ #	Topic	Comments	References
	BDSA Type:	**Rapid Damage Assessment**	
	Local Name	**Rapid Building Usability Assessment, Level 1.**	Field Guide 2014

6.9.1e TECHNICAL REPORT

APPENDIX 4.2.2 NEW ZEALAND BUILDING DAMAGE SAFETY ASSESSMENT PROCESS 2014

RQ #	Topic	Comments	References
AG_001	Goal	To quickly assess the impact of damage observed on the continued use of a building or adjacent property. The emphasis is on public safety. The objective of a rapid assessment is to assess the impact of damage observed on the continued use of a building or adjacent property.	Field Guide 2014
AG_003	Description	Brief visual assessments of damage to individual buildings.	Field Guide 2014
AG_015	Legal Authority	Carried out during a declared State of Emergency acting under the authority of the Civil Defence Controller.	
AG_037	Types of Buildings Teams Can Assess	Non-residential and complex residential buildings; buildings constructed using typical residential construction types.	
AG_005	Dispatched By	Building Assessment Manager (EOC)	
AG_038	Implementation		
AG_006	Team Members	Volunteer engineers and building officials building control officers, structural and civil engineers, architects, experienced building contractors and other suitable experienced building professionals.	Field Guide 2014
AG_009	Team Size		
AG_010	How Selected		
AG_016	Interior/Exterior Check?	external inspection only	Field Guide 2014
AG_018	Assessment Outcomes	See overview	
AG_020	Info Gathering Tools	formal records. Information Sheet (to occupant) Level 1 Assessment Report (to Territorial Authority) (p. 52) Photos	Field Guide 2014
AG_028	Type of Placard System	See overview	
AG_030	Assessment Time	Around 20 minutes each.	Field Guide 2014
AG_030	Destination for Info Collected	Discussion with building owner/occupant Provide Information Sheet	Field Guide 2014

6.9.1e TECHNICAL REPORT
APPENDIX 4.2.2 NEW ZEALAND BUILDING DAMAGE SAFETY ASSESSMENT PROCESS 2014

RQ #	Topic	Comments	References
	BDSA Type:	**Detailed Building Damage Assessment – Simple Buildings**	
	Local Name	**Rapid Building Usability Assessment, Level 2.**	Field Guide 2014
AG_001	Goal	To quickly assess the impact of damage observed on the continued use of a building or adjacent property. The emphasis is on public safety.	Field Guide 2014
AG_003	Description	Brief visual assessments of damage to individual buildings.	Field Guide 2014
AG_015	Types of Buildings Teams Can Assess	Non-residential and complex residential buildings; buildings with typical commercial construction details (unreinforced masonry walls, tilt-up panels, multi-storey buildings, and others) All essential facilities (hospitals, schools, police and fire stations) All buildings of 2 or more storeys and containing 3 or more household units Any other buildings where the Level 1 Rapid Assessment identifies the need for further and more specific inspection.	Field Guide 2014
AG_037	Legal Authority	Carried out during a declared State of Emergency by mostly volunteer engineers and building officials acting under the authority of the Civil Defence Controller.	Field Guide 2014
AG_005	Dispatched By	Building Assessment Manager (EOC)	Field Guide 2014
AG_038	Implementation		
AG_006	Team Members	Volunteer engineers and building officials (intro) At least one structural engineer, with input from geotechnical engineers where necessary.	Field Guide 2014
AG_009	Team Size		
AG_010	How Selected		
AG_016	Interior/Exterior Check?	Both external and internal inspection.	Field Guide 2014
AG_018	Assessment Outcomes	See overview	
AG_020	Info Gathering Tools	formal records. Information Sheet (to occupant) Level 2 Assessment Report (to Territorial Authority) (p. 58) Photos	Field Guide 2014
AG_028	Assessment Time	30 min to 2 hours each	

RQ #	Topic	Comments	References
AG_030	Destination for Info Collected		

RQ #	Topic	Comments	References
	BDSA Type:	**Detailed Building Damage Assessment – Complex Buildings?**	
	Local Name	**Interim Use Evaluation (IUE)**	Field Guide 2014
AG_001	Goal	To quickly assess the impact of damage observed on the continued use of a building or adjacent property. The emphasis is on public safety.	Field Guide 2014
AG_003	Description	Conducted either during or after a declared State of Emergency by engineers contracted by building owners or tenants.	Field Guide 2014
AG_015	Legal Authority	Unlike the Rapid Building Usability Assessment the IUE outcome does not have a legal status.	Field Guide 2014
AG_037	Dispatched By	Contracted by building owners or tenants.	Field Guide 2014
AG_005	Implementation		
AG_038	Team Members	Structural engineers, preferably Chartered Professional Engineers	Field Guide 2014
AG_006	Team Size	one or more	
AG_009	How Selected	Selected by building owner	
AG_010	Types of Buildings Teams Can Assess	Non-residential and multiunit residential buildings in greater Christchurch	Field Guide 2014
AG_016	Interior/Exterior Check?	Essentially similar to a Level 2 Assessment (both external and internal inspection), but the evaluator identifies and observes the vertical and lateral load-resisting systems.	Field Guide 2014
AG_018	Assessment Outcomes	See overview	
AG_020	Info Gathering Tools	formal records. Information Sheet (to occupant) Assessment Report (to Territorial Authority) (form not specified) Photos	
AG_028	Assessment Time		

RQ #	Topic	Comments	References
AG_030	Destination for Info Collected	Territorial Authority	

RQ #	Topic	Comments	References
	BDSA Type:	**Engineering Assessment**	
	Local Name	**Detailed Damage Evaluation (DDE)**	Field Guide 2014
AG_001	Goal	To determine the full scope of repairs and rebuilds, and resource requirements. Provides confidence in the remaining building stock to assist the recovery.	Field Guide 2014
AG_003	Description	Detailed review and specification of repairs and/or strengthening required.	Field Guide 2014
AG_015	Dispatched By	Contracted by building owners.	Field Guide 2014
AG_037	Implementation	Conducted as part of the recovery phase.	Field Guide 2014
AG_005	Team Members	Engineers	Field Guide 2014
AG_038	Team Size		
AG_006	How Selected	Contracted by building owners.	Field Guide 2014
AG_009	Types of Buildings Teams Can Assess		
AG_010	Interior/Exterior Check?	• Detailed review of existing documentation • Evaluation of capacity • Identification of weaknesses • Observation of damage	Field Guide 2014
AG_016	Assessment Outcomes	Specification of repairs and/or strengthening required.	Field Guide 2014
AG_018	Info Gathering Tools		

6.9.1e TECHNICAL REPORT
APPENDIX 4.2.2 NEW ZEALAND BUILDING DAMAGE SAFETY ASSESSMENT PROCESS 2014

Appendix 4.3: New Zealand Case Study: Christchurch Canterbury New Zealand Earthquakes 2010, 2011

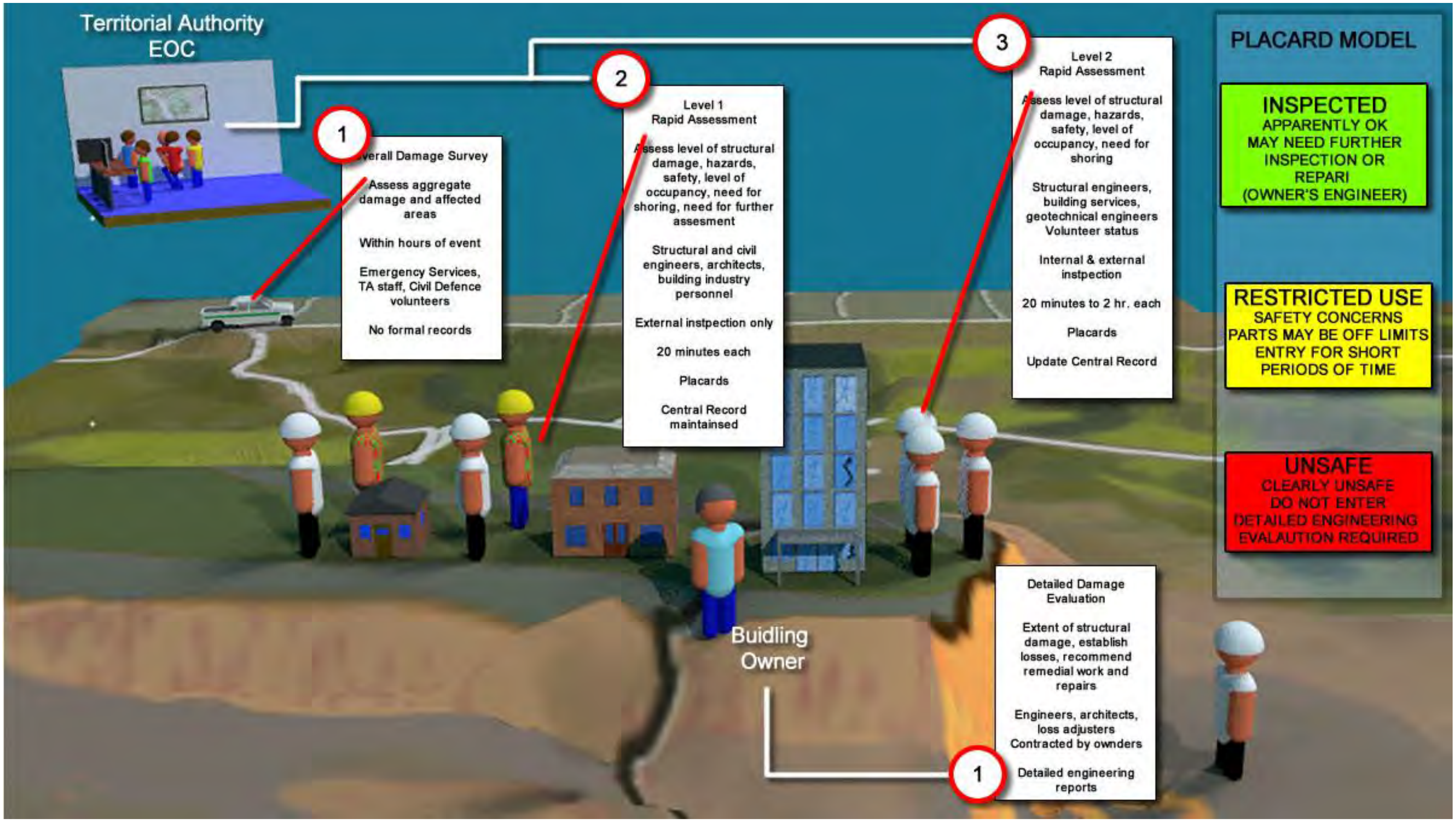


Figure A3. Case Study: Christchurch, 2010, 2011.

Case Background

RQ #	Topic	Comments	References
	Case Title	**New Zealand 2010, 2011 Earthquakes**	
		Introduction	
	Case Background	In 2010 and 2011, the area in and around Christchurch Canterbury New Zealand experienced a series of earthquakes and aftershocks, the most significant of which occurred on 4 September, 2010, 26 December 2010, and 22 February, 2011.	
	Location	Christchurch located on east coast of New Zealand's South Island Canterbury region At time, 390,000 population	Gallagher, p. 2
	Event	**Initial earthquake:** 0435 4 September, 2010 7.1 magnitude Epicentre 40 km West of Christchurch **Aftershocks:** 1030 26 December, 2010 4.7 magnitude Epicentre 1.8 km from Christchurch Cathedral 22 February, 2011 6.2 magnitude Epicentre 6km southwest of the Christchurch CBD 13 June, 2011 6.0 magnitude Near Sumner, southeast of the CBD	CERC 0004.1 Gallagher, p. 2

RQ #	Topic	Comments	References
	Extent & Type of Damage	Christchurch suffered significant damage to a large number of its buildings. The most damaging of the earthquakes was the 22 February event which seriously damaged most of the buildings in the Central Business District and resulted in 189 deaths (Gallahger)	
		Catastrophic damage was experienced in the Central Business District. Most older brick buildings there were severely damaged. A five-story and a six-story building collapsed with loss of life. More than 40 significant buildings were so badly damaged as to require demolition, including many high-rises. Large areas of the city experienced liquefaction, and over 5,000 homes in the liquefaction areas have been permanently abandoned, with the possibility of this number growing substantially.	Gallagher, p. 3
		The most damaging, and therefore most significant, of these was the Mw 6.3 event which occurred on the 22nd February 2011 at 12:51 (local time) and is the main topic of this paper. The close proximity of the epicentre to Christchurch and its shallow focus resulted in widespread structural damage, collapse of buildings, disruption to services and the loss of 182 lives and a further 164 serious injuries.	Wilkinson, p. 2.
		The team was told that of the approximately 4,000 buildings there, some 1,000 may be demolished.	Gallagher, p. 10
		At least 30 percent, and probably more, of the high-rise buildings in the CBD were seriously damaged. Two buildings collapsed outright during the February event.	Gallagher, p. 21
		The Christchurch earthquake of 22 February 2011 caused tragic deaths and injuries, severe damage to tens of thousands of homes and the devastation of the city central business district (CBD). It was an unprecedented challenge for civil defence emergency management in New Zealand.	McLean p.10
		Feb 22 event: The devastation of the CBD was extensive, with only about a quarter of buildings undamaged enough to be repairable.	McLean p. 13
	DSA Process	Initial Building Safety Assessments generally followed New Zealand Society for Earthquake Engineers guidelines. Each local authority expected to adapt to meet local circumstances. Building Safety Process, with three types of assessment: • Overall Damage Survey; area assessment; conducted by emergency services, Territorial Authority staff, Civil Defence volunteers. • Rapid Assessment Level 1; Level of damage and occupancy; conducted by structural and civil engineers, other personnel from building industry – note volunteer status; formal system exterior inspection, placards, central record, sites needing further investigation, unsafe areas cordoned off • Rapid Assessment Level 2: Level of damage and occupancy; conducted by structural engineers, building services, geotechnical engineers, - note	Adapted from CERC 0004.1 p. 7

RQ #	Topic	Comments	References
		volunteer status; formal system with exterior and interior inspection as well as reference drawings, revised placards, central records, cordon off unsafe areas, urgent work recommendations • Detailed Engineering Evaluation and Remedial Work: ascertain extent of structural damage, establish losses for insurance, recommend remedial work; engineers, architects, loss adjusters; meets insurance and restoration requirements under Building Act 2004.	
		The inspection of damaged buildings to determine their safety was a substantial task and was carried out well technically. Some improvements are required in organisation and in communications with owners and tenants. Better communications are also needed regarding demolition of buildings and for systems for access to the cordoned area.	McLean, p. 13
		Guidelines from NZSEE, adapted from ATC 20.	Wilkinson, p. 137
		The procedures used to evaluate building safety in Christchurch drew upon a document developed by the New Zealand Society for Earthquake Engineering (NZSEE, 2009). The original ATC-20 procedures (ATC, 1989a) were used as a basis for this document, but significant changes were made.	Gallagher, p. 3
		The basis of this building safety evaluation system is to visually identify damage that could compromise the pre-earthquake resistant capacity of the building structure. The building evaluation process is founded on the premise that if a building has not been severely damaged in the initial earthquake, it should be capable of surviving an aftershock or aftershocks without serious damage or collapse.	NZSEE, p. 3
	Goal	Focus on prioritizing buildings as unsafe and requiring further evaluation. Less emphasis on whether or not building can be reoccupied.	CERN 0004.1 p.
		Were buildings safe to enter?	Wilkinson, p. 137
		It is the Society's opinion that the process of managing the risk to buildings following an earthquake should be treated as a special case of the general and ongoing requirements for managing the earthquake risk to buildings. The risk assessment principles are the same, and the same options are available for treating the risk. The major difference is that the level of risk is higher than normal, and rapid decisions must be made to addresses these risks.	NZSEE, p. 2
	Placard System		
	Results	Results used to "make decisions on controlling traffic, cordons, safe traffic corridors, and to indicate the economic impact of the earthquake." P. 137	Wilkinson, p. 137
	Use of Personnel	Note Process above. Most comprehensive description of personnel found yet. • Emergency services and TA personnel involved in Overall Damage Survey.	CERN 0004.1 p. 7

RQ #	Topic	Comments	References
		• Structural and civil engineers along with other personnel from building industry engage in Level 1 assessments as volunteers. • Structural and geotechnical engineers along with building services personnel engage in Level 2 assessments as volunteers. • Engineers, architects, and loss adjusters are engaged in Detailed Engineering Evaluation.	
	Commentary	Analysis of the earthquakes that impacted Christchurch and area through 2010 and 2011 generated a substantial amount of documentary discussion on building assessment. The Canterbury Earthquakes Royal Commission's Discussion Paper (CERC 0004.1) lists seven documents it requested, another seven submissions directly related to building assessment, five private submissions, and eight further documents that mention building assessment.	
		Part I BDSA Framework	
	EM Overview		
	Legislative Authority		
	EM framework		
	Stakeholders & Relationships		
	<image>		
	Ownership & Sustainability	Three groups are mentioned throughout the documents: early procedures drafted by the New Zealand Society of Earthquake Engineers, Civil Defence, and Local/Territorial Authorities. The latest documents describing New Zealand building damage assessment are published in 2014 by the Ministry of Business, Innovation, and Employment. Note discussion on p. 21 on mandate and accountability for the overall framework. ***QUESTION: Who "owns" the overall BDSA process, and what are the formal and informal mechanisms for its maintenance?***	CERC 0004.1
		The building safety evaluation system is designed to rapidly assess the safety of buildings during an emergency and to inform owners, tenants and the public of their safety status by, among other methods, a building placard system. The New Zealand building safety evaluation system is based on California practice with further developments reflecting European practice and the experience of New Zealand building evaluation teams in Gisborne, Indonesia and elsewhere. The guidelines had been developed over 20 years by the New Zealand Society for Earthquake Engineering and in 2009 National	McLean, p. 134

RQ #	Topic	Comments	References
		Procedures134 were published with the support of the Department of Building and Housing.135 A revised draft of the guidelines had been prepared in July 2010 together with a draft Field Guide which included an induction module for _on the day_ operational briefing. These drafts had not been reviewed and signed off by the time of the 4 September 2010 earthquake.	
		Part II BDSA in Operation	
	Case		
	Operational Functioning:		
	• Who managed / administered process	Sept 2010 "Within an hour of the earthquake, Chirstchurch City Council, Waimakariri District Council and Selwyn District Council declared a local state of emergency for their area" (CERC 0004.1, p. 6). Local Authorities established their own EOCs, each run by a Local Controller. Local Controller was in charge of the response to the earthquake, including BSA.	CERC 0004.1
		26 Dec 2010 Aftershock Following the aftershock in Dec 2010, CCC chose not to declare a state of emergency as the event was manageable by emergency services, few residential buildings were impacted, and damage was localized. CCC adapted their process (as no formal state of emergency).	CERC 0004.1
		The Terms of Reference for this Review require examination of the management of building safety evaluations and the management of building demolitions and cordoned areas.130 Some of these matters were however dealt with in submissions to the Royal Commission and information from them is used in the preparation of this Review. Particular references include: ENG.NZSEE.0001: Building Safety Evaluation Following the Canterbury Earthquakes. New Zealand Society for Earthquake Engineering, September 2011131 EBG.CCC.0001: CCC Building Evaluation Team _ Processes used and lessons learned following the Darfield Earthquake of 4 September 2010. Sisirc/McNulty January 2011132 ENG.BRU.0001: Integrating Professional Engineering Within Emergency Management Planning and Response in New Zealand. Dave Brunsdon, January 2012133	Mc:Lean, p. 133
	• How were priorities established?	**3.6 High Priority Evaluation of Shopping Centers and Drug Stores** ATC-20 offers the advice to conduct safety evaluations of essential facilities first. Hospitals, police and fire stations, and emergency headquarters must be among the first buildings inspected. Officials in Christchurch added shopping centers and drug stores to the list of high priority inspections. It was felt that the public need for items such as food, diapers and	Gallagher, p. 23

RQ #	Topic	Comments	References
		medicines was important and that the best way to ensure supply was to inspect the buildings of these businesses and identify those that could be left open.	
	•	**3.8 Targeted Safety and Evaluation Teams** Another innovation was the creation of specialized task forces that were set up to address sections of the city or issues of the community. The task forces targeted the suburbs, shopping malls (to make food and necessities available to the public), the Central Business District, critical buildings (six or more stories), cordoning and access, and demolition. The teams were named after the community element that they targeted for safety assessment and clearance, as follows. • Operation Suburb • Operation Critical Buildings • Operation Shop • Operation Cordon and Access • Operation Demolition By focusing selected resources to pursue the building safety evaluation of these targeted community elements, the Christchurch authorities were able to move more rapidly to open up, or deem unsafe, entire segments of the community. This approach has certain advantages over the block-by-block method used in California and other places	Gallagher p. 24
	• What principles guided operational decisions	“There is a direct trade off between: Taking the time to ensure that buildings are safe before allowing public access; and Getting the community and local businesses recovering from the disaster as soon as possible.”	CERC 0004.1, p. 6
		The placarding (i.e., posting) systems of the ATC and NZSEE procedures are the same, but placarding procedure is done somewhat differently. The Christchurch City Council used UNSAFE, RESTRICTED USE, and INSPECTED placards only on commercial buildings. For residential buildings, if a building was not posted UNSAFE, the occupant was given a small flyer that advised them that part of the building might be unsafe and that they should contact an engineer.	Gallagher, p. 4
		A Critical Buildings Team was established to review major buildings in the CBD and establish stabilisation measures as well as to assess the effects of aftershocks on indicator buildings. Re evaluation of indicator buildings post aftershocks was used to inform the evaluation teams of potential changes of building status and hence the need for further inspection.141 The information was also used to inform the establishment and extent of the cordon. Significant leadership and advice was provided through engineers associated with DBH.	McLean, p. 136
	Teams:		
	• Recruitment	Members made available from Institution of Professional Engineers of New Zealand and Building Officials Institute of New Zealand.	CERC 0004.1 p. 22

RQ #	Topic	Comments	References
	•	3.9 Use of Private Engineers for Safety Evaluation Private engineers were permitted to inspect and post buildings under the authority of the Christchurch City Council. The arrangement used required the engineer to sign the form shown in Appendix B.	Gallagher, p. 24
	•	There is no register of trained and pre�warranted engineers prepared to undertake rapid building safety evaluations. This is partly due to a lack of legal mandate which inhibits the development and maintenance of an effective organisational structure and appropriate systems.	McLean, p. 134
	• Deployment	Only CPEng used in CBD due to safety and assumption that CPEng more capable than non-chartered engineers	CERC 0004.1 p. 22
	•	A limited pool of engineers provided for evaluation of suburban residential dwellings (Operation Suburb) and suburban commercial dwellings (Operation Shop).	McLean, p. 136
	• Use of teams	Only experienced Chartered Professional Engineers were used for evaluations in the CBD due to the requirement for higher level expertise and the significantly heightened risk	McLean, p. 136
	• Liability	Liability waiver in effect during state of emergency that “provides protection from liability for damages or loss for engineers and other civil defence workers during a state of emergency, unless they acted in bad faith or were grossly negligent.” P. 22 Means that liability is issue if no state of emergency declared.	CERC 0004.1 p. 19
	•	Immunity from liability for volunteer engineers was granted by means of a contract between the individual and the emergency operations center manager (termed the “Controller”). No mention of worker’s compensation in the event of injury was mentioned in the contract.	Gallagher, p. 40
	• Preparation	This was done with virtually no preparations for the scale of damage that occurred. There was little time to train safety evaluators. Consequently, there was a considerable need to improvise on an urgent basis, and in this regard officials did an outstanding job.	Gallagher, p. 3
	BDSA:		
	• # teams	Approximately 250 volunteers between 4 -1 5 September	CERC 0004.1 p. 22
	•	In a massive effort by local officials, with considerable outside assistance	Gallagher, p. 3
KEY	•	The number of the building evaluations required a planned team of up to 100 engineers and 50 building control officials. In fact a total of 352 professional engineers were involved in the rapid building evaluation process.142As a result of the linkages developed through the September 2010 earthquake many of the engineers were sourced through IPENZ143 and the building officials through the Building Officials Institute of New Zealand.	McLean, p. 136
	• Composition	Approximately 75 engineers with 25 Urban Search and Rescue Engineers. Building Officials are referred to but numbers and backgrounds are not given.	CERC 0004.1 p. 22

RQ #	Topic	Comments	References
		CPEng seen as more experienced than non-chartered engineers	
	•	**5.8 Welfare Personnel Added to Safety Evaluation Teams** In discussions with Christchurch officials, it was learned that a typical safety evaluation “team” for houses and residential buildings might consist of four people: one safety evaluator, two “welfare” staff (e.g., members of a non-governmental organization such as the Red Cross), and a driver. The consensus of those individuals interviewed was that the addition of the two welfare staff, while of aid to the occupants, significantly slowed the building safety evaluation process and is generally not desirable.	Gallagher, p. 43
KEY		Whilst normally an evaluation team consisted of an engineer and a warranted building official, limitations in the supply of building officials because of the high demand for building officials for Operation Suburb meant there were not sufficient of these available for all teams and experienced engineers acting as building safety evaluation team leaders were temporarily warranted.	McLean, pp. 136-7
		Data gathering and the use of multidisciplinary teams In Operation Suburb multidisciplinary teams consisting of an engineer, building control official and 1 or 2 social workers were used to visit homes in affected areas to assess dwellings and gather information on the needs of the people. However the times required for these different tasks were often radically different. The building assessment might take 10 15minues but the social needs assessment often took longer. It was reported that the forms on which the information was recorded were not entirely appropriate and the quality of the information entered problematic. Data processing lagged behind and resulted in _weeks of work post event to fix inaccurately entered records_.	McLean, p. 138
	• Selection	Manpower was obtained from a number of sources, including Christchurch building department staff, volunteer engineers, private engineers, and building inspectors (e.g, building control officers), engineers and others from other New Zealand cities.	Gallagher, p. 11
	• Logistics	The management of large volumes of assessments (9,300 over 21 days in September 2010 compared to 130,000144 over a corresponding period in February 2011) would not have been possible without the experience and process improvement as the result of the September 2010 earthquake.	McLean, p. 137
	•	There were reportedly issues with mobilisation and management including: o Difficulties in communication with the EOC and uncertainty as to who to contact (a common theme) Too many engineers arriving at the wrong time instead of being programmed so as to allow for graduated relief o The lack of prequalification/warranting meant some additional confusion as engineers sought confirmation of their CPEng. Status o Training/safety briefing was repeated every day even for those who had been through it before thus wasting some time	McLean, p. 138

RQ #	Topic	Comments	References
		o Transfer from unpaid volunteer to paid status was not clear although the general assumption was that volunteers would give up to three days on an unpaid basis.	
	• Timeline		
	• # buildings assessed	In a massive effort by local officials, with considerable outside assistance, over 72,000 buildings in Christchurch were inspected in the 10 days immediately after the February earthquake.	CERC 0004.1 ???
	•	local officials, despite being initially caught off guard and unprepared for the scope and severity of the damage, made over 72,000 building inspections in 10 days.	Lizundia et al., 2017, p. 1
	•	Over 130,000 buildings were inspected in the first 21 days (NZSEE, 2011).	In Gallagher, p. 3
Key	•	Following the September earthquake an Indicator Building procedure had been developed where specific buildings were re‐evaluated post aftershocks to assess the effects of these aftershocks and make decisions on whether general building re‐evaluations were required. This proved invaluable in the safe and efficient use of resources	McLean, p. 137
	• outcomes	After the 22 February earthquake, all buildings were inspected and given either a green, yellow or red placard to indicate the safety of the building. A green placard meant that a building had been assessed and no apparent structural or other safety hazards were found. A yellow placard meant that a building had restricted access and a red placard meant a building must not be entered because it was deemed unsafe [6]. Some 79 % of the buildings in the survey were given either a yellow or red placard.	Baird, Palermo, & Pampanin, 2012, p.6
	Information:		
	• Types of info collected		
	• How recorded	Excel sheet	CERC 0004.1 p.
	•	Data management in the EOC did not seem to keep pace with the incoming data and data in respect of particular buildings was difficult to access and relate to earthquake prone buildings There is a need to pre‐plan the gathering of data and the subsequent analysis to produce useful intelligence.	McLean, p. 138
	• Where did info go	Building inspection databases were maintained by Christchurch City Council for reporting and analysis.	Wilkinson, p. 138
	•	The data base used in September was further developed with the data inputting management and mapping outputs resourced by CCC.	McLean, p. 137
	• Types of dx made		
	Commentary		

6.9.1e TECHNICAL REPORT
APPENDIX 4.3: NEW ZEALAND CASE STUDY: CHRISTCHURCH CANTERBURY NEW ZEALAND EARTHQUAKES 2010,2011

RQ #	Topic	Comments	References
	• Overall		
	• Strengths	One innovation in Christchurch was the use of "indicator buildings." Indicator buildings represented the unreinforced masonry, reinforced masonry, reinforced concrete, and precast concrete structures typical of Christchurch. One such building is shown in Figures 3-1 and 3- 2. If an indicator building showed damage after an aftershock, similar buildings could then be re-examined for safety. This is better than the rather intuitive methods currently used in California.	Gallagher, p. 21
	•	The generally successful implementation of the building safety evaluation process (triage) after the earthquakes of 4 September 2010 and 22 February 2011, was a result of the preplanning that had occurred by members of NZSEE, supported by member's employers, EQC, the (then) Department of Building and Housing, and by the Ministry of Civil Defence & Emergency Management. The pre-planning included: adaptation of rapid response building triage procedures developed for the New Zealand environment; drafting guidelines that were tested following the Gisborne earthquake of 2007; amendment and publication by NZSEE of the first New Zealand Guideline in 20091; testing of that Guideline in Padang, Indonesia; gathering further experience from Samoa and L'Aquila, Italy; delivery of introductory training, including to senior Christchurch City Building Managers and others from Wellington and Dunedin,	NZSEE, p. 3
	•	A Critical Buildings Team was established to review major buildings in the CBD and establish stabilisation measures as well as to assess the effects of aftershocks on indicator buildings. Re evaluation of indicator buildings post aftershocks was used to inform the evaluation teams of potential changes of building status and hence the need for further inspection.141 The information was also used to inform the establishment and extent of the cordon. Significant leadership and advice was provided through engineers associated with DBH.	McLean, p. 136
	•	The Review considers that the following features of the immediate response worked well: ・ Early inclusion and warranting of consulting engineers who had worked on building evaluation following September 2010. ・ Specific evaluation plans developed for evaluation of the CBD, key shops and critical community services (pharmacies, supermarkets, medical centres, hardware stores, etc.) and the arterial routes into and out of the central city. ・ The establishment of a Critical Buildings Team using experienced Chartered Professional Engineers. ・ Following the September earthquake an _Indicator Building_ procedure had been developed where specific buildings were reevaluated post aftershocks to assess the effects of these aftershocks and make decisions on whether general building reevaluations were required. This proved invaluable in the safe and efficient use of resources.	McLean, p. 139-140

RQ #	Topic	Comments	References
		▪ Over 130,000 assessments were done over 21 days compared with 9,300 over 21 days a corresponding period in September 2010.151	
	• Challenges	CERN 0004.1, p. 6 Consistency: • Multiple processes – building owners were completing own assessments with contracted engineers alongside formal process, resulting in inconsistent evaluation processes being used. . These evaluations were similar to, but not the same as the Level 1, 2, and Detailed Engineering evaluations. • A similar challenge to consistency is that some of the contract engineers had participated in Rapid Assessment teams and others had not; thus the engineers conducting the assessments for building owners had variable experience. •	CERC 004.01 p. 8
	•	Multiple Placard Systems • Some engineers developed or modified placards so that up to four different types of placard/notice systems were in use (p. 9).	CERC 004.01 p. 9
	•	Information Flow • Local Authorities did not have access to building owners reports. There was no legal requirement to share results of the assessment, thus LAs did not have a complete picture of building status.	CERC 0004.01 p. 8
	•	Status of Buildings • Building owners did not know, or just assumed, that their evaluations would change the status of the buildings in LA records. CERC 0004.1 notes instances of inconsistencies between placards and official records.	CERC 0004.01 p. 8
	•	Changing Placards • During state of emergency, placards/status could only be changed by civil defence and emergency management. After the state of emergency, only local authorities could change placards. However, unauthorized personnel did change placards. As noted above, sometimes building owners and engineers changed the placard after the detailed engineering evaluation without consultation with the technical authority.	CERC 0004.1 p. 10
	•	CPEng Forms • CCC developed a process and form for Chartered Professional Engineers to	CERC 0004.1 p. 10

RQ #	Topic	Comments	References
		submit following Detailed Engineering Review. This ensured consistent information and that the reviews were carried out by properly credentialed personnel.	
	•	Transition from Civil Defence to Local Authority • Gaps were found in the legal status of placards and status when the state of emergency ended. Placards were only in effect during the emergency, and yet many of these buildings had not been repaired or demolished before the emergency ended. Christchurch City Council (CCC) developed processes and a recommendation was made to develop formal transition processes.	CERC 0004.1 p. 12
	•	Transition from Local Authority to building owners • The process for transition of responsibility to building owners was not clear. Some waited, expecting the local authority to conduct detailed engineering evaluations.	CERC 0004.1 p. 12
	•	Maintaining Cordoned Areas • Again, while setting up fencing is typically the responsibility of the building owner, in the emergency local authorities determined where and when cordons were put in place. The report notes several issues around establishing, maintaining, and removing cordons.	CERC 0004.1 p. 13
	•	Barriers for building owners • Building owners faced challenges to repair due to insurance issues, contractor shortages, and other issues.	CERC 0004.1 p. 13
	•	Overlapping legislative and legal requirements • Noted that overlapping legislative requirements created challenges for owners. A particular challenge was noted as consenting (guessing that this is equivalent to BC building inspection). The varied acts that were applicable were not designed with recovery from an earthquake as a possibility.	CERC 0004.1 p. 13
	•	Insurance requirements • Two concerns were noted – owners had little control over the time and process for getting insurance approval to proceed/pay; relationship between how buildings were categorized and what insurers would pay for.	CERC 0004.1 p. 13
	•	Placard system issues: • Designed for commercial buildings. • Uncertainty in public about what the actual meaning of placard colours and terminology meant	CERC 0004.1 p. 13 - 14

RQ #	Topic	Comments	References
		• Guidelines for Rapid Assessment were at a greater level of detail than those for Detailed Engineering Assessments, leading to inconsistency in their performance. Also, language on placards were inconsistent, calling for a "detailed structural engineering assessment" rather than a detailed engineering assessment. • Uncertainty on how implications of placard levels for indicating level of damage/need for further evaluation and for indicating long term safety and reoccupation. • Green placards could have different meanings. System designed to prioritize buildings for further assessment. Not clear how to handle buildings that were safe to use, but required further work and subsequent assessment. •	
	•	Detailed Engineering Evaluations • Need for detailed engineering evaluations was uncertain. While guidelines indicate it is the owners' responsibility, the local authority did not have the authority to demand these assessments. It's not known how many building owners chose not to complete evaluations or did not follow all recommendations. • Inconsistency in experience and capability of engineers (not: phrased as quality of assessments by individual engineers) – found that many lower quality assessments tended to be overly conservative in their assessments. • Variability in skill and training of engineers in performing DDE – process and judgment are different than in design and determining earthquake readiness. • Different models are required for determining outcome based on different building stock, age, size, construction, and condition. • Use of damage – based assessment may be problematic. Suggest that additional factors should be considered such as damage to non-structural components, possible hazard to neighbouring buildings, utility lines, asbestos, hazardous materials. • Consideration should be given to extending past damage assessment to using seismic vulnerability assessment. • Assessments assumed that subsequent aftershocks would be less than main shock. This was not the case with the 11 Feb incident where the aftershock in	CERC 0004.1 p. 17 - 19

RQ #	Topic	Comments	References
		Christchurch CBD was stronger than the initial event. • Discussion on what types of training engineers require to be adequately prepared.	
	• KEY follow up	Issues with Framework Uncertainty on mandate and accountability for developing and maintaining system.	
	•	A document prepared by the New Zealand Society for Earthquake Engineering was used (NZSEE, 2009). While based somewhat on the original ATC-20 document, the New Zealand document covered primarily Rapid Evaluations and provided limited safety evaluation guidance, possibly because it was under on-going development. It did not contain basic instructions on how to inspect a building, examples of posting and barricading, guidance on how to inspect various types of buildings, guidance on filling out safety assessment forms and placards, and advice for dealing with occupants and owners of damaged buildings. It also introduced two levels of Rapid Evaluation (ATC-20 has only one).	Gallagher, p. 33
	•	Management of logistics was fragmented between the CRC, NCMC and government departments. Less division and better involvement of government agencies in emergency management would be helpful.	McLean, p. 14
	• KEY	Of significance was the failure to convert the large inflow of raw information into intelligence and a common situational awareness. Internal information sharing was problematic for the CRC and there did not appear to be one area within the CRC which was considered the most reliable source of information. Information was not generally well displayed. Many CRC staff did not understand the distinction between information and intelligence.	McLean, p. 14
	• KEY	The New Zealand Society for Earthquake Engineering (NZSEE) in a report to the Royal Commission included the following issues: ▪ Difficulty in communicating the meaning of the placards to the public. ▪ Inconsistent skill sets, knowledge and confidence of evaluation team members. ▪ Lack of integration of owner appointed engineers with the Council led process. ▪ A clear approach to the managing of changing of placards was not established in the early stages. ▪ The register of building placards was not publically available. ▪ The transition to normal building regulatory processes on the lifting of the state of emergency required legislation139 to address the extra time required to process the large number of buildings to be transferred from status under the declared emergency to the normal CCC building processes. The CCC also set up a Building Evaluation Transition team to manage this transition. This operated until 30 Nov 2010.	McLean, p. 135

RQ #	Topic	Comments	References
		▪ After the 26 December 2010 aftershocks, although a state of local emergency was not declared, a form of rapid evaluation and placard system was used for the first two days but this was replaced by the normal process under the Building Act, e.g. the issuing of s124 notices for dangerous buildings.140	
	●	Inconsistent results of assessment by evaluation teams. Many engineers turned up voluntarily to assist with building evaluations. Most had not been trained in the evaluation protocols and required training, briefing and safety induction on site prior to being tasked. Notwithstanding the pool of engineers who had participated after the September 2010 earthquakes and those that were trained in?house within their companies, inevitably the hasty training ave rise to variation in understanding. This led to inconsistent evaluations with some judgements being unduly conservative but with others more liberal. The result was that the status of some buildings seesawed between classifications when re?inspected with some consequent confusion.	McLean, p-. 137
	●	There was reportedly widespread confusion among the public, tenants and building owners as to the meaning of the placards	McLean, p-. 137
	●	Clearly the wording and colour of the placards needs to be revisited to reinforce not only the building status but also the obligations on owners for further inspections.	McLean, p-. 138
	●	This is also linked with the need for defined processes for further detailed engineering evaluation of placarded buildings which is not defined in the 2009 NZSEE Guidelines. Although information is available it is not in an easily available form.146 Detailed Engineering Evaluation Guidelines are required together with consideration of which buildings must be or should be further evaluated after placarding, particularly bearing in mind the possibly significant further deterioration due to aftershocks.147	McLean, p-. 138
	●	▪ Green and yellow placards were not posted by residential building evaluation teams. This was because the focus of residential evaluations was to determine which houses could not be occupied. A decision was made to use only the red placard where it was required on residential buildings. A black and white leaflet was used to inform residents that their building was safe to enter. Although yellow/green assessments were done and entered into the CCC data base they were not	McLean, p-. 138
	●	Identification of buildings and coordination???In certain areas there were evidently difficulties in consistently identifying buildings correctly	McLean, p-. 138
	●	Mobilisation and management of volunteer engineers???Because of the large numbers of buildings to be evaluated suitably qualified engineers were sourced and mobilised from around New Zealand, mostly by IPENZ. There were reportedly issues with mobilisation and management including:	McLean, p-. 138
	●	The number of chartered engineers required to be available in New Zealand for rapid building	McLean, p-. 138

RQ #	Topic	Comments	References
		assessment has been estimated at over 600.149 There are suggestions that greater efforts be made to link normal engineering operations with emergency management response, inclu exposure to emergency management issues, during education and professional development	
	•	It was clear how important it was for both the Local Controller and later the National Controller to have access within their respective OCs to high level engineering expertise with respect to building evaluation and engineering. The ability to clearly communicate technical issues to the public is also important.	McLean, p-. 138
	•	Data management in the EOC did not seem to keep pace with the incoming data and data in respect of particular buildings was difficult to access and relate to earthquake prone buildings.	McLean, p-. 139
	•	18 Given the experience following the earthquakes of 4 September 2010 and 22 February 2011 in the Canterbury area, it is evident that the procedures can be improved, by: a. Amending and extending the two phased (Level 1, Level 2) “Red”, “Yellow”, “Green” of the building triaging process to cater for significant damaging aftershocks, and support all stakeholders; b. Improving communications among building owners, occupiers, businesses, territorial authorities, building officials, engineers, architects, building officials, the building sector, CDEM sector, the insurance sector, the media, Central Government and the public ; c. Requiring the improvement of the information management system, including having a fully functional secure computer database of property, building, and address information operating as part of normal Territorial Authority/Building Consenting Authority day-to-day processes and accessible securely from the internet; d. Requiring pre-event understanding and knowledge of critical buildings (Building Importance Level 4, and those critical to emergency functions including functions of lifeline utilities); and also e. understanding and knowing of vulnerable buildings such as those assessed as “Earthquake Prone” and/or “Dangerous”, with priority given to reducing risks, particularly those from critical weaknesses (parapets, gable ends, chimneys, foundation systems), non-structural elements (ceiling tiles, light fittings, air conditioning), and storage rack systems. Buildings that could adversely affect lifelines should also be identified and be included on a priority list for assessment following a damaging event; f. Providing National standard operating procedures for the effective management of cordoning of dangerous buildings; g. Training and exercising of building management officials, including staff of Territorial Authorities/Building Consenting Authorities, engineering and architecture consultancies, and property managers and CDEM staff; h. Amending the Building Statutes to enable procedures for the “normal” management of dangerous buildings to be utilised seamlessly between “normal” business, of one or two	NZSEE, pp. 4 – 5

RQ #	Topic	Comments	References
		dangerous buildings a year, and civil defence emergencies involving upwards of thousands of dangerous buildings. i. The current model focus on buildings does not adequately consider the hazards associated with the environment – ground failure, slope stability etc. The triage system was extended in Canterbury to include such hazards for example, rock fall and slope failure. There are reported instances where placards placed for reasons of such geotechnical hazards being removed and replaced during subsequent inspections where the inspectors did not consider the hazards from the surroundings. It would be important to explicitly include consideration of such hazards in the guidelines and training for future post-earthquake building inspections.	
	•	The resources required for rapid emergency building evaluations exceeded a thousand volunteer engineers, Building Consenting Officials, and support staff. While a few had been on introductory training courses prior to the Canterbury earthquakes, the majority were only inducted on their first day. There is a need for formalised training in rapid emergency building evaluations and for a register that holds contact details and information on the currency of engineers, building control officials, architects, property managers, and CDEM staff who have been trained.	NZSEE, p. 7
	• Recommendations	Field guide with examples of different types of damage to promote consistency of evaluations	CERC 0004.1 p. 18
	•	Engineers performing detailed engineering evaluation need more training as process for dealing with damaged buildings substantially different than determining earthquake readiness of building designs	CERC 0004.1 p. 18
	•	Recommend that DEE be performed by CPEngineers with experience in earthquake assessment.	CERC 0004.1 p. 18
KEY		Consider different assessment models for different building stock: age, size, construction, and condition.	CERC 0004.1 p. 19
		Use of damage – based assessment may be problematic. Suggest that additional factors should be considered such as damage to non-structural components, possible hazard to neighbouring buildings, utility lines, asbestos, hazardous materials.	CERC 0004.1 p. 19
		Consideration should be given to extending past damage assessment to using seismic vulnerability assessment. See Cavli et al.	CERC 0004.1 p. 19
		Give consideration to whether or not aftershocks may be greater than initial event in determining building safety.	CERC 0004.1 p. 19
		Need to do more comprehensive review on what the requirements are for engineers to be adequately trained and prepared for doing building assessments.	CERC 0004.1 p. 19

6.9.1e TECHNICAL REPORT
APPENDIX 4.3: NEW ZEALAND CASE STUDY: CHRISTCHURCH CANTERBURY NEW ZEALAND EARTHQUAKES 2010,2011

RQ #	Topic	Comments	References
	KEY	Review discussion on p. 23 on building assessment models. Check Vidal reference.	
	KEY	Information management: review discussion on p. 25 for recommendations.	
		This was done with virtually no preparations for the scale of damage that occurred. There was little time to train safety evaluators. Consequently, there was a considerable need to improvise on an urgent basis, and in this regard officials did an outstanding job.	Gallagher, p. 3
		4.2 Little or No Training of Safety Evaluation Personnel It was reported by a number of individuals interviewed that safety evaluation personnel received little or no training before the earthquake and only a relatively modest amount of training immediately after the earthquake and before going into the field.	Gallagher, p. 33
		4.3 No Prior Credentialing of Safety Evaluation Personnel There was no prior certification of the Christchurch safety evaluation personnel. This contrasts with California where the California Emergency Management Agency (Cal EMA) has trained and certified over 7,000 individuals. Cal EMA requires all students to provide their credentials at the time of the class. Credentials include a professional architect or civil engineering license (structural and geotechnical engineers in California are also civil engineers), or one of a number of building inspector certifications that require understanding of structural load path. These are checked against licensing board websites, and only those with current credentials are allowed into the active database for deployment. Those without these credentials are placed into an archive database, in the event they obtain their credentials later. Not having a pre-qualified cadre of personnel to draw from put New Zealand officials in the difficult situation of trying to qualify personnel on the spot. Understandably, there was little choice in the matter at the time.	Gallagher, p. 34
		Both building safety evaluations and demolition would be improved by: - the development of a high level national resource to manage the evaluations of buildings - a national system for the selection, training, warranting and mobilisation of building professionals in an emergency - revision of the Guidelines for Building Evaluation in light of Christchurch experience, in particular revision of the placarding system and education of the public in its meaning - development of protocols for consultation prior to demolition and for the establishment, management and access through cordons.	McLean, pp. 13 - 14
		Early restoration of business, including preservation of jobs should be an objective of the Response; and a senior business liaison person should be part of the organisation of the EOCs for any emergency or disaster that significantly affects economic activity and the business community.	McLean, p. 14
		The Guide to the National Civil Defence Emergency Management Plan should include a section on logistics. A more formal adoption of a CIMS structure at all levels would have helped.	McLean, p. 14

RQ #	Topic	Comments	References
		Of significance was the failure to convert the large inflow of raw information into intelligence and a common situational awareness. Internal information sharing was problematic for the CRC and there did not appear to be one area within the CRC which was considered the most reliable source of information. Information was not generally well displayed. Many CRC staff did not understand the distinction between information and intelligence. ***A strategic plan for information collection and intelligence analysis was lacking and there was little development of a _common operating picture_. An operations _knowledge board_ or an electronic intelligence summary was needed in the CRC.***	McLean, p. 14
		The Review considers that the duplication of control and EOCs between Christchurch city and the regional CDEM group was not only inefficient but put people and property at risk. Under existing legislation the same situation could arise in a number of different parts of New Zealand. The Review considers that for efficiency and clarity only one level of emergency management should exist below the national level. **The Review therefore recommends that while territorial local authorities should continue to be able to declare a state of emergency the responsibility for leading and controlling the response should rest solely with CDEM Groups.**	McLean, p. 16
		The Review recommends that a small cadre of personnel be established to lead in senior emergency management positions during natural disasters, that they be highly trained in catastrophic event management (including staff and command training from NZDF and Police) and that they be drawn from CDEM groups and public and private sector organisations. They would carry on with their regular job for much of their time; but would be well trained and maintain their emergency management skills through education, training, and regular exercises.	McLean, p. 16
		A national system be developed for the selection, training, warranting and mobilisation of building professionals for building safety evaluation in an emergency. The logical focal point for engineers would be IPENZ, which already maintains data bases of capability as the registration authority under the Chartered Professional Engineers Act. Because this would be a national resource this activity should be properly funded by government rather than by the members of such an organisation.	Mclean, p. 142
		That building evaluation during an emergency be given a legal mandate and that this address the issues of: o authorisation and mechanisms for implementation of building evaluation both inside and outside declared states of emergency o appropriate liability protection for those undertaking assessments in both circumstances o clear legal status of posting, maintaining and removing placards o practical transition to normal building control arrangements	Mclean, p. 142

RQ #	Topic	Comments	References
		Territorial Authorities or their Building Consenting Authority have a responsibility for maintaining property and building information records (Resouce Management Act, Building Act, Local Govt & Meetings Act). Property and building information management is an evolving domain with developments occurring to address the shortcomings that are known nationally. For efficient emergency management of buildings, electronic records should be accessible via the internet from secure and backed-up computer databases	
		it is recommended that the expression "Building Safety Evaluation" be replaced by "Rapid Evaluation of Buildings in an Emergency", because the evaluations judged necessary immediately following a damaging hazard event, such as earthquake, are rapid, and are under emergency conditions, and may be in high risk situations. The outcomes are thereby compromised, hence the need, as stated in the NZSEE Guidelines, for a subsequent "Detailed Engineering Evaluation" as has now been implemented in the Greater Christchurch area under the Department of Building and Housing Engineering advisory Group6	NZSEE, p.7

Appendix 4.4: Article Review Data Extraction, Italy

This appendix provides an annotated list of key and useful documents uncovered in the literature review. Many of these documents provide similar information, though sometimes from different perspectives. Due to saturation of themes, not all documents are fully reviewed. Note that many of the documents reference each other and there is substantial overlap, particularly in regards to case history, BDSA procedures, issues, and recommendations. The articles listed here as KEY or USEFUL should be further assessed as the project moves from data collection to analysis and synthesis.

Readers are directed to the following KEY readings:

Dolce, M., & Goretti, A. (2015). Building damage assessment after the 2009 Abruzzi earthquake. *Bulletin of Earthquake Engineering*, *13*(8), 2241-2264.

Goretti, A., & Di Pasquale, G. (2002, September). An overview of post-earthquake damage assessment in Italy. In *EERI invitational workshop. An action plan to develop earthquake damage and loss data protocols, California*.

Citation	Dolce, M., & Goretti, A. (2015). Building damage assessment after the 2009 Abruzzi earthquake. *Bulletin of Earthquake Engineering*, *13*(8), 2241-2264.	
Inline Ref	Dolce & Goretti 2015	
Description	The paper, after describing the procedures and the form that were used for the assessment, discusses the time evolution of the inspections and analyses the data on building type and seismic damage. The empirical damage distribution conditional upon seismic intensity and building type is provided and the role of several vulnerability factors, such as the quality of masonry, the construction year, the number of stories, and the pre-existing damage, is highlighted. Lastly the damage consequences, such as the immediate occupancy conditional upon building damage and building type, are reported. P.241	
Informs	Case background Composition of teams Rationale for decision-making	

	Use of process and forms – rationale and examples	
Commentary	This is an excellent article and provides a comprehensive overview of a BDSA process in progress. Excellent description of the AeDES form and its criteria. Significant information on # teams, time per building, distribution of damage. NOT CODED, but excellent discussion on distribution of different types of damage (e.g., # A, # B, etc)	
Status	KEY	

Citation	Goretti, A., & Di Pasquale, G. (2002, September). An overview of post-earthquake damage assessment in Italy. In *EERI invitational workshop. An action plan to develop earthquake damage and loss data protocols, California*.	
Inline Ref	Goretti et al 2002	
Description	The paper describes old and recent Italian experiences in the field of damage assessment, highlighting resolved, but also not yet resolved problems, that have been encountered in assessing procedures, forms, tools, computerisation, validation, maintenance, and data dissemination.	
Informs	Historical aspects of damage assessment; damage assessment in relationship to larger/other assessment activities; comparison of BDSA processes, albeit older.	
Commentary	Excellent for overall discussion on BDSA and for historical development of BDSA in Italy. Nice comparison of systems, but all data is dated and several of the systems described have changed since this article was written. However, its structure and the elements it discusses are very useful. Not included in Italy Case or Program data extraction – will be covered in detail in the Comparison section	
Status	NOT USEFUL for Italian Cases KEY for comparisons.	KEY USEFUL LIMITED NOT USEFUL

APPENDIX 4.4: ARTICLE REVIEW DATA EXTRACTION, ITALY

Citation	Goretti, A., Di Pasquale, G., & Rota, M. (2007). Analysis and reporting on state-of-the-art on post-earthquake safety and damage assessment. Lessloss Risk Mitigation for Earthquakes and Landslides Integrated Project. European Commission.	
Inline Ref	Goretti et al 2007.	
Description	This report contains a state-of-the-art on post-earthquake safety and damage assessment procedures adopted in different European countries.	
Informs	Overall procedures of BDSA Team composition Training Time on task Forms and information	
Commentary	Brief, but relatively comprehensive overview of BDSA in Italy. Very useful document and probably has the most detailed description to date on Italian procedures.	
Status	KEY	KEY USEFUL LIMITED NOT USEFUL

Citation	Masi, A., Santarsiero, G., Digrisolo, A., Chiauzzi, L., & Manfredi, V. (2016). Procedures and experiences in the post-earthquake usability evaluation of ordinary buildings. Bollettino di Geofisica Teorica ed Applicata, 57(2).	
Inline Ref	Masi et al. 2016	
Description	In this study, after an overview of the survey forms adopted in several countries throughout the world, the form currently used in Italy for usability surveys (called the AeDES form) is described, especially focusing on those points that highlight the role of vulnerability in the final usability evaluation. An analysis of the extensive database of the L'Aquila 2009 earthquake usability surveys is presented, particularly discussing those buildings that were judged unusable despite having no or light damage. Finally, a case study analysed during the Emilia 2012 earthquake is reported. Masi, p. 200	
Informs	Case background Use of non-credentialed personnel	

	Building taxonomies	
Commentary	Good discussion on history of damage assessment and development of current model. Discussion comparing BDSA models for Italy, Greece, US, NZ, Japan Break down of damage patterns for types of buildings (private, public, heritage) Building types (p. 207) – NOT CODED	
Status	KEY	KEY USEFUL LIMITED NOT USEFUL

Citation	Molinari, D., Menoni, S., Aronica, G. T., Ballio, F., Berni, N., Pandolfo, C., ... & Minucci, G. (2014). Ex post damage assessment: an Italian experience. *Natural Hazards and Earth System Sciences*, *14*(4), 901.	
Inline Ref	Molinari et al 2014.	
Description	This paper studies this context, and describes ongoing activities in the Umbria and Sicily regions of Italy intended to identifying new tools and procedures for flood damage data surveys and storage in the aftermath of floods. In the first part of the paper, the current procedures for data gathering in Italy are analysed. The analysis shows that the available knowledge does not enable the definition or validation of damage curves, as information is poor, fragmented, and inconsistent.	
Informs	Flood damage assessment Higher order data management	
Commentary	Consider doing a case study on flooding based on this article. The process and procedure should be compared to the earthquake procedures and also to the NZ earthquake and flood field guides. While not much information is taken from this article into the case or BDSA data extraction templates for Italy, there is a lot of really useful information in this article. The lack of data extraction is related to the earthquake-centric cases and programs, not to the quality of data in the article.	
Status	USEFUL – generally KEY to contract flood with earthquake processes.	KEY USEFUL LIMITED NOT USEFUL

Citation	Baggio, C., Bernardini, A., Colozza, R., Corazza, L., Della Bella, M., Di Pasquale, G., ... & Papa, F. (2007). Field manual for post-earthquake damage and safety assessment and short term countermeasures (AeDES). *European Commission—Joint Research Centre—Institute for the Protection and Security of the Citizen, EUR, 22868.*	
Inline Ref	Baggio et al 2007.	
Description	This manual extends the Instructions reported on page 4 of the form, with the aim of providing a tool for a correct training of the surveyors and for a full awareness of the principles of the form, as well as for the necessary homogeneity of judgment. In Chapter 2, some information and guidelines on issues concerning the organisation of the damage and usability survey and the procedures for preparing and carrying out the building survey are given. Chapter 3 provides a detailed description of each structural component, correlating it to the building component behaviour (thrusting or non thrusting roofs, masonry of good or bad quality, rigid or flexible floors, etc.).	Baggio, p. 5
Informs	Definitions and discussion of usability Elements of a BDSA system p. 4 Building taxonomy p. 10.	
Commentary	Detailed field guide for use of the AeDES form. Much of the information if structured in the context of completing the forms, making it difficult to extract for overall description of the BDSA process. The Manual does not describe the overall BDSA process.	
Status	USEFUL	KEY USEFUL LIMITED NOT USEFUL

Citation	Dolce, M., & Di Bucci, D. (2014). National Civil Protection Organization and technical activities in the 2012 Emilia earthquakes (Italy). *Bulletin of earthquake engineering*, *12*(5), 2231-2253.	

Inline Ref	Dolce 2014.	
Description	Description of NCPO response to Emilia earthquake in 2012	
Informs	Some information decision making.	
Commentary	Good overall description of broader earthquake assessment, with minimal information on actual BDSA procedures.	
Status	LIMITED	KEY USEFUL LIMITED NOT USEFUL

Appendix 4.5: Italy Building Damage Safety Assessment Process

This section contains key data extracted from documents describing both the Building Damage Assessment process in place during the 2011 Earthquakes in Italy.

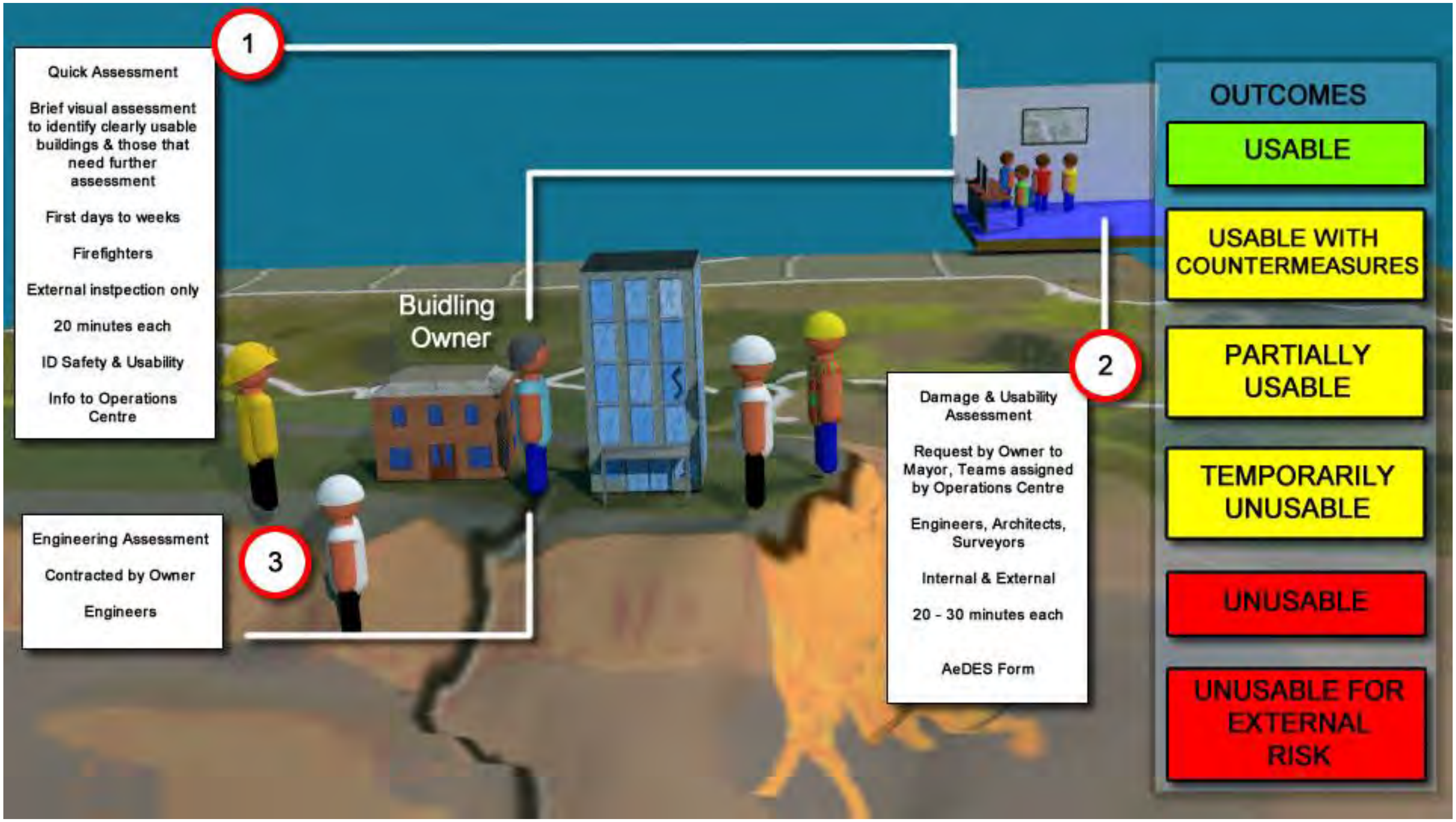


Figure A4. Italy DSA Process.

DSA Overview

RQ #	Topic	Comments	References
AB_001	Elements	1.3 Emergency management and surveyor's responsibility In order to optimise the emergency management and the treatment of the collected data, the procedures should be unified on a national basis. They include for example: – the definition of the reference event, – the procedure for calling for an inspection, – the recruitment and the management of the surveyors teams for what concerns a territorial limitation of the area of action, – the compilation of the usability form, – the computerization of the data included in the form, – the procedures for the order of evacuation, – the procedures for repeating some usability inspections in order to obtain a more detailed investigation and/or to evaluate variations of the building conditions.	Baggio, p. 4
		The organisation in short requires that: the assessment of buildings begins after a request addressed by the citizens to the mayor. A first organisational work of these requests is carried out within the municipality, in order to associate all the requests, generally referred to building units, that refers to the same structural unit. The mayor will then forward these survey requests to the Mixed Operative Centre (COM) or to another similar structure, from where surveyors teams, registered and organized, are sent to carry out the inspection. The surveyors then go to the municipality to indicate the survey activity to be carried out, they check the relative data, they collect useful information with the help of the local structure, they complete their task and then inform the mayor about the result. The municipality must be organized for the collection of the results (registers and cartography) and for the openings of the provisions of its competence, including obviously the incidental ordinance of evacuation issued by the mayor. The surveyors go back to the COM, where they deliver the completed form. The data collected are then computerized and used both for the activities of the COM and for possible future elaborations of scenarios.	Baggio, p. 7
AF_001	Overall Goal	Despite the fact that, at least in Italy, a definition of usability has never been codified, usability may be related to the need of using the building during the seismic emergency, being reasonably safe from the risk of significant damage to people. For this reason, the usability assessment does not aim at safeguarding the construction from further damages, but only at preserving the life of occupants.	Baggio p. 2
		As a matter of fact, this assessment allows: 1. the population to safely stay in or re-enter their homes;	Dolce 2014

RQ #	Topic	Comments	References
		2. the shelter and temporary housing needs to be properly scaled, both in the emergency (tent camps, hotels, self-lodging financial support) and in the post-emergency (temporary housing); 3. activities to be rapidly restarted; 4. cost analyses to be carried out, in order to define the funds needed for the reconstruction; 5. priority and funding criteria to be identified for the interventions on each building.	
		The safety assessment has some implications on the reconstruction process: indeed, building usability is one of the parameters used to have access to public funds and to define priorities. On the other hand, the damage assessment does not have any implication on the reconstruction. In case an evaluation of damage is used to establish financial contribution given by the State or the Region for reconstruction, the damage is assessed again, in more detail by an engineer remunerated by the owner.	Goretti, p. 9
		In Italy, damage and safety assessment are jointly performed. The safety assessment aims mainly at distinguishing safe and unsafe buildings and evaluating the short term countermeasures necessary to make buildings safe. On the other hand, the damage assessment aims at establishing the overall cost of repair, upgrading or retrofitting in the affected area. Aims of short term countermeasures are to reduce private and public risk in case of aftershock and preserve monumental buildings from further damage.	Goretti, p. 9
Af_007	Overall Authority	Either the National or Local Civil Protection is in charge of the assessment, depending on the scale of the impact. Local authority may also be responsible for the safety assessment (Region, Province and Municipality). Even when buildings with different use have to be inspected all the inspections are managed by the same authority. Only the assessment of monumental buildings is usually managed by the Ministry of Cultural Assets.	Goretti, p. 9
		Inspections are managed at a local level, while resources are managed at the provincial or intermediate level.	Goretti, p. 10
AF_008	Legal Basis	In general terms, the definition of the juridical responsibilities of the surveyor - who is going to undertake, usually as a volunteer, the difficult task of deciding about the usability and hence about the normal use of a building, which can potentially be subjected to seismic shaking in the short period - is one of the crucial factors for the success of a good post-event management. It is evident that, first of all, the responsibility of the surveyor should not go behind his technical competences, which are those typical of people working in the technical field (engineers, architects, draughtsmen).	Baggio, p. 5
		It is likewise evident that the assumption of responsibility by voluntary workers can only be limited to the correct execution of the survey and to the release of the consequent usability judgment, based on their professionalism. It is also evident that the responsibility of the surveyor should be limited in time, since it is related to an emergency condition, which ends at	Baggio, p. 5

RQ #	Topic	Comments	References
		the moment of the following reconstruction. Finally, the responsibility will be smaller, since the judgment is less certain, in case the surveyor is asked, based on the level of damage and on the vulnerability of the building, to give his opinion on the behaviour of the building in relation to possible seismic events of much larger intensity than the one already experienced. From what said above, the authors of this text derive the opinion that the responsibility of the surveyor can only include what is related to his bad faith or to his negligence in the fulfilment of his task.	
AF_010	General Liability	The situation in Italy is somewhat different: the law concerning usability inspections in post seismic emergency is totally deficient and the jurisdiction is particularly penalizing the surveyor.	Baggio, p. 5
AF_003	Types of BDSA Assessment	An approach similar to the two-step Japanese and Greek approaches has also recently been used in Italy, during the 2012 Emilia (Italy) earthquake, where early inspections were made very quickly by firefighters who performed more than 63,000 surveys in the very first days of the seismic sequence. Based on the results of these preliminary surveys, only damaged or “suspect” buildings (about 38,000) were subjected to later more accurate and time-consuming evaluations made by trained technicians using the AeDES form. Therefore, it can be computed that around 25,000 buildings with no or clearly negligible damage were considered usable just on the basis of the first fast survey, thus remarkably speeding up the reduction of the homeless number.	Masi, p. 203
AF_012	Building Taxonomies	Several kinds of structures are considered in the assessment: residential buildings, monuments, special buildings such as schools or hospitals, commercial buildings and infrastructures such as bridges or dams.	Goretti, p. 9
AF_012b	Specific Assessments for Building Types		
AF_007a	Relationship of various assessments		
AF_013	Type of Placard System	The procedure also includes a posting system, this however, is not standard.	Goretti, p. 10
AF_014	Placard Colours		
AF_015	Potential Outcomes	Concerning the immediate occupancy classification, the form includes the following alternative options: A- Usable; B- Usable only after short term countermeasures; C- Partially usable; D- To be re-inspected; E- Unusable;	Dolce, p. 2244

<table>
<tr><th>RQ #</th><th>Topic</th><th>Comments</th><th>References</th></tr>
<tr><td></td><td></td><td>F- Unusable for external risk only.</td><td></td></tr>
<tr><td></td><td></td><td>According to the AeDES form, buildings are classified into the following usability categories:
A. Usable building. The building, albeit slightly damaged, can keep on housing the functions to which it was dedicated, keeping the human life reasonably protected in case of an aftershock as strong as the earthquake that motivated the inspection.
B. Building usable only after short term countermeasures. It is the case of a building with limited or no structural damage, but with severe non-structural damage. Once countermeasures are taken, however, the building can be re-used.
C. Partially usable building. It is the case of a building with limited or no structural damage, but with severe non-structural damage located in a part of the building. The possible partial or total collapse of the damaged part must not imply a risk for the usable part.
D. Building to be re-inspected. It is the case of unusual damage scenario, or of geological, geotechnical or other situations that require a specific, still visual, investigation.
E. Unusable building, as a consequence of at least one of the following conditions: high structural risk, high non-structural risk or high geotechnical risk.
F. Unusable building for external risk only, like in the case of landslides or adjacent near collapsed constructions threatening the inspected building.</td><td>Dolce 2014, p. 2251</td></tr>
<tr><td></td><td></td><td>Table 4.1. Usability classification adopted in Italy.
<table>
<tr><th>Classification</th><th>Building use</th><th>Residual capacity</th></tr>
<tr><td>Usable</td><td>Usable</td><td>Unchanged or slightly reduced</td></tr>
<tr><td>Partially unusable</td><td>Unusable in the portion of the building specified by inspectors</td><td>Unchanged or slightly reduced in the safe portion, reduced in the unsafe portion, but partial collapses in this area do not affect the safe portion</td></tr>
<tr><td>Usable after countermeasures</td><td>Unusable, until short term countermeasures specified by inspectors are inserted</td><td>Not really reduced, so that short term countermeasures may remove risk</td></tr>
<tr><td>To be inspected again</td><td>Unusable before new inspection</td><td>Not clear</td></tr>
<tr><td>Unusable</td><td>Unusable</td><td>Strongly reduced</td></tr>
<tr><td>Unusable due to external risk</td><td>Unusable, until removal of external risks</td><td>Fully or slightly reduced</td></tr>
</table></td><td>Goretti, p. 10</td></tr>
<tr><td>AF_016</td><td>Changing Placards</td><td></td><td></td></tr>
<tr><td>AF_016</td><td>Removing Placards</td><td></td><td></td></tr>
</table>

RQ #	Topic	Comments	References
AF_018 – AF_024	Reporting and Information	The assessment was carried out using the AeDES form (Baggio et al. 2007; Goretti and Di Pasquale 2002). The form and its field manual (Baggio et al. 2007) are based on the experience gained from several earthquakes (1997 Umbria and Marche, 1998 Pollino and 2002 Molise). The form, which consists of 9 sections and contains information on the building identification, dimension, age, use, constructional type and suffered damage, is specifically conceived to unambiguously define the collected data and to be self-explained. At the same time, the data to be collected are selected in order to be maximally informative of seismic performance, compatibly with the limits of a visual inspection. As an example, the classification of the vertical and horizontal building components is based on their seismic performance features rather than on their technology and materials. In addition a multiple choice-multiple answer option allows a rather detailed description of the building characteristics to be made using few categories. For instance, the R/C and steel building classification makes use of the following multiple choices-multiple answers: R/C shear walls, R/C frames and steel frames, thus allowing R/C frames, R/C walls and steel frames to be considered in the same building. In Figs. 1 and 2, the masonry, R/C and steel building classifications are reported.	Dolce, p. 2243
		At the regional level, information on flood damage is obtained from individual municipalities that collect such data in order to apply for reimbursement on the basis of the total extent of the damage incurred (it should be noted that in Italy no insurance policy covering natural hazards has to date been created for residential buildings (Maccaferri et al., 2012)), and as a consequence any form of compensation is a part of public expenditure). The damage data collected by municipalities are then organised and maintained by the Regional authorities, which receive compensation funds from central government and distribute them to affected communities on the basis of their own evaluation of what constitutes priorities and acceptable claims. Compensation can only be obtained if a state of emergency has been declared by the National Civil Protection Department. One problem deriving from the division of responsibilities among national and regional authorities is that survey methods and procedures differ from region to region, and sometimes even from municipality to municipality, which leads to inconsistencies among databases, and to poor levels of comparability. In addition, damage to different sectors, such as infrastructures, industries, and residential properties, are kept in separate archives and managed by different offices, which are responsible for compensation and reconstruction funds. Regional databases do not account for indirect damage, as it is not subject to compensation	Molinari, p. 903
		A third limitation of the systematic use of these data for analysis purposes is that they are in paper form (i.e. the original survey forms). Few regions are provided with electronic structured databases such as the RasDa database in the Lombardy Region, which provides data going back to 1995. A distinction is made in the RasDa database between private	Molinari, p. 904

RQ #	Topic	Comments	References
		and public facilities. Damage data relating to the latter is then split into damage to infrastructures and damage to buildings. In the case of buildings, whether private or public, damage to structures and contents is reported separately. As with most regional databases, a very generic description of the physical triggering event is reported, with no reference to any relevant hazard parameters. The resulting information is therefore poorer than that contained in the AVI database mentioned above. As a consequence, even though digitalised regional databases such as RasDa are better organised where they need to be used to develop or validate damage functions, the poor geo-location of damage, and especially the absence of hazard data, represents a significant barrier.	
		A damage classification is included in the safety assessment form. Inspectors have to assess physical damage, for each building component, in terms of both damage grade and extension. Safety assessment inspections must be performed necessarily both from outside and inside the building, using expert judgment and based on data collected by visual inspection.	Goretti, p. 10
		Data entry for computerization is performed by dedicated personnel. The procedure includes a standard software for data entry, query and reports, but no information technology is used for data entry. During inspection management, inspection results are spatially visualized on paper (e.g. cadastral maps). Data are then inserted in a GIS system when the emergency is ended.	Goretti, p. 10
AF_017	Other markings		

Personnel

RQ #	Topic	Comments	References
		Personnel	
AU_001	Types of Personnel	Each survey team is typically composed of 2 people, which may be engineers, architects or surveyors. The average number of daily inspections made in one day by one team, considering also transportation time is 7. The average ratio between the number of persons managing the inspections and the number of inspectors is approximately 5:200, while the average ratio between people in charge of the data entry and inspectors is 7:200.	Goretti, p. 11
	Training	A standard training course has been set up for training inspectors in peacetime. This course is addressed to both public employees and professionals and lasts approximately 40 hours. Sometimes however safety assessment is part of a more general course (lasting 60-120 hours) that includes also other topics, such as building vulnerability, pre-event survey and so on. The training course consists mainly of lecture notes, papers, books, PowerPoint slides and Pdf files.	Goretti, p. 12

RQ #	Topic	Comments	References
	Category	Engineer	
AU_004	Professional Certification		
AU_007	Pre-Event Training		
AU_011	JIT/Event Preparation		
AU_012	Relationship		
AU_013	Liability		
AU_014	Capabilities		
AU_015	Types of Assessments performed		

	Category	Building officials	
AU_004	Professional Certification		
AU_007	Pre-Event Training		
AU_011	JIT/Event Preparation		
AU_012	Relationship	1.	
AU_013	Liability		

AU_014	Capabilities		
AU_015	Types of Assessments performed		

Building Damage Assessment

RQ #	Topic	Comments	References
	BDSA Type:	**Area Assessment, Windshield Assessment**	
	Local Name		
AG_001	Goal		
AG_003	Description	As said above, soon after being notified of the May 20th main shock, teams of experts moved from Rome to the epicentral area to carry out a first survey of the real damage distribution and make an on-site evaluation of the macroseismic intensities (Galli et al. 2012). Their work was preliminarily aimed at identifying the localities with the highest level of damage, in order to correctly address the first activities of rescue and assistance to the population.	Dolce 2014
AG_015	Types of Buildings Teams Can Assess		
AG_037	Legal Authority		
AG_005	Dispatched By		
AG_038	Implementation		
AG_006	Team Members		
AG_009	Team Size		
AG_010	How Selected		
AG_016	Interior/Exterior Check?		
AG_018	Assessment Outcomes		
AG_020	Info Gathering Tools		
AG_028	Assessment Time		
AG_030	Destination for Info Collected		

RQ #	Topic	Comments	References
	BDSA Type:	**Rapid Damage Assessment**	
	Local Name		
AG_001	Goal		
AG_003	Description		
AG_015	Legal Authority	Buildings are inspected on citizen’s demand.	Goretti, p. 10
AG_037	Types of Buildings Teams Can Assess		

APPENDIX 4.5: ITALY BUILDING DAMAGE SAFETY ASSESSMENT PROCESS

RQ #	Topic	Comments	References
AG_005	Dispatched By		
AG_038	Implementation		
AG_006	Team Members	Firefighters	Masi, p. 203
AG_009	Team Size		
AG_010	How Selected		
AG_016	Interior/Exterior Check?	A damage classification is included in the safety assessment form. Inspectors have to assess physical damage, for each building component, in terms of both damage grade and extension. Safety assessment inspections must be performed necessarily both from outside and inside the building, using expert judgment and based on data collected by visual inspection.	Goretti, p. 10
AG_018	Assessment Outcomes		
AG_020	Info Gathering Tools		
AG_028	Type of Placard System		
AG_030	Assessment Time		
AG_030	Destination for Info Collected		

APPENDIX 4.5: ITALY BUILDING DAMAGE SAFETY ASSESSMENT PROCESS

RQ #	Topic	Comments	References
	BDSA Type:	**Detailed Building Damage Assessment – Simple Buildings**	
	Local Name		
AG_001	Goal		
AG_003	Description		
AG_015	Types of Buildings Teams Can Assess		
AG_037	Legal Authority		
AG_005	Dispatched By		
AG_038	Implementation		
AG_006	Team Members	Each survey team is typically composed of 2 people, which may be engineers, architects or surveyors.	Goretti, p. 11
AG_009	Team Size		
AG_010	How Selected		
AG_016	Interior/Exterior Check?		
AG_018	Assessment Outcomes		
AG_020	Info Gathering Tools	AeDES form	Masi, p. 205
AG_028	Assessment Time		
AG_030	Destination for Info Collected		

RQ #	Topic	Comments	References
	BDSA Type:	**Engineering Assessment**	
	Local Name		
AG_001	Goal	In case an evaluation of damage is used to establish financial contribution given by the State or the Region for reconstruction, the damage is assessed again, in more detail by an engineer remunerated by the owner.	Goretti, p. 9
AG_003	Description		
AG_015	Dispatched By		
AG_037	Implementation		
AG_005	Team Members		
AG_038	Team Size		
AG_006	How Selected		

RQ #	Topic	Comments	References
AG_009	Types of Buildings Teams Can Assess		
AG_010	Interior/Exterior Check?		
AG_016	Assessment Outcomes		
AG_018	Info Gathering Tools		

Appendix 4.6: Italy 2009 - 2011 Case Studies

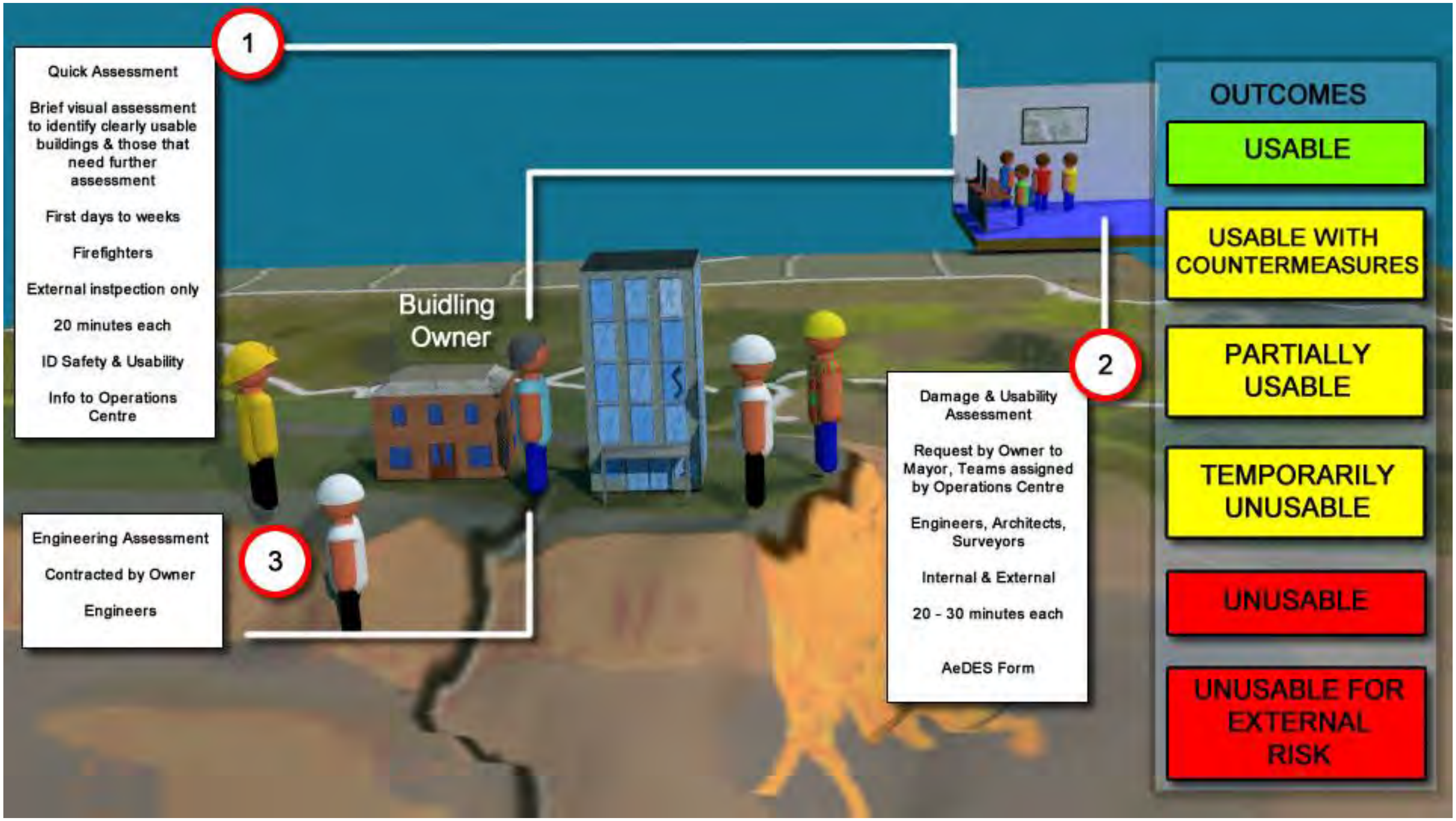


Figure A5. Case Study: Italy 2009 – 2011.

Note that there are several articles in this section that address differing earthquakes occurring between 2009 and 2011.

Case Background

RQ #	Topic	Comments	References
	Case Title		
		Introduction	
	Case Background		
	Location	The 6th of April 2009, at 3:32 a.m., an earthquake of magnitude 5.9 on the Richter scale (Mw6.3) hit the city of L'Aquila, where about 73,000 people were living. It also affected some tens of municipality towns.	Dolce 2241
	Event	On April 6, 2009, at 03:32:39 a.m. local time, a magnitude MW=6.3 earthquake with shallow focal depth (10 km) occurred in the Abruzzo region (central Italy) very close to L'Aquila (the urban centre is less than 10 km away from the epicentre), the capital town of the region (Masi et al., 2011). This vent was the third strongest earthquake recorded in Italy after the 1976 Friuli (north-eastern Italy; MW=6.4) and the 1980 Irpinia (southern Italy; MW=6.9) earthquakes, and it is the strongest event providing recordings from accelerometric stations located very near to the epicentre. Specifically, four accelerometric stations (AQA, AQG, AQM, AQV) were located across the Aterno valley and recorded PGA values up to 0.66 g. Specifically, the station AQK, located in the urban centre, recorded a PGA value of about 0.35 g with a peak ground velocity around 35 cm/s. In the first two days after the main shock, four earthquakes with MW≥5.0 occurred. Among them, the first (MW=5.1, April 6) and the third event (MW=5.1, April 7) occurred nearby L'Aquila city. The second one (MW=5.1, April 6) was localized at about 15 km NW of L'Aquila (Campotosto area), while the fourth one (MW=5.5, April 7) was localized SE of L'Aquila, in an area where the main event practically destroyed the small village of Onna and caused extensive damage in other villages.	Masi, p. 205
	Extent & Type of Damage	The April 6 main shock and the subsequent severe aftershocks caused heavy and extensive damage in the urban area of L'Aquila as well as in several surrounding villages, mainly located in the south-eastern part of L'Aquila province (central part of the Aterno valley), where MCS (Mercalli-Cancani-Sieberg) intensity values ranging from VI to IX degree were observed (Galli and Camassi, 2009). Conversely, intensity values generally did not exceed VI MCS in the area NW of L'Aquila town, as displayed in the map in Fig. 1. Five villages suffered intensities equal to, or greater than, IX-X MCS (i.e., Onna and Castelnuovo), four villages suffered intensities of IX (e.g., Sant'Eusanio Forconese), while two villages and the urban centre of L'Aquila town felt intensities of VIII-IX.	Masi, p. 205

RQ #	Topic	Comments	References
		A total of 315 localities were classified with a MCS intensity equal to, or greater than, V, as displayed in Fig. 2, which reports the number of localities classified in terms of the assigned value of MCS intensity.	
		The most damaged ones were located SE of L'Aquila. The earthquake caused 309 victims, about 1,600 injured, more than 65,000 people needing assistance and about 30,000 long term homeless	Dolce p. 2241
	DSA Process	In DPC (2000) and Baggio et al. (2007) usability is defined as follows: "The evaluation of usability in the post-earthquake emergency is a temporary and rough evaluation - i.e., based on an expert judgment and carried out in a short time, on the basis of a simple visual inspection and of data which can be easily collected - aiming at determining whether, in case of a seismic event, buildings affected by the earthquake can still be used with a reasonable level of life safety".	Masi, p. 200
		Usability surveys are first and foremost focused on the short-term use of the buildings under examination (Goretti and Di Pasquale, 2002). However, together with the usability survey, a global damage assessment can be done to provide data and directions useful in establishing longterm strategies on the affected building stock.	Masi, p. 200
	Goal	Just after the event a field survey, aimed at evaluating the building immediate occupancy and the structural and non-structural damage, was performed.	Dolce p. 2241
		The immediate occupancy assessment was aimed at evaluating the short term use of buildings. The buildings that can be safely used even in case of aftershocks, as well as the emergency countermeasures to be taken in order to reduce the risk for people, were identified (Goretti and Di Pasquale 2005). The damage to structural and non-structural components was also annotated.	Dolce, p. 2242
		After an earthquake, usability of buildings definitely plays a major role in the recovery of the essential social and economic activities of the affected communities. Yet, usability of a structure represents a delicate calculation, involving the safety of individuals because of the possibility of significant aftershocks (Baggio et al., 2007).	Masi, p. 199
		On one hand, assessing usability determines if there is a significant risk to human life in using the affected and possibly damaged buildings, thus minimizing the risk which people could be subjected to when returning to their houses once the initial panic has ended. Considering this objective, being conservative in such an evaluation appears mandatory. On the other hand, timely usability inspections are essential in order to minimize the number of homeless hosted in provisional or temporary structures. Too conservative evaluations can be detrimental, causing unnecessary discomfort, and therefore they should be avoided.	Masi, P. 199

RQ #	Topic	Comments	References
		The social impact of this activity can be better understood by comparing the number of homeless before and after usability campaigns that followed past earthquakes.	
	Placard System		
	Results		
	Use of Personnel	•	
	Commentary		
		Part I BDSA Framework	
	EM Overview		
	Legislative Authority		
	EM framework		
	Stakeholders & Relationships		
	<image>		
	Ownership & Sustainability		
		Part II BDSA in Operation	
	Case		
	Operational Functioning:		
	• Who managed / administered process	As for other past recent earthquakes (Pollino 1998, Molise 2002), the damage and usability assessment was managed by the Italian Civil Protection Department, with a substantial support from Regions, Provinces, Municipalities, Firemen, ReLuis, Eucentre, National Chambers of Engineers, Architects and Surveyors and National Research Council.	Dolce, p. 2242
		The coordination of all inspectionswas carried out by the ItalianCivil ProtectionDepartment.	Dolce, p. 2242
	• How were priorities established?	Prior to building inspections, an aerial evaluation identified 27 non-accessible zones, the so called “red zones”. They were typically located in the historical centres of L’Aquila and of the surrounding villages. In order to rapidly detect the actually usable buildings, and to limit the risk for the inspectors due to strong aftershocks, the inspections were initially carried out in the less-damaged areas and only after a couple of months they were extended to the “red zones”.	Dolce, p. 2242
	•	Just after the earthquake, the macroseismic intensity was assigned to 316 municipalities and localities following a visual survey performed by experts (Galli et al. 2009).	Dolce, p. 2242

RQ #	Topic	Comments	References
	•		
	• What principles guided operational decisions	In order to speed up the recovery and to reduce the social hardship due to the halt in production, priority to public buildings was given, in particular to hospitals, schools and headquarter buildings, as well as to commercial buildings.	Dolce, p. 2242
		Prior to building inspections, an aerial evaluation identified 27 non-accessible zones, the so called “red zones”. They were typically located in the historical centres of L’Aquila and of the surrounding villages. In order to rapidly detect the actually usable buildings, and to limit the risk for the inspectors due to strong aftershocks, the inspections were initially carried out in the less-damaged areas and only after a couple of months they were extended to the “red zones”.	Dolce, p. 2242
		Public buildings, such as hospitals, schools and headquarters, as well as buildings entirely dedicated to industrial or commercial activities had been given higher priority with respect to residential buildings. The inspections to these buildings were performed by more specialized teams.	Dolce, p. 2242
		The survey of residential buildings was carried out building by building in all the municipalities where the felt macroseismic intensity in the Mercalli–Cancani–Sieberg (MCS) scale (Sieberg 1930) was higher than IMCS = VI, and only under request in all the other cases.	Dolce, p. 2242
		In conclusion, it should be stressed that having a clear and well-founded procedure to follow during the inspections is essential, although the use of expert judgement is crucial to effectively apply the official procedures when one works on such a sensitive matter as the usability judgement. In this regard, some remarks reported in the foreword of the current version of the AeDES manual are noteworthy: “The activities during an emergency phase always proceed along a narrow line, along a boundary where the rapidity of the expected answers and the capacity in providing effective assessments based on poor judgment factors sometimes have difficulty in finding the right balance. The surveyor stands in the middle of it: only guarantee strictly derives from his/her technical competence and ability to fully operate on the basis of professional ethics”.	Masi, p. 218
		Emilia In the 2012 Emilia earthquakes, instead, the assessment of a building was carried out only in case of specific request made by the owners or the tenants, and after a preliminary inspection aimed at providing a first quick survey aimed at identifying clearly usable buildings; in case of first positive assessment (i.e., no damage), the survey based on the AeDES form was no longer performed. Therefore, the AeDES inspections were carried out only on a selected sample of buildings having higher probabilities of being judged as not usable. This strategy was adopted in Emilia, as well as in other previous earthquakes, to speed up the survey, because of the high number of buildings in the epicentral area, a figure much higher than in Abruzzo, and, at the	Dolce 2014, p. 2246

RQ #	Topic	Comments	References
		same time, of the low number of damaged buildings. The outcome of the usability assessment is urgently needed by the citizens and the authorities in charge of the emergency management, as it can be easily understood. Therefore, the most efficient way to complete the survey of damaged buildings as soon as possible must be pursued in any case.	
	Teams:		
	• Recruitment		
	• Deployment	The inspection process benefited from the implementation of a specific Geographical Information System (GIS), based on a digital regional technical land-usemap. The inspectors were given a paper map containing their weekly working area, where the buildings to be inspected were reported, together with a building identification number used to insert data in the GIS. The GIS was also updated according to the findings of the inspectors on the field (new buildings, demolished buildings, etc). Inspections in the "red zone" of L'Aquila city turned out to be extremely delicate for the widespread damage.	Dolce, p.2243
	• Use of teams		
	• Liability	All the about 8,000 inspectors operated as voluntarily.	Dolce, p;. 2242
	• Preparation	The teams were trained throughout specific on-site short courses held in the morning of the first day of activities.	Dolce, p;. 2242
	BDSA:		
	• # teams	All the about 8,000 inspectors operated as voluntarily.	Dolce, p;. 2242
	•	About 28,029 inspector working days were required to complete the inspections. About 2,000 working days were required for the inspection management and about 8,190 for data computerization. It corresponds to about 1 working day for every 2.0 inspected buildings.	Dolce, pp. 2261-2
	• Composition	The inspector's teams were made up of two or three experts from Italian Regions, Provincial and Municipal technical offices, Fire Brigades, Universities coordinated by the Network of University Earthquake Engineering Laboratories, the National Chambers of Engineers, Architects and Surveyors, European Centre for Training and Research in Earthquake Engineering and the National Research Council.	Dolce, p. 2242
		Public buildings, such as hospitals, schools and headquarters, as well as buildings entirely dedicated to industrial or commercial activities had been given higher priority with respect to residential buildings. The inspections to these buildings were performed by more specialized teams.	Dolce, p. 2242

RQ #	Topic	Comments	References
		Inspections in the "red zone" of L'Aquila city turned out to be extremely delicate for the widespread damage. A Fireman was added to the team with the aim to evaluate the safer way to reach the building and the possibility that citizens safely enter their buildings.	Dolce, p.2243
		An approach similar to the two-step Japanese and Greek approaches has also recently been used in Italy, during the 2012 Emilia (Italy) earthquake, where early inspections were made very quickly by firefighters who performed more than 63,000 surveys in the very first days of the seismic sequence.	Masi, p. 203
		The 2012 Emilia earthquake struck the northern part of the Emilia-Romagna region (centrenorth of Italy). …About 3,000 expert technicians were employed to carry out a total of more than 40,000 usability inspections	Masi, p. 215
		During the post-earthquake emergency, immediately after the second shock (May 29, 2012), the authors carried out many usability surveys on school buildings in the framework of a collaboration between the ReLUIS Consortium (the Italian Network of University Laboratories of Seismic Engineering, www.reluis.it) and the Emilia-Romagna Regional Authority. Most of the inspections were performed in towns located far away from the epicentre (i.e., around 20 km or more), and therefore the surveyed buildings generally showed little damage.	Masi, p. 216
		Emilia Also in the case of the 2012 Emilia earthquake, a huge effort was made to organize the damage and usability assessment survey. The assessment was actually performed by experts coming from different Regions and from the National Fire Brigades, by researchers of the DPC Centres of Competence (ReLUIS and EUCENTRE), and by engineers, architects and surveyors coordinated through the related national professional Councils (Fig. 5).	Dolce 2014, p. 2244
	• Selection		
	• Logistics	A minimum operational stay of one week was requested to the inspectors.	Dolce, p. 2242
		The inspection process benefited from the implementation of a specific Geographical Information System (GIS), based on a digital regional technical land-usemap. The inspectors were given a paper map containing their weekly working area, where the buildings to be inspected were reported, together with a building identification number used to insert data in the GIS. The GIS was also updated according to the findings of the inspectors on the field (new buildings, demolished buildings, etc). Inspections in the "red zone" of L'Aquila city turned out to be extremely delicate for the widespread damage.	Dolce, p.2243
		The inspection management required, on average, the daily presence of 11 officers and 4 volunteers for team and archive management and form validation, 8 operators for the real-time computerization, 65 operators for the S.E.T. computerization, 15 operators for data checking and GIS implementation, 3 operators for the coordination of the data processing.	Dolce, p.2244
	• Timeline		

RQ #	Topic	Comments	References
	• # buildings assessed	Just after the event a field survey, aimed at evaluating the building immediate occupancy and the structural and non-structural damage, was performed. Two months after the earthquake, about 50,000 buildings had been inspected. This number increased up to more than 72,000 by the end of August 2009 (Dolce et al. 2009). The number of inspections is even greater, since strong aftershocks, as well as uncertain evaluations, required several buildings to be re-inspected.	Dolce p. 2241
		In the first 60 days after the event, about 50,000 surveys were made in order to check the safety of buildings and evaluate their usability (DPC, 2014b). Until March 2010, about 80,000 surveys were performed on a total of 73,521 buildings. This means that up to about 6,500 buildings were surveyed two times. This work was performed by more than 5,000 voluntary technicians from all over the country	Masi, pp. 205-206
		The 2012 Emilia earthquake struck the northern part of the Emilia-Romagna region (centrenorth of Italy). Its epicentre was located in the Emilia region, about 30 km to the west of the town of Ferrara. About 3,000 expert technicians were employed to carry out a total of more than 40,000 usability inspections on ordinary buildings using the AeDES inspection form. During the period of maximum activity, the damage and usability survey involved about 180 teams per day (with maximum of more than 200 teams). The maximum number of inspections per day ranged between 1,000 and 1,200 (Dolce and Di Bucci, 2014). As a result of the usability inspections, 37% of the surveyed buildings were judged usable (outcome A) and almost the same percentage were judged unusable (36%, outcome E), while the remaining buildings were distributed among the other usability outcomes (B, C, D, and F) but mainly attributed to B (building usable after short-term countermeasures).	Masi, p. 215
	•	The analyzed data base, updated to 6 October 2009, contains 74,576 inspected buildings. The number of inspections is even greater (78,062) since sometimes repeated inspections were performed on the same building because of aftershocks, inaccurate inspections or errors in building identification. In any case, all the following analyses are based on inspected buildings, rather than on inspections. When repeated inspections on the same building were found, the data associated to the last inspection have been considered. After 2009, October the 6th, only repeated inspections were performed, resulting inminor changes to the collected data. The number of daily inspected buildings, DI(t), performed by all the teams working on day t, versus time t, is reported in Fig. 4. After 3 months from the event, more than 70,000 buildings were inspected. Additional 4,200 buildings were inspected in the followings 50 days. The daily distribution shows that the statistical mode of the daily inspected building distribution (1,716 inspected buildings per day) occurred at day 17 from the event. Note that the distribution decreases with a long tail and that a 7 days periodic component can be added to the general	Dolce, p. 2245

RQ #	Topic	Comments	References
		trend, due to decrease in inspections during the week-ends. Figure 4 also shows that some days were initially required for the activation of the inspection process, due to the need to wait the end of the Search and Rescue activities and to set up the management centre and the inspector recruitment.	
	•	In Fig. 5 the number of daily teams, DT(t), versus time is reported. It can be noticed that the time evolution of the inspected buildings (Fig. 4) reflects the time evolution of the teams involved in the inspections (Fig. 5), so that the decrease of the number of inspections during the week-ends is due to he decrease of the number of involved teams. This is confirmed by the correlation between daily inspections and daily teams, equal to $\rho = 0.985$. The dashed line represents the time average of the daily teams up to a certain time after the event:	Dolce, p.2246
	•	The sum of the number of daily teams, _tDT(t), was 10,919 (team working days); the maximum number of daily teams, DTmax = maxt[DT(t)], was 222 at day t = 16 from the event; the average number of daily teams at the end of the survey, EDT(Tf in), was 63; the maximum average number of daily teams up to time t, maxt[EDT(t)], was 157 at t = 39 days from the event. In Fig. 6 the average (over the working teams) number of daily inspected buildings per team, DIT(t), versus time t is reported. It provides the average team productivity and is given by the total number of inspections performed during one day over the number of teams working on the same day:	Dolce, p.2246
	•	It can be seen that the average daily team productivity was higher during the third and fourth weeks from the event, with amaximum of 10 inspections per day per team. It decreased to about 4 at the end of the survey, due to the greater difficulties of making inspections of buildings located very far, or far from each other or in rural areas.	Dolce, p. 2247
	•	It is reported in Fig. 6 by a dashed line. The average (up to time t) daily productivity increased from 4.75 inspected buildings per day per team at the beginning of the survey to 7.84 at about 1 month from the event. It decreased to 6.8 at the end of the survey. This again reflects the greater difficulty in performing the very last inspections. The lesser productivity in the tail of the survey is compensated by a reduced amount of inspected buildings, so that the average (over time) productivity does not substantially change.	Dolce, p. 2247
	•	The time needed to complete the inspections is similar in L'Aquila and Molise earthquakes even if the number of inspections in L'Aquila earthquake is 3.6 times more than in Molise earthquake. This is mainly due to the greater number of involved teams. The comparison of the average team productivity is reported in Table 2. The final productivities in the 2002 Molise (Goretti and Di Pasquale 2004) and 2009 L'Aquila earthquakes are quite similar and greater than in the 2002 Etna earthquake (Goretti and Sortis 2003). The time when the peak average (up to time t and over the teams) productivity occurred, Tpeak , is quite different in the three earthquakes, due to the different number of inspections carried out. It still differs	Dolce, p. 2247

RQ #	Topic	Comments	References
		when compared with the time needed to complete the inspections (Tf inal), due to the long tails in the inspections that make Tf inal a very sensitive parameter. The above differences reduces when Tpeak is compared with the time needed to complete 75%of the inspections (T75%). It appears then that T75% is more stable than Tf inal .	
Key	•	The modal value of the number of inspections per team per day is 4, while 5 and 6 inspections per team per day are just slightly less frequent. The time evolution of the immediate occupancy for the whole	Dolce, p. 2247
	•	during the 2012 Emilia (Italy) earthquake, where early inspections were made very quickly by firefighters who performed more than 63,000 surveys in the very first days of the seismic sequence. Based on the results of these preliminary surveys, only damaged or "suspect" buildings (about 38,000) were subjected to later more accurate and time-consuming evaluations made by trained technicians using the AeDES form.	Masi, p. 203
	•	Emilia A total of more than 40,000 inspections have been carried out, each of them corresponding to one AeDES inspection form. During the period of maximum activity, the damage and usability assessment involved about 180 teams per day (with a maximum of more than 200 teams; Fig. 6). The maximum number of inspections per day ranged between 1,000 and 1,200. About 3,000 experts were employed.	Dolce 2014, p. 2245
	• outcomes	The immediate occupancy assessment was aimed at evaluating the short term use of buildings. The buildings that can be safely used even in case of aftershocks, as well as the emergency countermeasures to be taken in order to reduce the risk for people, were identified (Goretti and Di Pasquale 2005). The damage to structural and non-structural components was also annotated. The outcome of the entire process had significant implications on both the emergency management and the reconstruction phase. Furthermore, the analysis of the collected data contributes to the scientific improvement of the vulnerability assessment of existing buildings (Braga et al. 1982).	Dolce, p. 2242
	•	Concerning the immediate occupancy classification, the form includes the following alternative options: A- Usable; B- Usable only after short term countermeasures; C- Partially usable; D- To be re-inspected; E- Unusable; F- Unusable for external risk only. When a building is classified under category A, even if slightly damaged, its use can be continued. Categories B and C are the cases of buildings with limited or no structural damage,	Dolce, p. 2244

RQ #	Topic	Comments	References
		but with severe non-structural damage. In case a building is classified under category B, inspectors have to report the short term countermeasures deemed necessary to enable the use of the building, such as the removal of false ceiling, the propping of a lintel, etc. In case of category C, the possible partial or total collapse of the damaged part must not imply a risk for the usable part. Only in special cases, buildings can be re-inspected and the form re-compiled.	
	Information:		
	• Types of info collected	In order to apply the above-mentioned definition of usability, three elements need to be identified, as widely discussed in Goretti and Di Pasquale (2002): • the structural and non-structural building damage; • the reference earthquake to which the building needs to resist (seismic scenario); • the building vulnerability	Masi, p. 201
	•	Assuming that these preliminary surveys were correct, the only drawback of this approach is represented by the lack of structural information on the buildings not inspected with the AeDES form.	Masi, p.203
	• How recorded	The assessment was carried out using the AeDES form (Baggio et al. 2007; Goretti and Di Pasquale 2002). The form and its field manual (Baggio et al. 2007) are based on the experience gained from several earthquakes (1997 Umbria and Marche, 1998 Pollino and 2002 Molise). The form, which consists of 9 sections and contains information on the building identification, dimension, age, use, constructional type and suffered damage, is specifically conceived to unambiguously define the collected data and to be self-explained. At the same time, the data to be collected are selected in order to be maximally informative of seismic performance, compatibly with the limits of a visual inspection.	Dolce, p.2243
	•	It is worth noting that specifically assessing and considering the role of building vulnerability in post-earthquake usability judgements is unique to the AeDES form, and therefore it can be considered unique to the Italian approach. In fact, in other countries such as Japan (Goretti and Inukai, 2002), Colombia (AIS, 2009), U.S. (ATC, 2005), New Zealand (NZSEE, 2009) and Greece (Dandoulaki et al., 1998), the usability judgement is dependent only on the observed damage. Another peculiarity of the AeDES form is the clear and unequivocal evaluation of usability, which is different from other countries such as Japan, whose form gives general indications like safety, caution, or danger. Also, in Italy the recommendation of the AeDES survey becomes compulsory once accepted by the mayor of the municipality where the inspected building is located-not a simple recommendation or suggestion to the owner.	Masi, 202
	• Where did info go	The data entry requested the daily preliminary partial computerization of 1,000–1,800 forms in the first five weeks (Dolce et al. 2009), needed to keep under control the survey operations and to obtain important data for the emergency management. The final complete computerization was carried out through the S.E.T. software (Coppari 2001). The inspection	Dolce, p. 2244

RQ #	Topic	Comments	References
		management required, on average, the daily presence of 11 officers and 4 volunteers for team and archive management and form validation, 8 operators for the real-time computerization, 65 operators for the S.E.T. computerization, 15 operators for data checking and GIS implementation, 3 operators for the coordination of the data processing.	
	•	Once the inspections were performed, the completed forms were taken to the DPC offices, where they were digitized. This operation allowed the building of a broad database that provides a clear picture of the surveyed building stock, from the structural typology, damage, and usability judgement points of view.	Masi, p. 206
	• Types of dx made		
	• Tracking Buildings	The inspection process benefited from the implementation of a specific Geographical Information System (GIS), based on a digital regional technical land-usemap. The inspectors were given a paper map containing their weekly working area, where the buildings to be inspected were reported, together with a building identification number used to insert data in the GIS. The GIS was also updated according to the findings of the inspectors on the field (new buildings, demolished buildings, etc). Inspections in the “red zone” of L’Aquila city turned out to be extremely delicate for the widespread damage.	Dolce, p.2243
	Commentary		
	• Overall		
	• Strengths		
	• Challenges	Emilia After the May 29th earthquake, it was once more evident that the post-seismic damage and usability assessment of industrial buildings had to be conducted with a methodology different from that adopted for the typical multi storey ordinary buildings, that are characterized by masonry or R.C. continuous structures and limited window size. As a matter of fact, the use of the AeDES form is not appropriate for prefabricated one-storey large-span industrial buildings.	Dolce 2014, p. 2248
	• Recommendations		

Appendix 4.7: Article Review Data Extraction: Japan

This appendix provides an annotated list of key and useful documents uncovered in the literature review. Many of these documents provide similar information, though sometimes from different perspectives. Due to saturation of themes, not all documents are fully reviewed. Note that many of the documents reference each other and there is substantial overlap, particularly in regards to case history, BDSA procedures, issues, and recommendations. The articles listed here as KEY or USEFUL should be further assessed as the project moves from data collection to analysis and synthesis.

Citation	Nakano, Y., Maeda, M., Kuramoto, H., & Murakami, M. (2004, August). Guideline for post-earthquake damage evaluation and rehabilitation of RC buildings in Japan. In 13th World Conference on Earthquake Engineering (No. 124).	
Inline Ref	Nakano et al 2004	
Description	This paper describes the basic concept of the Guideline for Post-earthquake Damage Evaluation and Rehabilitation of RC Buildings in Japan. In this paper, (1) the damage rating procedure based on the residual seismic capacity index consistent with the Japanese Standard for Seismic Evaluation of Existing RC Buildings, (2) its validity through calibration with observed damage due to the 1995 Hyogoken- Nambu (Kobe) earthquake, and (3) the decision policy and criteria to determine necessary actions considering earthquake intensity and damage, are mainly focused. P. 1	
Informs	BDSA for Reinforced Concrete buildings by “inspector engineer.”	
Commentary	Limited description and flowchart within the context of Reinforced Concrete buildings. Unsure how generalizable process is to overall BDSA.	
Status	LIMITED	KEY USEFUL LIMITED NOT USEFUL

Citation	Seismic.ca.gov Table 1 – Comparison of Post-earthquake Building Evaluation Programs retrieved from: http://www.seismic.ca.gov/meeting_info/Item%20F3.2%20International%20Post-eq%20Comparison.pdf June 8, 2017	
Inline Ref	Comparison Table n.d.	
Description	Comparison table from seismic.ca.gov site – unable to find link or source, although link is active. Comparison on BDSA programs from EU, Italy (AeDES), Japan, Greece, US (ATC 20), SEAOC (California)	
Informs	Types of assessments Outcome categories Placard use Use of form Time per inspection # trained assessors Liability protection	
Commentary	NOTE _ UNABLE TO VERIFY OR VALIDATE INFORMATION. Very useful document, but cannot verify. Do not know when table was compiled, or by whom, or from what document.	
Status	KEY	KEY USEFUL LIMITED NOT USEFUL

Citation	Isoda, K. (1995). Issues to be Solved in the Establishment of Institution of Assessing the Safety of Damaged Buildings in Japan. 8th International Research and Training Seminar on Regional Development Planning for Disaster Prevention Emergency Assessment System of Damaged Buildings.	
Inline Ref	Isoda, 1995	
Description	Presentation given in 1995 as part of the Proceedings of the 8th International Research and Training Seminar on Regional Development Planning for Disaster Prevention 16 January 1995 Osaka, Japan	
Informs	Limited information on personnel and categories of outcome for BDSA in 1990s.	
Commentary	Presentation gives some peripheral information. Dated – from 1995.	
Status	LIMITED	KEY USEFUL LIMITED NOT USEFUL

Citation	Goretti, A., & Di Pasquale, G. (2002). An overview of post earthquake damage assessment in Italy. EERI Invitational workshop, An action plan to develop earthquake damage and loss data protocols. September, 2002.	
Inline Ref	Goretti & Di Pasquale 2002.	
Description	The paper describes old and recent Italian experiences in the field of damage assessment, highlighting resolved, but also not yet resolved problems, that have been encountered in assessing procedures, forms, tools, computerisation, validation, maintenance, and data dissemination.	
Informs	Building selection Data collection Categorization	
Commentary	Limited but useful	
Status	LIMITED	KEY USEFUL LIMITED NOT USEFUL

Appendix 4.8: Japan Building Damage Safety Assessment Process

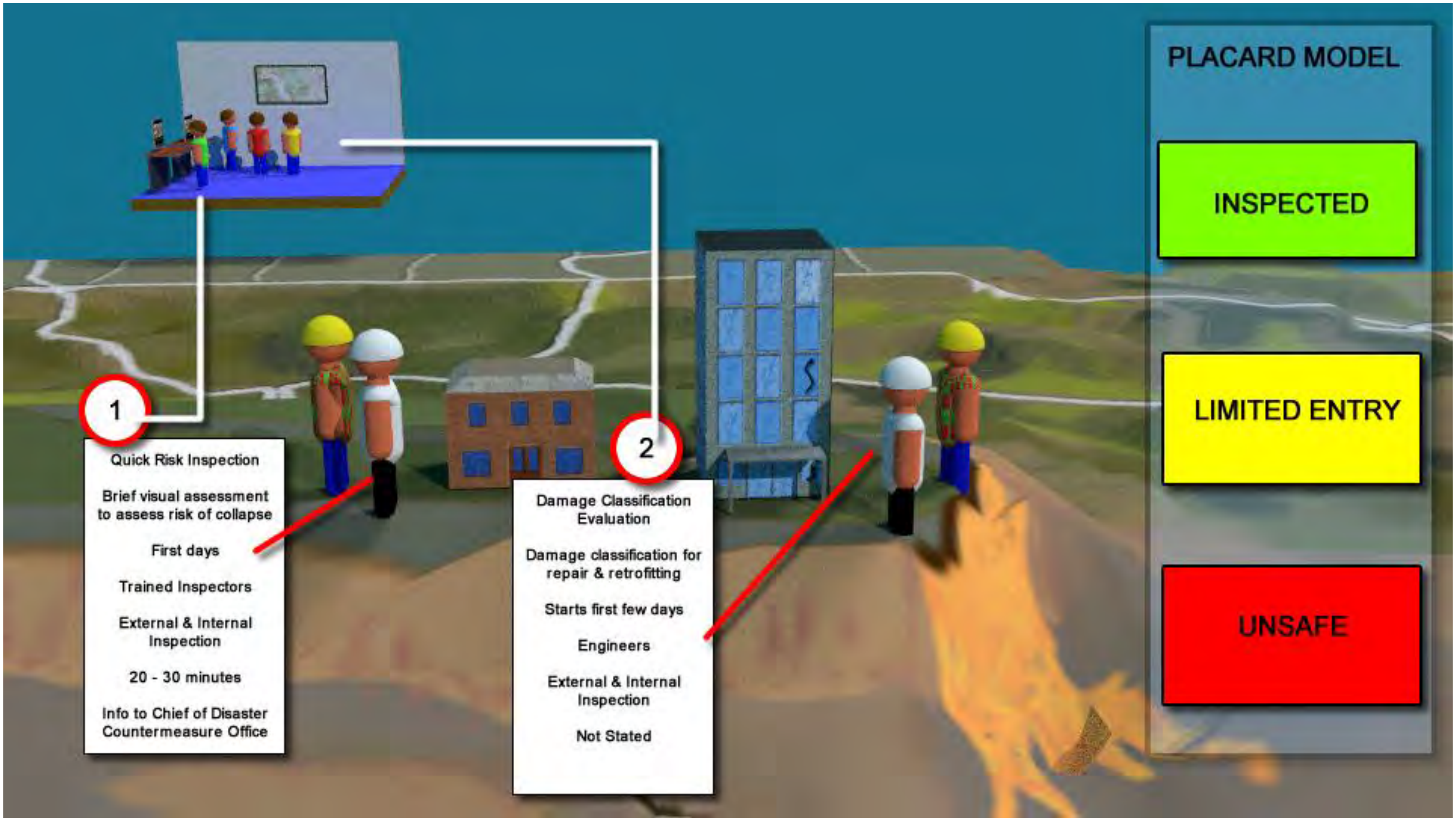
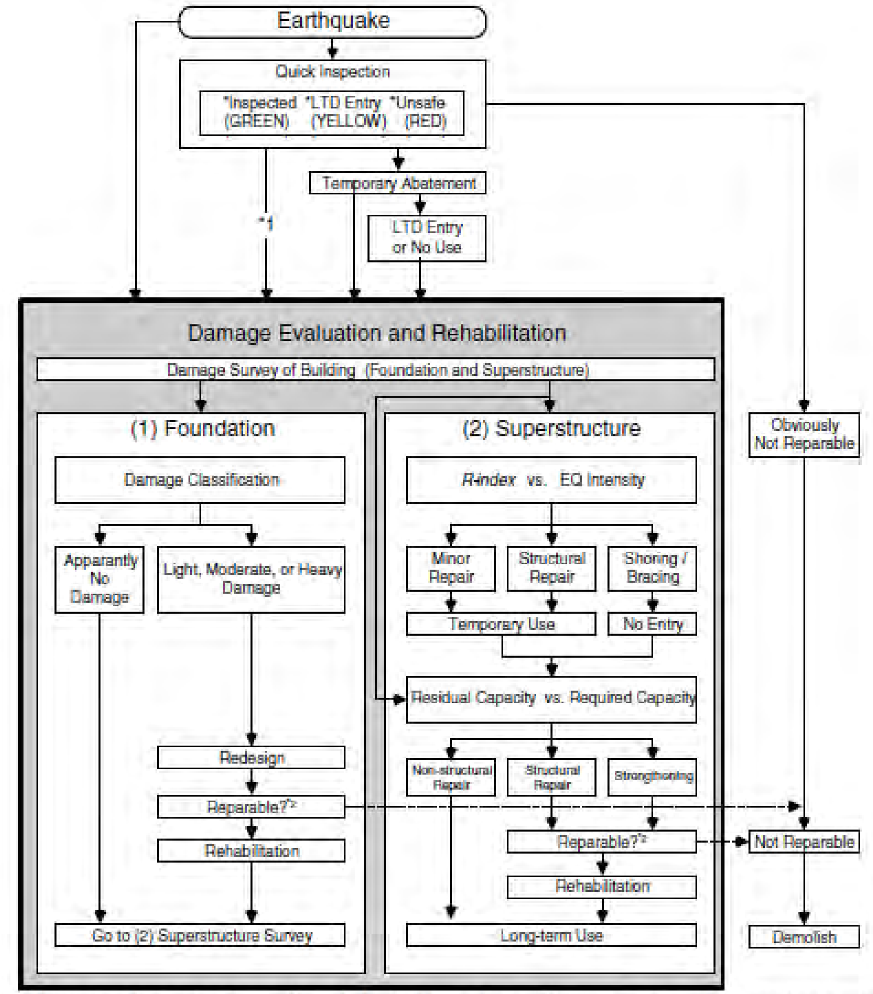


Figure A6. Japan DSA Process.

There is very limited information available through searches of online databases of English-language articles describing Japanese BDSA processes.

DSA Overview

RQ #	Topic	Comments	References
AB_001	Elements		
AF_001	Overall Goal	RC Buildings: When an earthquake strikes a community and destructive damage to buildings occurs, immediate damage inspections are needed to identify which buildings are safe and which are not to aftershocks following the main event. However, since such quick inspections are performed within a restricted short period of time, the results may be inevitably coarse. Furthermore, it is not generally easy to identify the residual seismic capacities quantitatively from quick inspections. In the next stage following the quick inspections, a damage assessment should be more precisely and quantitatively performed, and then technically and economically sound solutions should be applied to damaged buildings, if rehabilitation is needed.	Nakano, p. 1
		In Japan, the aim of the damage assessment is to evaluate the long term use of buildings. The result of the evaluation is a suggestion to the owner of the building concerning the repair, retrofit, or the demolition of the building.	Goretti, 2002, p. 4
		Emergency Assessment is to assess the risk of collapse of the whole or part of buildings by aftershocks or other forces and to judge risk of usage of buildings. The purpose of this assessment is to prevent a secondary disaster. Immediately after the earthquake, an emergency assessment will be done by Structural Engineers to observe the outline of buildings, sinking and leaning of buildings, damages of structural elements and risk of collapse.	Isoda, p. 46.
		In Japan, the aim of the damage assessment is to evaluate the long term use of the buildings. The result of the evaluation is a suggestion to the owner of the building concerning the repair, the retrofit or the demolition of the building.	Goretti & Di Pasquale, p. 3
Af_007	Overall Authority		
AF_008	Legal Basis		
AF_010	General Liability		
AF_003	Types of BDSA Assessment	RC Buildings:	Nakano, p. 3.

<table>
<tr><th>RQ #</th><th>Topic</th><th>Comments</th><th>References</th></tr>
<tr><td></td><td></td><td>


*1 Damage evaluation fundamentally includes buildings after quick inspection since the inspection results do not necessarily provide sufficient information related to the residual seismic capacity which is most essential to judge appropriateness of continued long-term use of buildings.
*2 Economic as well as technical issues should be considered.

Figure 1: General Flow of Damage Evaluation and Rehabilitation Assumed in the Guideline
</td><td></td></tr>
<tr><td></td><td></td><td>From Figure 1:</td><td></td></tr>
</table>

RQ #	Topic	Comments	References
		Quick Inspection Damage Survey of Building: • Foundation Survey • Superstructure Survey	
		Quick Inspection	Comparison table
AF_012	Building Taxonomies	damage evaluation basis and rehabilitation techniques for three typical structural systems in Japan, i.e., reinforced concrete, steel, and wooden buildings.	Nakano, p. 2
AF_012b	Specific Assessments for Building Types	Reinforced Concrete (RC) and Steel Encased RC (for EU's Exercise)	Comparison Table
		In Japan, inspections are performed only on multi-owner buildings. Buildings to be inspected are selected after a rapid post-earthquake screening.	Goretti & Di Pasquale, p. 4
AF_007a	Relationship of various assessments		
AF_013	Type of Placard System	RC Buildings: Not Stated, but implied by Figure 1, p. 3	Nakano, p. 3
		Yes	Comparison Table
		A posting system, reflecting the building usability classification, is adopted.	Goretti & Di Pasquale, p. 4
AF_014	Placard Colours	•	
AF_015	Potential Outcomes	RC Buildings: Green: Inspected Yellow: LTD Entry (limited entry) Red: Unsafe NOTE: appears that both Yellow and Red lead to: • Temporary Abatement or • LTD Entry or No Use	Nakano, p. 3
		・ Inspected (Green) ・ Limited Entry (Yellow) ・ Unsafe (Red)	Comparison Table
		Results of the assessment are categorized into: "Danger", "Caution" and "Safe". "Danger" persons from entering the building “Caution” asks persons to pay attention.prohibits	Isoda, pp. 46 - 47

APPENDIX 4.8: JAPAN BUILDING DAMAGE SAFETY ASSESSMENT PROCESS

RQ #	Topic	Comments	References
		In Japan, the aim of the damage assessment is to evaluate the long term use of the buildings. The result of the evaluation is a suggestion to the owner of the building concerning the repair, the retrofit or the demolition of the building.	Goretti & Di Pasquale, p. 3
AF_016	Changing Placards		
AF_016	Removing Placards		
AF_018 – AF_024	Reporting and Information	RC Buildings: Damage evaluation form	Nakano, p. 10
		▪ Steel Bldgs ▪ Wood Bldgs ▪ Building Land ▪ Damage Classification Forms (for each structural system, 2 pages)	Comparison Table
		In Kobe damage assessment has been performed sending to each inspector team a plan of the city containing the buildings to be inspected. The inspectors, after completed the damage collections, delivered to Building Research Institute the 2 page forms, already computerised. After the damage classification, the repair, upgrade or demolishing of the damaged buildings is suggested to the owner. The suggestion, unless public safety is involved, [is] not compulsory for the building owners.	Goeretti, p. 4
AF_017	Other markings		

Personnel

RQ #	Topic	Comments	References
		Personnel	
AU_001	Types of Personnel	inspection engineer	Nakano, p. 4
		Trained and Registered 1st or 2nd Class Authorized Architect	Comparison Table
		Structural Engineers	Isoda, p. 47
	Training		
	Liability	Liability Protection for Evaluators Yes Evaluator's Injury Insurance Provided Yes	Comparison Table

Building Damage Assessment

RQ #	Topic	Comments	References
	BDSA Type:	**Area Assessment, Windshield Assessment**	
	Local Name		
AG_001	Goal		
AG_003	Description		
AG_015	Types of Buildings Teams Can Assess		
AG_037	Legal Authority		
AG_005	Dispatched By		
AG_038	Implementation		
AG_006	Team Members		
AG_009	Team Size		
AG_010	How Selected		
AG_016	Interior/Exterior Check?		
AG_018	Assessment Outcomes		
AG_020	Info Gathering Tools		
AG_028	Assessment Time		
AG_030	Destination for Info Collected		

RQ #	Topic	Comments	References

RQ #	Topic	Comments	References
	BDSA Type:	**Rapid Damage Assessment**	
	Local Name	**Quick Inspection**	
AG_001	Goal		
AG_003	Description		
AG_015	Legal Authority		
AG_037	Types of Buildings Teams Can Assess		
AG_005	Dispatched By		
AG_038	Implementation		
AG_006	Team Members	Trained and Registered 1st or 2nd Class Authorized Architect	Comparison Table
		Structural Engineers	Isoda, p. 47
AG_009	Team Size		
AG_010	How Selected		
AG_016	Interior/Exterior Check?	Structural Engineers investigate the leaning of buildings and damages of structural elements from both inside and outside of buildings.	Isoda, p. 47
AG_018	Assessment Outcomes	RC Buildings: Green: Inspected Yellow: LTD Entry (limited entry) Red: Unsafe	Nakano, p. 3
		Results of the assessment are categorized in to five levels "little damage", "slightly damaged", "half damaged", "seriously damaged" and "collapsed". The judgments of the necessity of restorations are divided into three categories, namely, "restoration", "restoration or reinforcement (detailed investigation needed)", "reinforcement or demolition (detailed investigation needed)" by damage extents and the intensity.	Isoda, p. 47
		In Japan, the aim of the damage assessment is to evaluate the long term use of the buildings. The result of the evaluation is a suggestion to the owner of the building concerning the repair, the retrofit or the demolition of the building.	Goretti & Di Pasquale, p. 3
AG_020	Info Gathering Tools		
AG_028	Type of Placard System	yes	Comparison Table

RQ #	Topic	Comments	References
AG_030	Assessment Time	20 – 30 minutes	Comparison Table
AG_030	Destination for Info Collected		

Appendix 4.9: ATC Building Damage Safety Assessment Process

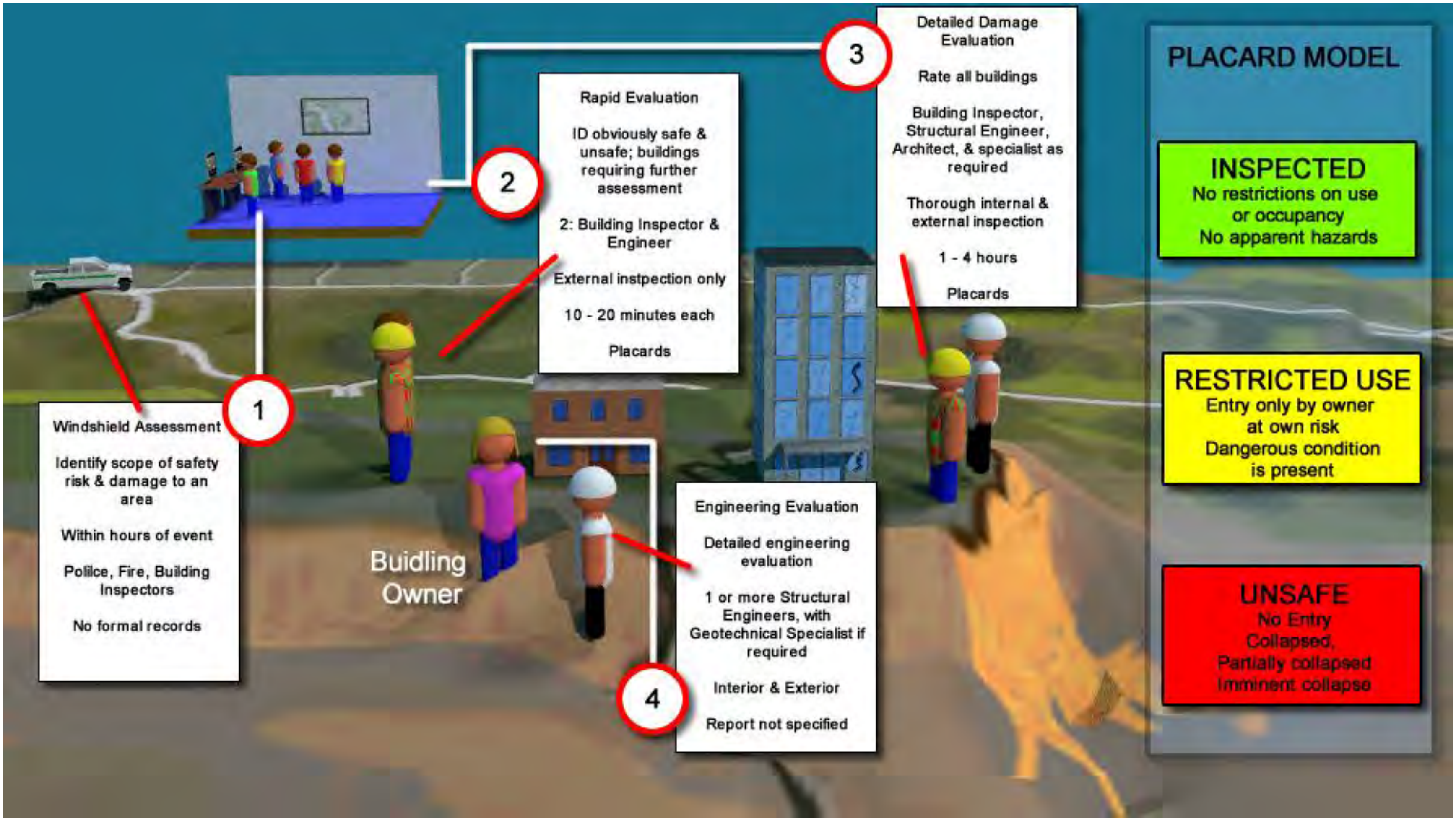
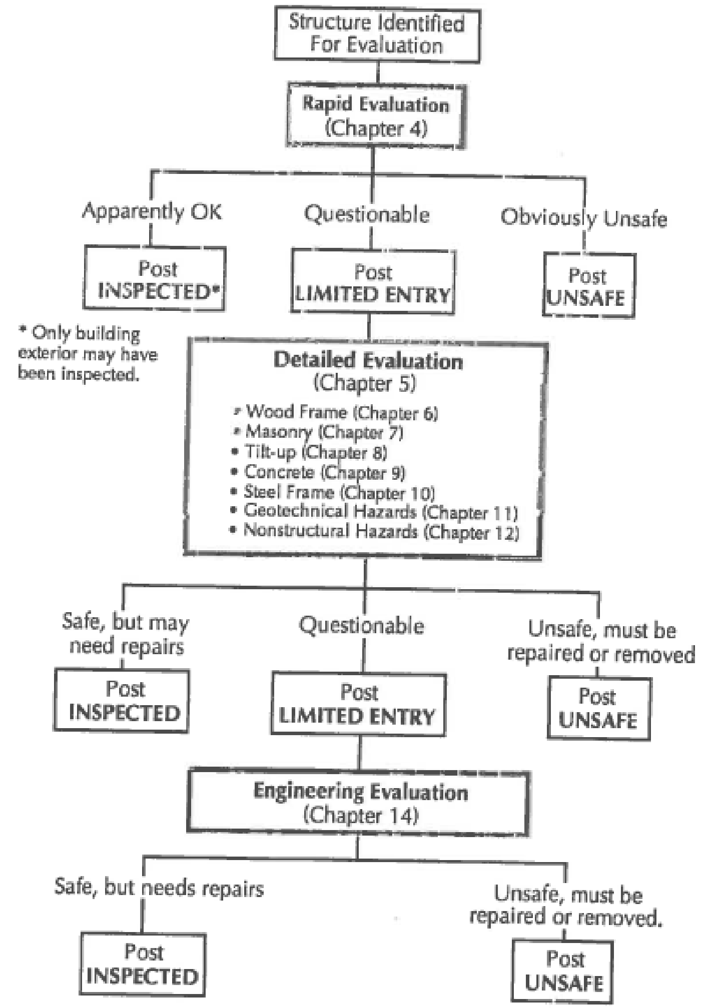


Figure A7. ATC DSA Process.

DSA Overview

RQ #	Topic	Comments	References
AB_001	Elements		
AF_001	Overall Goal		
		Postearthquake safety evaluation and posting of buildings involves assigning an appropriate level of occupancy or entry to buildings with some degree of earthquake damage.	ATC 20-2 p. 3
Af_007	Overall Authority		
AF_008	Legal Basis		
AF_010	General Liability		

RQ #	Topic	Comments	References
AF_003	Types of BDSA Assessment	 ure 3.1 *Flowchart showing the normal building safety evaluation and posting process. See Section 3.7 regarding procedures for changing posting classifications.*	ATC p. 14
AF_012	Building Taxonomies		
AF_012b	Specific Assessments for Building Types		

APPENDIX 4.9: ATC BUILDING DAMAGE SAFETY ASSESSMENT PROCESS

RQ #	Topic	Comments	References
AF_007a	Relationship of various assessments		
AF_013	Type of Placard System	3 colour	
AF_014	Placard Colours	INSPECTED Green – no apparent hazard found, although repairs may be required. Original lateral load capacity not significantly decreased. No restriction on use of occupancy. LIMITED ENTY Yellow – Dangerous condition believed to be present. Entry by owner permitted only for emergency purposes and only at own risk. No usage on continuous basis. Entry by public not permitted. Possible major aftershock hazard. UNSAFE Red – extreme hazard, may collapse. Imminent danger of collapse from an aftershock. Unsafe for occupancy or entry, except by authorities	ATC p. 15
AF_015	Potential Outcomes	INSPECTED, for buildings that have no restrictions on use or occupancy, because no apparent hazard has been found (repairs may be required) RESTRICTED USE, for buildings that can be entered only by owners on an emergency basis and only at their own risk (public entry not permitted), because a dangerous condition is believed to be present UNSAFE, for buildings that cannot be entered except by local regulatory authorities, because they have collapse, partially collapsed, or are in imminent danger of collapse from an aftershock.	ATC 20-2 p. 1
AF_016	Changing Placards	By a representative of the local building department and that the posting will be enforced by local authorities.	ATC, p. 17
AF_016	Removing Placards	By a representative of the local building department and that the posting will be enforced by local authorities.	ATC, p. 17
AF_018 – AF_024	Reporting and Information	ATC 20 Rapid Evaluation safety assessment form ATC Detailed Evaluation Safety assessment form	ATC 20-2 p. 4
		One of the most basic capabilities needed to adequately respond to an earthquake disaster is to have a computer database program available for immediate use. It is vitally important to begin recording observations made during the very early phases of emergency response (e.g., windshield surveys) to inform local, state, and federal officials of the extent of damage. Safety evaluation teams using the ATC Rapid and Detailed Evaluation forms will later collect considerable data each day that must be stored in an orderly manner and be available for quick access.	ATC 20-2 p. 17
		Laptop computers and networking capabilities are also useful in recovery database management.	ATC 20-2 p. 19
AF_017	Other markings		

Personnel

RQ #	Topic	Comments	References
		Personnel	
AU_001	Types of Personnel	Engineers, architects, building inspectors	ATC20-2 p. 1

RQ #	Topic	Comments	References
	Category	Engineer	
AU_004	Professional Certification		
AU_007	Pre-Event Training		
AU_011	JIT/Event Preparation		
AU_012	Relationship		
AU_013	Liability		
AU_014	Capabilities		
AU_015	Types of Assessments performed		

	Category	Building officials	
AU_004	Professional Certification		
AU_007	Pre-Event Training		
AU_011	JIT/Event Preparation		
AU_012	Relationship	4.	
AU_013	Liability		
AU_014	Capabilities		
AU_015	Types of Assessments performed		
		Rapid Evaluation	ATC 20-2 p. 3

Building Damage Assessment

RQ #	Topic	Comments	References
	BDSA Type:	**Area Assessment, Windshield Assessment**	
	Local Name	**Preliminary or "Windshield" Survey**	
AG_001	Goal	Determine the scope of safety risk and damage in the jurisdiction	ATC 20-2 p. 4
		A preliminary evaluation carried out within hours after the earthquake. The main function of this survey is to quickly provide preliminary information to the jurisdiction, such as: • The general extent of damage within the community, • The extent of areas with high-intensity damage, • An estimate of the number of obviously unsafe buildings, and • The extent of other obvious unsafe conditions.	ATC 20-2 p. 20
AG_003	Description	The survey has been called a "windshield" survey because it is usally done by driving the streets and quickly observing and recording obvious damage, generally without stopping to post individual structures.	ATC 20-2 p.4
AG_015	Types of Buildings Teams Can Assess		
AG_037	Legal Authority		
AG_005	Dispatched By		
AG_038	Implementation	Within hours of the earthquake	ATC 20-2 p. 4
AG_006	Team Members	It is usually performed by police officers, firefighters, or building inspectors.	ATC 20-2 p. 4
		Safety evaluation volunteers may be requested to assist.	ATC 20-2 p. 4
		An "ideal" survey team might include a building official who knows the community thoroughly, and a structural engineer with practical experience in all kinds of construction. Under emergency circumstances, however, the survey might be done by firefighters or police officers observing building damage conditions as they respond to other specific emergencies.	aTC, p. 15
AG_009	Team Size		
AG_010	How Selected		
AG_016	Interior/Exterior Check?		
AG_018	Assessment Outcomes		
AG_020	Info Gathering Tools	Detailed maps should be ready, and an agreed-upon colour and symbol system should be inplace. This system should indicate building type (commercial, industrial, etc) and observed level of damage. The classification of damage should be compatible with the INSPECTED, RESTRICTED USE< and UNSAFE placards used in the Rapid and Detailed Evaluations.	ATC 20-2 p. 20
AG_028	Assessment Time		
AG_030	Destination for Info Collected		

RQ #	Topic	Comments	References

RQ #	Topic	Comments	References
	BDSA Type:	**Rapid Damage Assessment**	
	Local Name	**Rapid Evaluation**	
AG_001	Goal	This … is designed to quickly designate the apparently safe and the obviously unsafe structures. Those not specifically designated, the so-called gray area structures, are then designated for a more detailed visual examination by a structural engineer.	ATC p. 13
		Rapid assessment of safety. Used to quickly post obviously unsafe and apparently safe structures, and to identify buildings requiring Detailed Evaluation.	ATC, p. 15
AG_003	Description	The Rapid Evaluation Team, which usually has two members, first identifies both the apparently safe and the obviously unsafe structures and then continues on to evaluate more difficult damage conditions that may require the Restricted Use posting.	ATC 20-2 p. 20
AG_015	Legal Authority	Performed under the direction of the local building department.	ATC, p. 16
AG_037	Types of Buildings Teams Can Assess		
AG_005	Dispatched By	Performed under the direction of the local building department.	ATC, p. 16
AG_038	Implementation		
AG_006	Team Members	Usually has two members	ATC 20-2 p. 3
		Ideally, two building inspectors or a building inspector and an engineer make up a team. Under more pressing circumstances, a building inspector and an unlicensed engineer might form an acceptable team.	ATC 20-2 p. 20
		Qualified building inspectors, Civil/structural engineers, architects, other individuals deemed qualified by local jurisdiction.	ATC p. 15
AG_009	Team Size	Ideally, two	ATC 20-2 p. 20
AG_010	How Selected	Designed for use by individuals with at least 5 years experience in general building design, construction, or inspection. This includes building inspectors in particular, as well as volunteer civil/structural engineers, architects, building contractors, and others who have been involved in the building design and construction process. …. The damage inspectors need to have a basic familiarity with building construction so that structural damage or any unusual situations can be readily recognized.	ATC, p. 17
		Individuals with previous postearthquake building safety evaluation experience as well as those who have participated in special training programs will generally make excellent choices.	ATC, p. 17
AG_016	Interior/Exterior Check?	Implied: external	

RQ #	Topic	Comments	References
AG_018	Assessment Outcomes		
AG_020	Info Gathering Tools		
AG_028	Type of Placard System		
AG_030	Assessment Time	10 – 20 minutes	
AG_030	Destination for Info Collected		

APPENDIX 4.9: ATC BUILDING DAMAGE SAFETY ASSESSMENT PROCESS

RQ #	Topic	Comments	References
	BDSA Type:	**Detailed Building Damage Assessment**	
	Local Name	**Detailed Evaluation**	
AG_001	Goal	This inspection… is designed to result in the rating of all structures as either safe, potentially dangerous (i.e. limited entry), or unsafe.	ATC p. 13
		Careful visual evaluation of damaged buildings and questionable situations. Used to identify buildings requiring and Engineering Evaluation.	ATC p. 15
AG_003	Description	Inspects buildings that are more difficult to assess.	ATC 20-2 p. 3
AG_015	Types of Buildings Teams Can Assess		
AG_037	Legal Authority	Performed under the direction of the local building department.	ATC, p. 16
AG_005	Dispatched By	Performed under the direction of the local building department.	ATC, p. 16
AG_038	Implementation		
AG_006	Team Members	Under the OES Plan, the Detailed Evaluation team will include a building inspector, a structural engineer, an architect, and other specialist as needed to address specific situations.	ATC 20-2 p. 3
		Structural engineers; Geotechnical specialists required for assessment of geotechnical hazards	ATC p. 15
AG_009	Team Size	Preferably as a member of a team of at least two persons.	ATC, p. 16
AG_010	How Selected	Ideally Detailed Evaluation should be conducted by damage investigators with experience in structural design and insights into the earthquake behaviour of buildings.	ATC, p. 25
		…may have to make do with available resources… Normally, structural engineers, structural plan checkers, and other engineers with structural design expertise will be excellent choices for this task. Additional desirable qualifications include 5 to 10 years or more of experience, previous postevent inspection experience, and knowledge of earthquake effects on buildings.	ATC, p. 25
AG_016	Interior/Exterior Check?	They are to make a detailed visual examination of the questionable structure for purposes of assessing whether the building is (1) apparently safe and can be used, even though it may require repairs; (2) unsafe, and must not be entered by anyone, or (3) still questionable and must be subject to an Engineering Evaluation.	ATC p. 16
		A Detailed Evaluation is a thorough visual examination of a damaged building, inside and out.	ATC, p. 25
AG_018	Assessment Outcomes		
AG_020	Info Gathering Tools		
AG_028	Assessment Time	1 – 4 hours	ATC, p. 15
AG_030	Destination for Info Collected		

APPENDIX 4.9: ATC BUILDING DAMAGE SAFETY ASSESSMENT PROCESS

RQ #	Topic	Comments	References
	BDSA Type:	**Engineering Assessment**	
	Local Name	**Engineering Evaluation**	ATC p. 15
AG_001	Goal	After this evaluation [Detailed], any further evaluation would normally be done by a structural engineering consultant retained by the owner to prepare an Engineering Evaluation of the structure.	ATC p. 13
		Detailed engineering investigation of damaged buildings, involving use of construction drawings, damage data, and new structural calculations.	
AG_003	Description	Such a study will typically include detailed reconnaissance and mapping of the damage, preparation of structural calculations, and a quantitative assessment of the strength of the damaged structure. It may also involve preparation of plans for emergency repairs (e.g., shoring) to enable the structure to be placed back in service during the immediate postevent period.	ATC p. 13
AG_015	Dispatched By		
AG_037	Implementation		
AG_005	Team Members	Structural engineering consultant; Geotechnical specialists required for assessment of geotechnical hazards	ATC, p. 15
AG_038	Team Size	One or more	ATC, p. 16
AG_006	How Selected	By owner	ATC, p. 15
		…require hiring a structural engineering consultant, who may need to remove portions of the building to complete the examination.	ATC, p. 111
AG_009	Types of Buildings Teams Can Assess		
AG_010	Interior/Exterior Check?	Implied interior and exterior	
AG_016	Assessment Outcomes		
AG_018	Info Gathering Tools		
AG_028	Assessment Time	1 – 7 days or more	ATC, p. 15
AG_030	Destination for Info Collected		

Appendix 5: Site Visit Participating Organizations and Agencies

The research team met with participants from a number of organizations, agencies, and levels of government. While the participation of individuals is confidential and anonymous, the following are groups that the team met with:

Auckland City Council

University of Auckland

Christchurch City Council Building Consenting Unit

Holmes Consulting

Royal Commission representatives

Tonkin and Taylor

Aurecon Group

Dr Sjoerd Van Ballegooy

Hong Kong Engineering Institute conference

Housing New Zealand, Area Managers for Christchurch

Canterbury Civil Defence Emergency Management

Institute of Professional Engineers

Wellington City Council - Building Damage assessment

Architecture School

NZ Ministry of Business, Innovation and Employment

Housing New Zealand

Hurunui District Council

Kaikōura District Council

Appendix 6: Recommendations Based on Site Visit Analysis

One of the key sources of data emerging from the Site Visit is a series of recommendations developed by members of the research team. These recommendations came directly from field notes (e.g., team members recorded key concepts, principles and recommendations while in meetings), and from subsequent review of their notes.

The recommendations are provided in two parts. The first column in the table is a “recommendation” for the team to consider in developing the BC damage assessment framework. The second column provides a link to field notes or contextual notes that support the recommendation.

All recommendations were consolidated into a single table. Each recommendation was then reviewed and coded, looking for themes related to the research questions. Each recommendation was coded against a “primary” theme, and also coded to additional, related themes. In this appendix, recommendations are grouped into their primary themes. Note that the recommendations have not been further organized or analyzed within these themes.

These recommendations will serve as a primary source of data for analysis and synthesis by the research in conjunction with other data sources.

6.9.1e TECHNICAL REPORT
APPENDIX 6: RECOMMENDATIONS BASED ON SITE VISIT ANALYSIS

Guiding Principles

Recommendation	Context/Data Element
Allow for changes in scope and governance as events unfold. must be able to accommodate transition from local to regional governance/operations if required.	September – CDEM not that involved. Ensure assistance was going on, and that it was being done well. Didn't have a lot to do with building assessment Feb 2011 Regional and local got joined together in one large coordination centre
Need graduated model for describing building status: USAR, RDA, 2nd level, engineering - markings, placard, Interim use, permits	
Consider having countermeasures capability to facilitate having people stay in homes	KK pull down chimney, then patching tarp, then family could stay in house.
Need to establish relationships between individuals and groups prior to events.	*****Biggest thing I learned; where there are relationships in place before things go better; where communication went well, things worked; when went poorly, usually not listening to each other;
KEY POINT - while our focus is on RDA, need to ensure we support transition and BA in broader context	KEY: Great at responding, but not so hot at recovery.
Need to articulate an overall process, not just BA procedures	** – guidelines how to do assessments but not how to manage process
Note that standards and thresholds change in an emergency setting. While this is to be expected, need to ensure there is good conversation and good understanding about this.	To be frank, most buildings damaged after an event, when you flip to building act get notices to be dangerous buildings – threshold is quite high – many probably wouldn't make the grade if challenged – however, practical, in an event, do what has to be done Chattam house rules on this
Framework must balance local process with national/prov guidelines. Common foundation, and adapt, but not each LA having its own system.	I think that comes in on the supporting systems. Last thing we wan tis local council to have own system; national process, so you can get engineers from around the country and they use same tools, processes, consistency (KEY – what's standard, what's local)
system must be scalable and adaptable; Local responsibility, but varied ability and resources to support.	Council can take ownership locally; build own resources; problem for lot small district councils; no budget or resources; rely on bigger councils
Examine how process changes when scaling from local to regional	If ours, we can do what we want; when you're not in charge, and having to go through 4 agencies to get a helicopter, very frustrating
Need to consider DA as ongoing process over probable multiple events. Building status over time. Associate damage with particular events. Note changes in damage from different events.	Difficult to distinguish damage from which event, which is problem for insurance. 1500 commercial buildings demolished
Sample size of 1. Each event unique; strategies not necessarily generalizable	KK – we'd been through it; put what we'd learned into practice. KK isolated; access cut off; only way in and out was air;
Need process to access local wisdom and knowledge, but within process and framework.	Driven by volunteers, particularly in the engineers. Wisdom and knowledge is in the community How do we get out of their head and into processes

	Clearly mandated processes and not let legislation get in the way
In initial response you want to get simple data quickly and accurately	In initial response you want to get simple data quickly and accurately
System is likely to be too conservative; experience changes how assessors evaluate buildings	PL – one of our concerns – people without experience being overly cautious – impact on emergency services; concern that we might be too overprotective; where do you find that line.
Don't rush in: do recognizance [? Reconnaissance?], sending advance team, know what you are getting into (maybe expanded scope of windshield-type-level, depending on event?)	
Have to consider the social and economic considerations as well as building itself. ? Strategic	Somewhere along the line, 27,000 where are you going to put all these people? Ongoing costs, lack of resources, talking a little bit of recovery;
allow room for innovation and use of alternate groups of people	CTV – immediate response – monitoring the building while the rescue team was in – monitoring to look for changes, moving, settling in real time.
Need to plan for scale of event	Operation suburb – 54000 houses on the east side 216 teams, 1 BI, 1 engineer, 1 welfare staff; 17800 houses per day
Guidelines: do you want to do a lot quickly or some with quality.	Day 1 everyone man and their dog hits the street to do assessment Some good, some not Do you want to do a lot quickly Or some with quality
Keep requirements and processes lean to allow for simpler solutions.	Kept things pretty simple – did it lean? Is it out of level?
Processes must be flexible and adaptable enough to meet needs in different regions with different levels of support and resources.	PL ? community volunteers? Varies across the country – registration process, but not well maintained – 17 teams across the country
Build with support from top, but response from local.	Bottom up sustainability framework; district plans, etc. focus on things they want to keep; council administers both; they should talk, but not always like that – particularly after an earthquake
Single biggest thing learned was to have the relationships (with geotech's) in place in advance. Need the names and contracts in place before the emergency	To facilitate the quick deployments of geotech personnel, a contact list is required in advance
Best laid plans - ensure that model/framework allows for people coming from outside the formal system. Especially in the first couple days.	Good to have that database, but if we have another event, they'll just show up whether they have the training or not.
Process must be able to be put into practice within 3 days.	Get underway with a process that will allow engineers, architects, others to get out in the field, day 3 on
Framework must include guidelines on supporting/accommodating staff and assessors.	Lack of accommodation. Look after your staff.
There will be hearings. Document and sort from the start.	There will be hearings or commission after that. Start storing rubble. Documented system on how things are taken down. Here so this doesn't happen again.
Need core group of expert personnel to maintain intellectual leadership over time.	Summit group – broad representation of building and engineering and architecture people – lead

	people in the engineering and geo and volcanologist and Civil Defence – Tier 1, but greater role as extra responsibility act as a clearing house for what we are doing in documentation. Last summit group, put through Tier 2 training and terms of reference. Getting guidance on the next step;
As groups develop expertise, we need a way to recognize, tap into, and collect that expertise to improve the system and inform the "next time."	We wound up having two types in ** Building inspection tribe in suburbs Engineering tribe – self-mobilized under different management structure By different focus, BI residential focus; engineers with the commercial Mental smart allocation of resources; operationally, this was difficult to manage
Create banks of guidelines, tips, stories tagged to different issues.	Lot of stories came out of protecting each other from things that others hadn't seen – holes in the floor, wires in the ceiling – hazards that weren't obvious to people walking around
Core goal of field guide: ensure consistency of process and documentation at individual level, but allow flexibility to meet unique needs of different situations.	Set up field guide to ensure consistency of process and documentation at individual level, but flexibility to meet unique needs of different situations. In different communities, different needs – range from hold your hands to life safety;
Keep requirements as specifications rather than solutions. Technology, situation at hand, etc. make "hard wired" processes difficult to implement.	The technology has changed. We have the ability to access information. New can capture a whole face of a building.
Need to examine BC building code and goal posts of assessment.	** – building standards are around life safety – about staying intact. Built to survive earthquake. Sept was a design earthquake for the buildings in ** – they were through it, but that doesn't mean they were intact; just that they had survived the first event. It stood up; but damaged and not able to stand second.

6.9.1e TECHNICAL REPORT
APPENDIX 6: RECOMMENDATIONS BASED ON SITE VISIT ANALYSIS

Damage Assessment as a Complex Process

Recommendation	Context/Data Element
Note overlap of USAR/EM with damage assessment and changing goals/operations over time. Need to consider how to acknowledge, allow, support these transitions.	All teams throughout NZ were pulled down here. Large part of the role of CDEM was managing teams. Brief teams each day; working with engineers – large part was searching and clearing buildings; dealing with rubble and crushed cars; 3 or 4 months. Key role was supporting engineers and entry into damaged buildings.
Decision-making complex exercise - not just a matrix/rubric.	Arguments could be really complex – placards
DA is more than just the building inspections - NZ analyzing data and noted types of buildings more susceptible to damage - led to re-investigation and re-placarding.	Ran three sessions on how to perform targeted assessments of the 72 buildings in wellington Quickly recognized because of the dynamic characteristics of the earthquake that a set of mid-rise buildings were likely to be damaged and with a particular type of damage.
Process must have a variety of facets - structural damage, land issues, danger from surrounding buildings, geotechnical hazards, larger area-sized issues (e.g. liquefaction).	Geotech community mobilized itself in ** – houses okay, but rocks and slides waiting to take them out.
More than just LA assessment in place - need to consider other processes and how they interact with LA process.	Some people in school district, etc., checking their own buildings, but not in position to placard for the council, but want to let their own people know what's up.
Need to consider "prior to level 1" - how to support and incorporate Ad Hoc phase	PL: Prior to level 1 damage assessment: initial triage: where do we even start? Thoughts on how information was collected?
More than just building assessment.	Other thing that happened in port hills, building inspectors go around with green; geotech sees big rock, then slaps red sticker on. Later on and engineer says building is fine; takes off the red. Geo techs working to the side; info falling down through the gap, not making it on to the spreadsheet – people tearing stickers off, hard to know whether they had been red stickered, geo techs sent back to check to see that red stickers were still on while aftershocks going on.
BA more than the building. Have to look at property and other potential hazards.	Need to inspect the entire property – hanging over edge
Need to have overall framework from act to plans on the ground - have to have - and be seen to have - links up and down the chain.	CDEM framework • Own act, 2002 • National cdem strategy – regulation • Into a plan national cdem plan – regulation • From plan make up plans for on the ground • Local risk reduction
Allow for changes in scope and governance as events unfold. must be able to accommodate transition from local to regional governance/operations if required.	September – CDEM not that involved. Ensure assistance was going on, and that it was being done well. Didn't have a lot to do with building assessment Feb 2011

	Regional and local got joined together in one large coordination centre
Need graduated model for describing building status: USAR, RDA, 2nd level, engineering - markings, placard, Interim use, permits	
Consider having countermeasures capability to facilitate having people stay in homes	KK pull down chimney, then patching tarp, then family could stay in house.
Need to establish relationships between individuals and groups prior to events.	*****Biggest thing I learned; where there are relationships in place before things go better; where communication went well, things worked; when went poorly, usually not listening to each other;
KEY POINT - while our focus is on RDA, need to ensure we support transition and BA in broader context	KEY: Great at responding, but not so hot at recovery.
Need to articulate an overall process, not just BA procedures	** – guidelines how to do assessments but not how to manage process
Note that standards and thresholds change in an emergency setting. While this is to be expected, need to ensure there is good conversation and good understanding about this.	To be frank, most buildings damaged after an event, when you flip to building act get notices to be dangerous buildings – threshold is quite high – many probably wouldn't make the grade if challenged – however, practical, in an event, do what has to be done Chattam house rules on this
Framework must balance local process with national/prov guidelines. Common foundation, and adapt, but not each LA having its own system.	I think that comes in on the supporting systems. Last thing we wan tis local council to have own system; national process, so you can get engineers from around the country and they use same tools, processes, consistency (KEY – what's standard, what's local)
system must be scalable and adaptable; Local responsibility, but varied ability and resources to support.	Council can take ownership locally; build own resources; problem for lot small district councils; no budget or resources; rely on bigger councils
Examine how process changes when scaling from local to regional	If ours, we can do what we want; when you're not in charge, and having to go through 4 agencies to get a helicopter, very frustrating

Ongoing and/or Multiple Events

Recommendation	Context/Data Element
Need to consider DA as ongoing process over probable multiple events. Strategy for reassessment	Difficult to distinguish damage from which event, which is problem for insurance. 1500 commercial buildings demolished
Need to consider multiple events. Not a static process.	Tricky when you have multiple earthquakes. Limit to number of times you can inspect the same building. Have to make a call at some point. This building was inspected by our engineers before we reoccupied it. We put up fire signs, but we've had 1400 bloody earthquakes. What are we doing about that?
Ongoing event; status changes as conditions change (e.g. additional shocks)	Sept shook it up a bit, 22 feb came along and shook it down
	we've had 1400 bloody earthquakes. What are we doing about that?

Overlapping Assessments

Recommendation	Context/Data Element
FF, USAR, and RDA all different types of assessment. Goals in first days are different than in subsequent phases of response and recovery.	First assessments critical in the firs couple days – ours took longer, two teams had to part ways. Relationship splits in second week – different focus with FF/USAR
Emergency response, USAR and RDA different process that are hard to combine - but can overlap when appropriate.	Fire act impact USAR, but not damage assessment Hard to combine two processes, but ability to share intel. Even Rapid building damage assessment asking if building might hurt someone. Hard to merge, but usefulness is different from how to repair.
LA is not only group doing assessments. Need to acknowledge this and incorporate in pre-planning and in post-event processes.	PL: were there other authorities or others doing own assessments (e.g. hospitals, schools); but may have training. Yes, building managers go through; schools, hosp; did cause some problems. Own engineer some of the engineers did own placards and reports – information didn't get to the Centre. Some were green when they shouldn't have been.
Consider whether or not non-LA assessment and placarding is looking at different things? How do different models/assessment inform/interact with each other?	** – schools, etc. impact triage with placards, owners' responsibility to do more formal assessment; triage is about immediate access to the building; generally speaking, placarding done reasonably well;
Need to consider whether to incorporate geotechnical assessment or suggest as separate but overlapping assessment.	Geotech rapid response
Leverage BA process with other types of assessment or EM functions.	Building inspector; engineer; USAR; welfare – aim to get into house quickly, do the assessment, wellness check – save a lot of time in one inspection
Need process to identify resources for short term countermeasures. Resources and processes will necessary vary between communities and incidents.	? recommended practice to use USAR Not in **, not available But in small community Why? Did have teams do some of that stabilization work. Didn't do the rescue team, engineer per se. Doing it pretty much on their own.
More than just structure involved in building assessment. Need to educate owner/occupant as well.	Having to explain to people; if the chimney going to fall, people get it; need to see that if there's a rock that could fall, same thing;
Need to understand different processes, standards, outcomes of private and non LA assessments. ? Tie to validation and use of knowledge?	building owner employing an engineer, this is where you start to see differences; where you get CTV building collapse – different standards. Didn't remove linings, didn't pick up cracks in the building;
More than structural damage.	**: geo tech side; liquefaction. Comment again; liq not a life safety issue, so wasn't a priority; could just send a geo tech out; but from a human perspective; thoughts on that? And Prioritizing
Targeted assessment process = reinvestigation of a category of building based on emergent damage patterns.	Quickly recognized because of the dynamic characteristics of the earthquake that a set of mid-rise buildings were likely to be damaged and with a

	particular type of damage. This is what you should look for, if you see it, this is bad news. This is what you have to look for in this type of event. 11 buildings were found with the targeted assessment in which there were significant problems and half a dozen were taken down. KEY: Not deficiencies, but once we got more information, assessments became more refined.
Develop process or guidelines for temporary shoring and countermeasures	SB did volunteer groups take down chimneys, etc. **; yes, spent a lot time with fire making chimneys safe – four pieces of wood and wrap it up to stabilize; not as big an issue in Feb as most taken care of in Sept.
Did Volunteer Rescue Teams help to make homes safe to occupy similar to SAR? Yes, in September they worked with fire service to take down chimneys	Other personnel can accompany the DA teams to perform one-stop services for occupants to keep them in their homes
Overlap with USAR and other EM - how to deal with people in imminent danger.	No firm way of dealing with people that are in imminent danger.
Guidelines for initial phase where USAR and RDA overlap.	Rescue teams involved in BDSA – escort engineers, particularly into commercial buildings – USAR 5 minutes, 10 min, all day in this building: USAR engineer – tell people how long they could go in there. Rescue team held engineers to that.
Need to consider geo-tech assessment	Yes, better if teams have geo technicians involved from the beginning. We got that going very quickly in KK, but was after the building inspections. Have of KK cut off from the south, different group doing this – didn't do geo tech assessments. Took a while to figure out and had to send geotechs back in.
Guidelines and principles for USAR engineers or engineers supporting USAR in early phase.	Rescue teams involved in BDSA – escort engineers, particularly into commercial buildings – USAR 5 minutes, 10 min, all day in this building: USAR engineer – tell people how long they could go in there. Rescue team held engineers to that.

Core Concept: Building Status

Recommendation	Context/Data Element
Concept of assessment should be around Building Status, which changes over time and from different assessment perspectives.	** – sept, these assessments done; stickers; white doesn't mean building is fine, just good for now and get an engineer to look at it. Green stickers at the time.
Need system to monitor building status over time, from various assessments and also as status changes,	3 bins: 1. USAR approach –

and as event moves from response to recovery to repair.	2. BA program – 3rd bin – private consultants doing their won assessments
need process to allow challenge to building status decisions.	Were the categorizations challenged? Yes.
Building status change process - LA does placarding, but up to owner to take responsibility for moving things forward after that. Intriguing comment.	Let council run process for placarding, then owner take responsibility for moving forward & changing placards. Etc. contract engineer takes on another aspect
DA is ongoing process.	This is where we look at BDSA as something that happens over time.
Status can change; need to be prepared for things to go wrong.	CTV – building 115 people died Things go really wrong. Initially yellow, then to green.
Need to track ongoing status of building as it undergoes multiple assessments.	3rd bin – private consultants doing their won assessments. Start with existing placard and data then do their own assessment.
Need to consider placards in larger framework - e.g. Building Status to allow for changes, follow up, remediation, etc.	Placards worked well, but the follow up. Only thing we had was Detailed Evaluation; that could be quite and extensive and expensive process; Royal Commission considered using a sledgehammer to crack a nut – forcing owners to give information
Like this definition - should be basis of defining building status: what we know about the damage observed in the context of the event that has occurred and the information that is available at this time.	Usability based on the damage observed in the context of the event that as occurred
Need to consider geotechnical and ground/land issues as well as structural issues during assessment.	Timber frame can move a meter and twist, but main damage was from liquefaction Concrete slabs did worse – liquefaction

Overall Goal of DA: Development of Situational Awareness

Recommendation	Context/Data Element
Information available from multiple sources. Need to incorporate into overall situational awareness and deployment.	3 bins: 1. USAR approach – 2. BA program – 3rd bin – private consultants doing their won assessments
This is about interpreting information. Make use of visuals like maps.	Very paper based; maps of area printed on the walls.
Outside RDA, but use of technology for overall situational awareness.	Have a better understanding of what's happening through UAV or drones; redirect satellites for high resolution data; feed into GIS; where are significant collapse; where are bridges and roads out; could capture a lot more strategic data to help coordinate the response; satellite says this area looks bad; send UAV to get more detailed; then send drone to look at that building in more detail. Large scale data pictures;
beyond DSA, but photos and satellite useful for neighbourhood and regional situational awareness	Getting pictures of changing landforms Series of pictures Understanding the hazards and risks
If outside the knowledge base, struggled to make a call – need a way to say "this is outside my comfort zone"	If outside the knowledge base, struggled to make a call – need a way to say "this is outside my comfort zone"
Have someone going through USAR and other emergency response data to gather intel on buildings	Need some form of record assessment – going through the forms and intel – use USAR for this
Lesson learnt – get the right resources – know what you are going into before you deploy a lot of resources.	Lesson learnt – get the right resources – know what you are going into before you deploy a lot of resources.
take a moment and evaluate before you send resources up there. Send an advance team to reconnaissance and then deploy the appropriate resources.	take a moment and evaluate before you send resources up there. Send an advance team to reconnaissance and then deploy the appropriate resources.
Would have been better if the data had been organized into buildings of significance, those that we need to stay away from, etc.	The priority of buildings to be assessed The ability to share the results of the DA quickly, to generate safety for DA personnel
Situational awareness: need overall picture to effectively deploy teams. Need to be aware of geohazards at local and area level as well	access – liquefaction a problem – teams are activated, but how do you get them to the places they need to go.
Big lesson, when you have an event, have to step back, sept – whew – we've made it through – didn't think about the next. Need to get in and REALLY look at things.	Big lesson, when you have an event, have to step back, sept – whew – we've made it through – didn't think about the next. Need to get in and REALLY look at things.
Establish strategy on broad scale; consider bigger picture when establishing priorities	Needed to get supermarkets cleared so we could get food to the communities.
Need mix of local knowledge and external expertise to be effective. Either without the other not as effective.	**: Big city folks who think they know best; how do you best use the local people; Shane: employ them in your decision-making; we don't know everything; don't have a big city mentality; went a long way.
Develop and maintain situational awareness through daily maps of the city.	Daily maps of the city – good snap shot of what the city would look like after the level 1 survey; then

	people conservative on first, lots of red; map started changing red to yellow, yellow to green
Monitor status of areas and regions through daily maps with updated information.	Daily maps of the city – good snap shot of what the city would look like after the level 1 survey; then people conservative on first, lots of red; map started changing red to yellow, yellow to green
Need geotech risk map in advance of DA	Geotech info is needed to determine whether or not it's safe for the DA personnel to deploy into areas
Daily briefing/debrief and also clearing house meetings	
Planning and intelligence are key elements of process.	One of the most important planning and intel.
Definition of building assessment situational awareness.	Understanding what BA means – the data coming out of it – the meaning of it and the learning coming from it.
Develop initial situational awareness as quickly as possible - use helicopter or other means to get overview of situation	Get them out- get them in a helicopter – what do we need to do; where do we need to be Create a model of what we're dealing with

Strategies for Employing and Managing Damage Assessment

Recommendation	Context/Data Element
Need to acknowledge that private assessments are being done. Need method to capture and use that data.	3rd bin – private consultants doing their won assessments. Start with existing placard and data then do their own assessment.
More than algorithm and procedures. Must include guidelines and support for EOC and political dimension. Need to include political decision-making in situational awareness and decision-making support.	Naïve in not knowing how things work politically. Process needs to consider political processes – be able to steer politics when it tries to impose poor decisions.
Consider risk tolerance in developing rubrics - note increasing sophistication/nuance in NZ placard categories with experience	Categories are not hard to deal with at all. More for internal thing – distinctions are quite useful. Trick is trying to define the limits between categories. How much risk re you putting people at. No right answer to much of this – it's up to the judgment of the person. Does your training teach them - criteria?
Have multiple DA types to maximize engineering resources	Initial surveys don't need to be engineers
More than rubrics - decision-making complex. ? Layered decision-making process? Easy, so-so (technical), complex (multi-factor)	Did you add the human element – yes, but more in how to not let that influence your decision. Judgment more around logic and evidence – lots of competing interests.
Have multiple strategies for assessing large number of buildings; use insurance companies, private sector assessors	Buster: how do we mobilize an adequate number of assessors Insurance companies rolled out program for homes of clients
Damage will vary from one area to another in region. Need to take this into consideration in strategic deployment of personnel.	Some disagreement in room – person needs some understanding of building – not necessarily engineers, but…. Even with the size of this event. Half the city didn't know anything had happened… very little damage;
Damage patterns in residential different - need to consider in developing assessment processes and guidelines.	Timber frame can move a meter and twist, but main damage was from liquefaction Concrete slabs did worse – liquefaction
Ensure that the first stage of DA is the reconnaissance, and stage the incoming DA assistance so that it's staggered over time	Most people want to assist in the immediate aftermath of the event, but that willingness runs out after a few weeks or months
Think beyond immediate shock; be ready if there is another rattle	Lessons learned – evaluation work in KK this front of mind – buildings that didn't loose facades – needed to be proactive and barrier to be ready for if there is another rattle;
Strategies - need to become more nuanced over time.	How do we not do all 1200 at once; how do we become more nuanced as we go.
Include layer of decision-making above the team - how do they resolve complex decisions? Who gathers experience/knowledge of overall situation?	How would you pick who to do the plan and know that they have the background and expertise to even develop the plan. So much is exposure - time. If you pull it back and make it too conservative, it causes problems.
Need for teams with variable skills dependant on context, resources, availability	** – do you need GEO on each team ** – challenge in different times required by each group – consider putting diff #s – e.g. two or three welfare people with one team if they are going to

	take longer than the structural engineers: 1 geo tech, 1 building inspector, 3 welfare people – varies to meet needs of particular areas.
Need guidelines matching teams to needs of the particular situation.	What are the guidelines we should be giving – teams can't be static – need to match the needs of the particular situation.
Consider sending 2 or more welfare people with each DA team	Welfare meetings with occupants often take longer than the DA and this allows some to stay with the occupants while others move with the DA team to the next site
Include local welfare people on the DA team	They know the local issues
Consider cascading hazards that threaten buildings (e.g. dams on farms which provide water storage)	Include this info in DA reports to advise of unknown hazards that also need to be assessed
Would have been good to have geotech's go out with the building assessors, and also a welfare person	Geotech's identified safety risks in the field which DA personnel did not
Include a welfare check with the initial rapid DA.	
More than BA - need to consider geohazards	Most deaths rock fall and structural collapse. Rocks on the hills turned into missiles – some would go right through a building
Look for ways to leverage information from varied sources, but remember that data will be gathered by different personnel who have different procedures, terminology, and goals for assessment. Valuable, but must be contextualized.	PL were their assessments that USAR or others could do that would provide information that would be useful? GIS "pin" locations, but system unreliable, so sometimes not giving accurate locations. Their assessment criteria very different – get people out of house; frustration between inspectors and USAR; to the point we had to go in and reevaluate – they would placard as white, but we'd come back and do yellow
Incorporate varied sources of data for ad hoc phase.	How that information could be gathered to build picture on where to start? **: Not in a structured way. Social media; ** doing workshop Initial impact done by police fire service, being in the community and seeing what was being done. Ad hoc, data coming in
Incorporate varied sources of data for ad hoc phase.	Other thing from EM, critical where phone calls coming from, or not coming from;. Not getting calls from this area, so they are okay, but actually were hard hit areas where they'd be evacuated. Need to consider impact of all data that is coming from you. Ask "why aren't they communicating?" M: liq. National insurance lobby; very quick drive arrive – knew where we were likely to get liquefaction; not public, but experts knew – walked every street, got the extent of it, really; fly overs, aerial photography to identify areas that probably were affected. Sept – there was standing water from rains; but still; first pass to identify liq. Feb; hills area, geotech community got together, self-volunteered, split the hills into sectors; we'll take this

	one; mapped all the boulders, starting where the population was, then moving out; compared how they were mapping things; several iterations
Risk involved in using non-engineers during rapid assessment	When these rapid assessments are done, assessors are not necessarily engineers – that's the risk;
When assessing buildings beyond basic timber frame, you need to use people who are skilled in that type of construction	Additional skills are needed to assess complex buildings. Non-complex buildings can be assessed by (certified) builders
Note Blue category in mapping. Need to consider guidelines/methods for mapping and tracking status at neighbourhood, regional levels.	Red area - no rebuilding. Blue areas need geotechnical assessment, foundation specific to building. Focused geotechnical expertise into areas that they are needed. Over 7500 homes taken out.
Develop a map layer of buildings by height that can be overlaid with other info	Can help to prioritize DA based on ground motion and period, even if buildings are only rated as high, medium, and low heights
Acceptable to use multiple people to gather information and provide opinion - but ensure responsibility and decisions rest with experienced structural engineers when possible.	Engineers need to be the ones who make the decisions; we were care to not make judgments;
Lists of buildings to assess, and details of those completed, are required each morning	Staff worked overnight adding the results of DA from the day before, which was submitted on paper at the end of each day. Lists were often not up to date
Don't wait for calls to tell you that DA is needed	Assumptions were made that areas were OK because they didn't call to request assistance, which was not the case
Use of technically-prepared and trained non-credentialed personnel for simple residential, but not complex residential or commercial.	Technical people doing the residential; not the complex residential or commercial Level 1 externals, perhaps – technical people could do, but not complex buildings.
Use building wardens (similar to floor wardens and fire safety directors) to perform an initial DA. Provide them with pictures of existing damage and a list, and training, of what to look for	This is much quicker and more cost-effective than having engineers assess every building
Composition of assessing team will vary, with type of building	
Residential rapid assessment effective with non-credentialed, e.g. building inspectors. Beyond timber frame, need commercial construction experience.	residential wise, assessors pretty good; beyond timber frame, you need people who are really familiar with commercial construction,
BA - other buildings not so easy - take more expertise, and you have to look at bigger picture.	Others need more consideration This building leaning onto the building next door If fence was around, you might not notice
Use of surveyors to monitor buildings during assessment	CTV – immediate response – monitoring the building while the rescue team was in – monitoring to look for changes, moving, settling in real time.
Model how to employ non-engineers for specific types of buildings or assessments.	Has to be the RIGHT engineer, not just an engineer – other hand where you have building officials and facilities personnel, but not engineer, they could be assessing some types of buildings satisfactorily.
May have multiple types of teams for different strategies and/or regions (e.g. critical buildings, suburbs).	We wound up having two types in ** Building inspection tribe in suburbs

	Engineering tribe – self-mobilized under different management structure By different focus, BI residential focus; engineers with the commercial Mental smart allocation of resources; operationally, this was difficult to manage
Have multi-skilled teams perform the assessments	Some areas felt “over visited” due to the different types of DA which was required, causing multiple visits to the same buildings
Designate the non-technical people on the DA team as the “spotters”	at least one of the DA would remain outside of the building in a safe area
Need to have systems to ensure that teams are thoughtfully put together and make best use of expertise available.	From BO tribe perspective, got sent out to, different types of buildings. Sent up on the hills; others in areas affected by liq but not damage to buildings; in early days teams put together, bull rush – line up two captains, I want them I want those; I wound up with a team a group from welfare, red cross, st johns, go get someone; morphed over a couple days that pre-recon. Which was completely differently if the engineering evolved, we were required to take someone out – rapid group, do assessment, don’t have the expertise for full estimate, can you send them out. We can get through more cause we know the risks of this are now.
Identify buildings and assessment types for different levels of personnel.	Building control officers very good at understand design, but limits based on their reference (Tier 1, 2, 3)
Don’t look at magnitude, look at peak ground acceleration	Magnitude helps but PGA is more important for prioritizing the DA
Peak Ground Acceleration is needed as an overlay map with the homes to help prioritize DA	
Residential didn't generally require structural engineering.	Residential space – often overlooked or limited engineering involvement. Arch design, limited structural engineering. 50, 000 taken out by liquefaction – move that population about and rebuild. Will need engineering.
Have strategies at larger level; don't overlook "lesser" priorities.	Big challenge was first 8 months was to deal with the larger buildings 12 engineers concentrated on significant buildings; greater than 4 stories; 270 buildings to look after; went through each one systematically; quantitative assessment of each
Strategy and guidelines for neighbourhood assessment and response.	Public safety was paramount – prioritize areas, focused engineering resource; need info from “here” to unlock that part of the city.
Need for area strategy, guidelines, approaches. Consider using things like CCC,KK experience as examples of process. Broad guidelines (establish zones, determine priorities within zones, balance needs of various zones with available resources…) then use criteria and examples from our various interviewees as examples of what similar places did.	Initial triage – level 1: eastern suburbs lots of damage liquefaction; western ok, level 1 focused on eastern;

6.9.1e TECHNICAL REPORT
APPENDIX 6: RECOMMENDATIONS BASED ON SITE VISIT ANALYSIS

Perform DA on all buildings/areas where the responders will be working	Some locations were later found to be unsafe
Ensure that facilities are available to support the health and safety of responders	Some responders arrived back from a day of DA soaking wet, and unable to have a shower
Have an auditing team - a small group of very skilled engineers reviewing some of the DA results coming in against the actual building assessments	This helps with public trust, and ongoing training and information for the DA teams
Surveyor's can set up monitoring equipment on buildings to see if they were still moving, for example, while SAR is working in the building	Survey equipment can confirm if a building is moving or out of plumb
Send people to multiple sector areas to perform DA rather than focus the teams into one sector area.	In the early stage of the disaster, you need to give assurances to the community. Must share resources across multiple sectors (e.g. housing, business, industrial sectors)
If cordon needed, conduct assessments systematically to make cordon progressively smaller.	
Main arterial routes have to be safe – keep the main roads safe	Main arterial routes have to be safe – keep the main roads safe
need to balance priorities - life safety and future shocks should win	Become thick skinned to closing the business down -
While focus is often on life safety in complex buildings, sheer number of residential units requires strategies for dealing with their assessment.	Overlooked part, the humble little house, but taken together, they are what makes up the city. 99% of building portfolio is lightweight timber frame houses with brick cladding. Shake at 1 g and not a lot happens, even if it's wobbly. From a life safety perspective – other tan lighting, plumbing, structure itself not at risk of imminent collapse. Not a life safety.
Have strategies for neighbourhood, regional assessment	Cordon – get the city back to the people – 18 months; clockwise frame, shrinking to the centre. Set up CERA;
Process must allow identification and development of priorities for DA process - what areas or resources done first, etc.	Staged, prioritizing area where hazard is highest, e.g. wellington One of the things that happens here. At least make them strengthen the parapets – that's been added into the building act. Concentrate on the things that are real problems Focus on main arterial routes – prioritize
Different ways of strategizing overall DA at regional level.	In **, trying to get around – may hear how well they do as far as their Building dept goes – three or four days – scathing of us for not getting inspectors as quickly as they wanted. We put back, why did you want to do it that quick? Did it need to be done in 3 days, could you have prioritized the buildings to do – e.g. commercial, then residential, etc. Rather than blanket across all levels at once. Put criticism on us on how slow – there's a formal process, they tried the informal and got it done – caused grittiness and grumbling and got it done. In the end they got it done.

6.9.1e TECHNICAL REPORT
APPENDIX 6: RECOMMENDATIONS BASED ON SITE VISIT ANALYSIS

Goals of Damage Assessment Change over Time

Recommendation	Context/Data Element
While LA responsibility, may need to have separate structure to manage overall assessment over time.	CERA coordinated recovery and rebuild
post RDA blends EOC, insurer goals and processes.	Therefore an insurer-led response. 100000 loss covered, and land damage, NZ govt effectively the first loss insurance for the residential portfolio. Damage assessment becomes the cost-of-repair, rather than life safety.
Changing priorities from first days to when system fully in place	In first days in cordon, just doing rescue. Focus at the beginning on trained USAR, FF, about contamination in the basement, wires here, hazards, about to collapse; two days to stabilize the building. Victims, found, when, etc. When the council placard teams come in, much different focus.
Priorities change with different levels of RDA. NZ experience	First assessment is health and safety – welfare and life safety Second splits – engineers for red/yellow? Project managers and everyone to get at others – get in the roof, and walls, etc. – wall cracks. Change the nature/scope – Third is detailed engineering
Examine relationship between ad hoc and managed phase. Look for ways to support early assessment, use info, but transition quickly to more formal process.	Early assessment done by fire services – engineers with fire service, triage, recover bodies, USAR Once it gets to the point where that front has settled down, people get concerned about their own property.
Process for post RDA - goals of engineering assessment different.	That means that the engineering assessment has to be very different. Building owner has responsibility to get Engineering assessment; recovery manager can go to building owner and require you to do assessment – in process of figuring out how to do this.
Process and goals and outcomes will change over time.	Diverse from initial days to insurance wrap up
Status changes over time - need to consider how various assessment processes interact with each other.	Other ting that happened in port hills, building inspectors go around with green; geotech sees big rock, then slaps red sticker on. Later on and engineer says building is fine; takes off the red. Geo techs working to the side; info falling down through the gap, not making it on to the spreadsheet – people tearing stickers off, hard to know whether they had been red stickered, geo techs sent back to check to see that red stickers were still on while aftershocks going on.
goals change over time.	Emergency work shifted over time to working with insurance companies to get their insurance
goals of DA change over time.	Damage assessment takes on a different perspective. Insurance or long term perspective different.

	Lasting legacy that needs to be considered 95% had replacement insurance
goals of DA change over time.	Early on, it’s about is it safe to stay in that building for a time – will it provide shelter in the short term Questions change over time Can we repair, should be we rebuild fi this is just going to happen again
goals of DA change over time.	Over time; have to think about health and shelter – things change – e.g. weather. Liq concrete slab around the house, same inside – it just came up through the concrete floor
Need to establish goals and goal posts for damage assessment - return to function; new codes; another shock?	Requiring people to do seismic restraining – bring them up to code Brought in as a law, on council to do it

Overall Emergency Operations

Recommendation	Context/Data Element
Require process for accepting and using international help.	International office of help – managing that tis a nightmare – they come from everywhere – some you have to decline, some is good stuff; SAR was international – another thin you have to deal with – everyone wants to come help and how you deal with that. Probably two levels; operational level; gov wants advisors and how you make up making use; 2 guys sent by aus govt, they wound up being useful; they had experience in dealing with day 20 and 30 and temporary accommodation demands; they came unannounced – had to figure out what their experience was and how we could actually use that.

Damage Assessment Operations & Administration

Recommendation	Context/Data Element
Build in ability of people to be creative and problem-solve, while still remaining safe and useful.	Pretty dynamic. Some of our structural engineers work with USAR, so they called we us up. Role emerged over time, not preplanned;
Leverage USAR resources once initial life safety work is complete. E.g.. Countermeasures to allow temporary use of damaged structures, but still keep people in their homes.	Multiagency approach allowed inspectors to do their thing while welfare dealt with family and person; army and USAR could deal with some of the damage (e.g., pull the chimney down).
Deployment strategy at team levels: adaptable to use various personnel most effectively.	USAR – limits on time to spend on quick repair, shoring, etc. team start together on a street, but may spread out a bit; get split up and meet again at the end of the street; Groups assigned to specific areas, so we'd know where they were if there were problems.
More than an algorithm and a field manual. Need to consider processes behind these and also ways that they will be implemented on the ground.	Having people well trained – how to deploy them – how robustly will you do it? Process from response to recovery
Consider strategies for utilizing other non-credentialed (e.g., building practitioners - ? Property managers?) for specific types of situations - e.g. low risk, simple buildings, areas with minimal damage.	**: Whole operation is a triage operation; most of the inspectors had been builders; some may have had emergency management training, but most was on building buildings. Training that would be given here, 6 hours, broken down to be more palatable for those people. Licensed building practitioner scheme – build into that scheme – you must understand now assessment works, cause you may be called up to do this in the future. 50,000 licensed building practitioners – bit group of people that could be trained and available in a bunch of different places.
Leveraging assessments; criteria for when having social services works.	Residential BI with engineering backup has more focus on welfare and may require more interaction with owners – take a welfare person with you
Consider having social services and geo tech with assessors, when appropriate.	Works very much better, especially in rural areas, have welfare with building assessors and geotechs, they can do their job much better if welfare along
Use UAV's for tall buildings and detailed DA	
Need to consider this - easy to say: "don't do this," but not realistic. It's going to happen, how can we make it as safe as possible.	Teams helped residents to go back into the building to retrieve stuff – make sure they were safe
Factors to consider in logistics and administration	structural engineers tearing off stickers not knowing about the rocks and not looking for them. Less administrative nightmares; consultants not getting paid, etc. needs to be at regional level. Ensured that consultants that came in had sufficient insurance to cover liability. Have liability in place before them come in, Contracted expertise vs volunteer expertise
Time briefings to maximize use of information that is coming in before sending new teams out.	8 am briefings and only one manager – sometimes data not available because assessors already out.

	Sometimes not back in time for 5 pm debriefing. Moved to shifts to help with this.
Take into account that many of your local resources won't be available.	What you need to factor in, a lot of the locals aren't available themselves, dealing with their own issues as home; need to factor that in – let locals get own house in order before they can really help you out.
Focus resource needs beyond just assessment: on admin side as well: data entry, processing, rostering, worker safety, coordination/admin roles behind scenes, food/shelter/wellness of assessors, etc.	
Residential teams required smaller team of structural engineers	Engineers mobilized through IPENZ wound up in right place; had a small engineering group supporting the residential stuff, MBIE engineers, suspect at we might have used more,
Need to anticipate workload and competing priorities. Have either predetermine processes/procedures to support workload, or have ongoing process to consider issues and support personnel over time.	Workload issues – lots of request from different channels; people, politicians, business owners; putting unreasonable expectations; too chaotic, sometimes sending multiple people to same jobs;
Get operations set up before bringing in operational staff	Set up admin and then call up your operational staff; too difficult and frustrating – better to set up control, then add operations. Fools rush in…
Although DA coordination is high level, the local authority should manage the personnel	The Local authority needs to arrange the travel, accommodation, feeding, etc., and take ownership of the incoming data
deploy 2 managers and two admin staff in advance to set up the DA	an advance reconnaissance team is needed so that DA personnel can be immediately put to work on the ground
Be weary – public falsified placards (red for demo or red cross $) or green to occupy; an "ambulance chasers" post-event (layers, consultants, etc. looking to cash in)	
Be prepared for volunteers, international and other unregistered – how to manage	
Have Engineers declare whether or not they know what the building system is	To determine whether they've reviewed the design drawings and specifications
Safety guidelines for teams; establish roles, have plan for entry, egress	Have an exit plan – how you would get into and out of the building in cordoned off area.
Don't accept volunteers who are only available for a few days. Must be available for 7 days	Some DA personnel only wanted to help for a few days and acted like tourists
Bring people from outside of the disaster area to assist	Those within the impacted areas are likely also impacted themselves
If possible, have prepared kits with all disposable supplies needed to function effectively.	Problem of photocopier fluid… lots of paper and communication required. Battery life on cells; lack of internet access;
LESSON: Now have a drop in box with technology for the first couple days.	LESSON: Now have a drop in box with technology for the first couple days.
Have a pre -deployment checklist for the DA team	** EQ showed that several items need to be confirmed in advance of having DA personnel on the ground. Example: who was responsible to pay for what in relation to DA? Example, payment for the building that DA personnel slept in?

Have a container (drop box) containing all of the DA equipment and material	Field equipment is not readily available at the DA location
Provide DA teams with resources to deal with immediate needs during DA, or the means to communicate with those resources	Many homes found with burst pipes could not have the water quickly turned off, as USAR resources were required to do so and time was spent finding them
Ensure staff are sent with the appropriate safety gear	Some personnel cannot access their PPE, or do not think to bring it along for DA

Basic Damage Assessment Process

Recommendation	Context/Data Element
3 assessments past RDA, really: structural/damage assessment, loss assessment (insurer), and return to use/usability assessment (Robyn's comments)	? loss assessment vs. damage assessment. Need damage assessment to do loss adjustment.
Need to carefully think about what goals of engineering assessment are.	** – similar design is to life safety; all it is; nothing on damage mitigation at all; using post-earthquake assessments to move to damage mitigation standards – what that criteria will be is a big standard.
Consider triage-based system - anything with apparent structural damage referred to structural/geotechnical engineers.	Impact of structural damage on a structure – by and large experienced practical structural engineers, geotechnical engineers,
Layered response strategy, "triage" concept.	Four phases: Initial damage survey - survey to see what the city looks like; no placarding; done within a few hours of the earthquake Rapid level 1 – redone for yellow and reds; 415 engineers: 10000 building in a week or so; greens cleared; others get Rapid level 2; Rapid level 2 – when red buildings deemed dangerous, then yellows and owners required to do DDE Detailed engineering
Need to establish what DDE goal posts are and what factors to consider.	Normal service loading Wind loading Earthquakes of similar or less than main shock
Have several engineers on call who can be asked to review specific non-complex buildings which are being assessed by non-credentialed personnel	Operations East & Suburb were performed by many non-credentialed personnel, supported by engineers who reviewed some of the work
Risk in single story wood frame different from commercial structure	Risk in single story wood frame different from commercial structure
Note goals: usefulness, repair	Hard to merge, but usefulness is different from how to repair.
Have 5 importance levels for buildings: 1 is regular houses, 2 is __ 3 is schools, 4 is emergency facilities	Allows you to prioritize buildings
Ensure that the second DA is extremely thorough and includes a drawing of the floor plans	To avoid requiring third and possibly fourth assessments

Placards, Outcomes

Recommendation	Context/Data Element
Like the Interim Use category - more than placard, less than permit.	Rapid system, then Detailed Damage Assessment Interim Use Evaluation – all these buildings have had some damage – should do more than an external. Should pull the draw the
Need to consider notes to accompany placards - describing in more detail what categories mean for owners/occupants.	The reality is that you're still trying to protect the safety of the person. If you can put it on the placard and they can make their own judgment.
have category for partial use, or use with countermeasures	What can be utilized? Is one part safe? Structurally the house is fine. But the sliding doors blown out. Take those doors out and building could be fine. In KK, quite cut off, so more acute – where do you put people if you take them our of their houses?
Rate the condition of the home from 1-10 during the initial visit	When several hundred buildings have been assessed and also require a re-assessment, a numbering system helps to prioritize the follow up
One organization used 1-10 scale of damage at triage/rapid assessment 9then 7+ ranked building referred to engineer, others to trained personnel)	
Yellow sticker; can reoccupy, but needs to be seen by an engineer; but if that's there, shouldn't you go straight to engineering assessment.	Yellow sticker; can reoccupy, but needs to be seen by an engineer; but if that's there, shouldn't you go straight to engineering assessment.
take the approach that some parts of the residential building is safe (if it is)	Accommodations are limited, so you don't want to evacuate homes if you don't need too
BA - no/little damage easy, require little training or expertise	Looking at buildings. Some easy. Untrained eye…
Differences in residential damage and outcomes.	It's not shaking for residential, it's liquefaction – note this is damage in COST, not in life safety.
Definitions of placard categories and meaning. Consider green/white	Green does not mean it's okay; still damage – you can use the building.
Consider white placards - green has implications of safety and not needing any more work.	Green to white to deal with false safety expectations. People would stop at the green and not do follow up, thinking that it meant they were okay
Ensure the green/white placard includes a message that the building still needs to be checked in detail	People assumed the green placard meant it was totally safe
Use white placards instead of green	The public sees a green placard and assumes that no further action is required with the building
Changes to placards: green changed to white - Change in language – "no recommendations"	

6.9.1e TECHNICAL REPORT
APPENDIX 6: RECOMMENDATIONS BASED ON SITE VISIT ANALYSIS

Information Flow

Recommendation	Context/Data Element
Need to consider type, volume of information to be moved and ways of facilitating this according to conditions of specific event.	No communication at that time between field and office, but now would have through cell phone etc., with battery backup, etc. Could make calls, but not send large volumes of data.
Emergency response, USAR and RDA overlap, but should have ability to share intel.	Fire act impact USAT, but not damage assessment Hard to combine two processes, but ability to share intel. Even Rapid building damage assessment asking if building might hurt someone. Hard to merge, but usefulness is different from how to repair.
Info forms may need to be different for different types of events and/or situations	Different form for flooding; different for geotech which is quite different
Communication with owners/occupants	**: geo tech side; liquefaction. Comment again; liq not a life safety issue, so wasn't a priority; could just send a geo tech out; but from a human perspective; thoughts on that? And Prioritizing
LESSON _ need to work with telecom providers to support	Need to rethink how we set up – one of the first things we have to set up is a cell network; ? RF – emergency radio network. Radio repeaters on generators and very unreliable – even handhelds not useful
Have multiple options for communication and data collection.	Need to rethink how we set up – one of the first things we have to set up is a cell network; ? RF – emergency radio network. Radio repeaters on generators and very unreliable – even handhelds not useful
Develop "national"/provincial strategy for data management but have flexibility to implement based on context on the ground.	Someone at national policy level should develop systems; strategically better than individual CCC doing own systems. Most of that data was static
Need process to ensure that USAR data is captured, collated, and passed along in meaningful way to DA teams.	1. USAR approach – no idea if any data was captured. Focus on clearing building from people – was it strong on paperwork, more about getting people done. Justifying later quite frustrating. But that data never made it to the council
Results from private assessments and detailed engineering assessments - how to incorporate into situational awareness and overall building status.	What was damage, what would it cost, how to go about repairs. How does this information get shared with CC.
Map different types of assessments and stakeholders (e.g. property managers, CI owners).	**: were there other authorities or others doing own assessments (e.g. hospitals, schools); but may have training. Yes, building managers go through; schools, hosp; did cause some problems. Own engineer some of the engineers did own placards and reports – information didn't get to the Centre. Some were green when they shouldn't have been.

System to differentiate between assessments by different groups - ? Different types of placards? Paint, placards, notices?	**: USAR – with an engineer on the team – some confusion on their carding buildings, then assessment team coming in with BI, E, W – did you have experience.
Important to have way of validating/ranking/understanding quality of information coming in from different sources - ? Levels of Evidence model.	Quality mixed; CERA's role was to ensure quality – we had to be happy with it.
System to reconcile/understand different markings - need different ways to note status, but also to tie status to the type of assessment that was done.	Look at rescue marks, but might not know what they meant.
How to validate information that comes from different assessments?	building owner employing an engineer, this is where you start to see differences; where you get CTV building collapse – different standards. Didn't remove linings, didn't pick up cracks in the building;
Need to find way to accommodate varied assessment and outcome information generated by different teams of assessors. Not about generating a single, best placard - rather about gathering and disseminating important information about a building's status at any given time.	USAR was placarding – political pressure to show that assessment was done and "we were here." People expect such a response now.
Need to ensure that USAR data isn't lost, and is available to DA folks who come later.	Teams were first into the buildings – do rapid assessment, put up markings, then building assessors come in days or weeks later. Usually the USAR markings – rather than placarding per se.
how to "level" information from different engineers/processes	others called by tenants, did lift and find cracks – you shouldn't really be in there. Conflict between engineers that start to play a role in post disaster management.
Need to track assessments taking place from private landlords as well,	to avoid duplication and missed information
Should collect and document with insurance/other concerns in mind, though not as priority	Difficult to distinguish damage from which event, which is problem for insurance. 1500 commercial buildings demolished
Develop taxonomy/criteria for assessing quality of information and assessments.	Day 1 everyone man and their dog hits the street to do assessment Some good, some not Do you want to do a lot quickly Or some with quality
Information management is key. Need well-set up information flow that is adaptable to technology available.	Paper based – repetitive information, dealing with all the paper Logistical issues, end of day – map not updated, so problematic
Create a clearinghouse of documents to share amongst emergency groups	DA coordination must be situated within easy access to this info. The IPENZ info was very helpful
Need system to allow assessors to debrief and share experience/learning/guidelines on an ongoing basis. ? Wiki to post	Lots of value in the discussion after – what your judgement and why- what was the logical reasoning. Talking about your reasoning was the important.
Set up process for accepting information and developing situational awareness as quickly as possible	That info important- get the staff you need to do what is needed; not enough, hence the national; people from all over new Zealand

Difficulty in managing incoming info – need to go through one channel to triage/prioritise	
need efficient and effective info management system that is scalable and adaptable.	2. BA program – lots of paper forms, of which there were always behind. Forms done day before day after, huge issue on managing tremendous amount of prep and data.
Have a central registry of the building types	Same as above
Need some form of documentation of meaning of incoming information	Need some form of record assessment – going through the forms and intel – use USAR for this
Critical to collect data whenever the opportunity arises	Collection of information has been of huge value for the ongoing disaster recovery Highly valuable information that has many uses Critical to collect data whenever the opportunity arises
Information plan has to extend past immediate or initial assessment to keep owners/occupants aware of changing conditions.	Had to send notices to building owners to let them know that engineers were going to be doing more invasive work – lifting carpets, opening walls, etc. take the pressure off the individual engineer; need for formal conversation to facilitate assessments. As the science improves, how do we better get the information out.
Ideally, way for on the ground assessors to access plans, drawings, particular for complex buildings	Access to drawings at CC – wat that a problem? They had difficulty – hard copy, off site, disorganized.
Have a GIS system publicly available to see DA results	To find out about the condition of a building you had to walk right up to the door to see the placard
Note that communications and data movement ability will change with time over an event. Methods for first days different than after a week.	
Now have a deployment form	Now have a deployment form
Need proper document tools and procedures. Have range to accommodate variable situation (e.g. lack of power or internet)	Lesson: don't give pieces of paper – have packages; with coverage, real time electronic very useful.
LESSON – find a single funnel for requests and jobs to reduce chaos	LESSON – find a single funnel for requests and jobs to reduce chaos
Need adequate resourcing and processes to manage incoming information flow and provide useable intel.	Paper based – repetitive information, dealing with all the paper Logistical issues, end of day – map not updated, so problematic
Need to resource information management from the start	2. BA program – lots of paper forms, of which there were always behind. Forms done day before day after, huge issue on managing tremendous amount of prep and data.
Data management: store if can't transmit.	Store information onboard equipment, then take it back to office, and upload to system.
Need data entry processes and resourcing to keep up with information that is coming in.	Engineers coming back with lots of reports, data entry couldn't keep up, first week or so; working long shifts; next morning when map came out, some areas hadn't been entered in the city; system wasn't real time.

6.9.1e TECHNICAL REPORT
APPENDIX 6: RECOMMENDATIONS BASED ON SITE VISIT ANALYSIS

Be aware that data entry and analysis are overnight/early morning tasks.	Engineers coming back with lots of reports, data entry couldn't keep up, first week or so; working long shifts; next morning when map came out, some areas hadn't been entered in the city; system wasn't real time.
strong recommendation for pads and tablets over paper, but have to problem solve power and download/connectivity issues	Pads and tablets would help: challenge –no power;
Need robust, scalable information management system - excel to GIS	No thought to information systems Spreadsheet – 250 buildings very simple tabular spreadsheet...Problems due to number of assessments taking place – close to 1000 buildings in ** alone, day 3 we started doing arterial roads out of central ** – 7 or 8 of those...Number of assessments grew quickly 10 or 20 people in the art gallery take the paper forms each night, enter into the spreadsheets Lose the spreadsheets every now and then, then amalgamate spreadsheets
Information system is going to evolve with the event.	4th or 5th day, council GIS team up and running to produce map – no blame, no one had thought about time and money into this kind of problem and setting up a system How can we provide the supporting infrastructure and systems
Ensure that the electronic database of DA results is widely accessible	An in-house software product made it difficult for outside personnel to access
Have an app that provides for the reporting needed	Residents, and DA personnel, could report what's needed more quickly if both had access to an app
Consider the impact of publicly posting the results of DA	One impact impaired business to buildings perceived as unsafe, a week before Christmas
Communication systems critical: - Between teams; with key decision makers - With public, people knowing what their home is placarded, what that means, etc. (education pre-event, flyer/notice post), green/white doesn't mean no damage, red doesn't mean demolition	
Digital documentation idea., paper back up always needed – data entry issues with paper (need lost of ppl to keep up overnight)	
Technology can create problems: network availability, devices, user management.	Challenges Internet and network availability Mobile devices- batteries, availability User management
Information system should link business as usual with event - pre and post	Worked great for business as usual, but not for these types of queries. Made it difficult to get info for third party agencies once it was in ** processes.

Recruitment and Types of Personnel

Recommendation	Context/Data Element
Have a 3 tier group of DA personnel • Tier 1 – the control group of 40 people o The summit group is a subset of the control group, representing a cross section of each stakeholder group. Performs all the regular role plus have a separate TOR describing extra tasks (need copy of TOR). • Tier 2 – building officials, engineers, architects, geotech's Only ones authorized to sign placards. • Tier 3 – building officials, engineers, architects (3 or 4 in each team)	Allows for focused expertise
Volunteers: online registry, (not excel!) same for all volunteers (managed by ?); have tiers, profession (somehow verified?), monitor education and renewal (Cont. Ed)	
Anticipate variation in background, expertise, ability.	Getting lots of assessments of various quality of limited use Even in training – varied understanding of construction form Differing expertise
need long term strategy to ensure engineering and other assessor resources are used effectively.	All buildings had to have DDE – commercial; residential greater than 2 swellings townhouses and apartments; onus on the owner; had to submit those to the CERA; put massive strain on the engineering resources
Have a pool of trained assessors throughout the country who will be activated for large events, but not local events	Smaller communities don't have the budget or resources to maintain a pool of personnel
Need mechanism for bringing in professionals for extended responses	Get 3 days voluntary by most communities; need memorandum of understanding that allows engineer to work for council; protected under their umbrella; signed by people and council or professional body; between non-council led staff – the person and civil defence.
Recruited personnel must have adequate briefing before going into area.	Not enough intel for staff; No briefing, poor communication; email, but no prep for what you were going into
Personnel and personality management are critical in selecting and deploying teams.	Some egos and personalities – everyone wants to be the hero Have an interview process to get the right people to be there – the right attributes to work in this.
Process for recruitment of personnel should include formal and informal networks, pre-event planning and post-event problem-solving	Every event has pulled BI and engineers – both ad hoc and formal way. BI often know each other – can you come help, and they come. When those networks get short, they go through us – we need 20 bI in three days time. Both ad hoc and formal Formal way can be quite slow at time – (KEY) ad hoc / relationship based

	Haven't heard of those coming from outside and parochial type issues
Need to consider how trained personnel are recruited at the local/incident level.	** – rapid building assessor designation – 400 assessors accredited. They are the ones that would be the assessor with the various teams. If you have an earthquake, who contacts these 400? ** – I don't know. ** what would your preference be? What agency best suited to maintain that list, contact people. ** – best way through the councils' engineers – they have the relationships, rather than emergency managers. Whatever they do for the council, needs to go back to the council – yes, it's being managed, no it's not being managed. Don't see us – as emergency managers – managing that process. The councils maintain their own database and should be ones doing it.
have the MOU signed between the Engineering Association and Civil Defence, so that individual people didn't have to sign their own	An MOU is needed for personnel who will perform DA, and having an overarching agreement is easier to manage
Have an interview process for selecting the engineers and DA team members	Some people wanted to be the hero, or wanted to be the manager, instead of wanting to assist with the role they've been selected for or are needed for
anticipate that people in the local community who would normally perform a role are not available	They have likely been impacted and are having to deal with the impact to themselves and their family
Have a list of staff which outlines their skill, AND, their willingness to go outside of their normal geographic area to assist	Some people are willing to assist only within the immediate area of their home
Anticipate that local engineering resources will be exhausted after a short time	Engineers will be assisting their clients with repairs and other work after the initial response
Have a dedicated volunteer management group	Needed a place to direct the convergent volunteers to

APPENDIX 6: RECOMMENDATIONS BASED ON SITE VISIT ANALYSIS

Training

Recommendation	Context/Data Element
Legal framework matched to event stages, goals of assessment, priorities in moving forward. Must ensure clear legal and liability considerations across event.	Tension clear an emergency don't want to infringe on property rights. No power to function outside the emergency. Can't clear people unless you declare a state of emergency.
Add a section to the Building Code to "Manage buildings damaged after an emergency event", which ensures the authority/power needed up to the point that the building is repaired	Legislation to inspect and require the repair of buildings is needed outside of the state of emergency
Ensure the Residential Tenancy Act provides landlords with access in the event of an emergency	Access to the suite without notice is needed in an emergency

Legal Issues

Recommendation	Context/Data Element
Special power (re: BDSA) to recovery managers to manage placards/buildings after state of disaster ends or if one not declared (or if ended and aftershocks)	
Need to consider legal, liability issues of temporary countermeasures.	Only done with building owners consent; if really unstable, might do it if no owner available Under emergency, no liability unless really negligent.
Legal authority must include access, assessment, and outcomes.	Full suite of powers – • Do rapid building assessments • Require further information • Require remediation • Specially provides for heritage • Includes a property rights framework
Need overall clarity - pre-event - on what legal grounds are and what power are.	1 – better planning, better response, consistency, clear set of powers people feel confident using
Lack of legislative power meant that local authority can't designate a building dangerous due to seismic/liquefaction risk. Being revised now in NZ.	
To address, CC formed CERA to handle recover and ongoing assessments	
need to understand legal, financial implications of placard categories	Welfare agencies put monetary value on placards – neighbour got red, so got 1000; I have a green, but want a red;
Need some way to embed the placard into legislation	If placards are tied to the emergency legislation, it must include authority which extends beyond the declaration of emergency
Include legal permission to enter buildings - both in initial and ongoing phases	Did you have the right to go inside buildings?
Consider legal basis for status and placarding/permitting as moving from emergency to business as usual.	Had to transition to the building act as the emergency receded Legal – had to have process to keep placards effect in place All of a sudden, we had to change to building notices
Legal framework matched to event stages, goals of assessment, priorities in moving forward. Must ensure clear legal and liability considerations across event.	Tension clear an emergency don't want to infringe on property rights. No power to function outside the emergency. Can't clear people unless you declare a state of emergency.
Add a section to the Building Code to "Manage buildings damaged after an emergency event", which ensures the authority/power needed up to the point that the building is repaired	Legislation to inspect and require the repair of buildings is needed outside of the state of emergency
Ensure the Residential Tenancy Act provides landlords with access in the event of an emergency	Access to the suite without notice is needed in an emergency

Psychosocial Aspects

Recommendation	Context/Data Element
need to consider psychosocial impacts of event	Lots of social issues, still – blaming the truancy rate on kids who went through the earthquake –

Consider social and psychosocial impacts on team over time	Energy that comes with an event like this. Everyone is in the same boat – lots of anxiety. Lasts a week or so, then people get tired; business is affected; kids are having issues; then dealing that would do anything to help; that that put barriers and roadblocks in front of you. Want to just give them a good shake;
Train Coordinators/Managers to understand how staff react after an EQ, and how they may be reacting differently as a result of their experiences	Some Managers or Supervisors did not manage the reactions of their staff very well, based on a lack of knowledge about PTSD
Ensure that stress debriefing is performed after each deployment	Some personnel encountered issues from their work (e.g. pets found starving after being left in cages; vermin and pests in homes with rotting food)
Need to consider stress and CIS	** – kiwis pretty good – but need to be put into consideration. Don't do well is manage the stress related issues that follow on after deployment – checking that people are okay. Stress debriefing.

Models and Taxonomies

Recommendation	Context/Data Element
Need to identify differences between building types for different assessments - for building taxonomy, may include height.	DDE Difference if you have a two story and a 27 story. Come of them needed a lot more work than others – some needed analysis and modeling and others were simpler.
Taxonomies - check Importance Level as part of strategic process for prioritizing BA	Need some form of record assessment – going through the forms and intel – use USAR for this
Building Taxonomies - include heritage buildings	Heritage buildings bit sensitive – dangerous, they kill people; others – we need to preserve them; they are a important; symbol of the argument; can't figure out the way forward; tricky buildings to restore; but how? Comes down to money –
Use list for building taxonomy.	All buildings had to have DDE – commercial; residential greater than 2 swellings townhouses and apartments; onus on the owner; had to submit those to the CERA; put massive strain on the engineering resources
Have buildings categorized as Tier 1, 2 & 3	This allows for easy direction of DA expertise to complex and non-complex buildings
• Apply an importance level to all buildings: o level 1 is a garage or garden shed o level 2 is a house or an office o level 3 (can be damaged but must be repairable within a level of time) for EOC's o level 4 (must be capable of continued operation) for hospitals o level 5 is a hydroelectric dam	To assist with prioritization of DA and remedial action
Terminology: Building assessment (no 'damage', no 'safety'), usability	
Ensure heritage building legislation is considered in DA	Heritage buildings have different provincial and/or local legislation which may not be aligned with the needs in an emergency situation

Geotechnical and Building Surveillance and Intelligence

Recommendation	Context/Data Element
Consider including concept of Indicator buildings, both for pre-event monitoring (with building surveillance) and post-event for monitoring for subsequent events.	Defining indicator buildings – list.
incorporate formal or informal indicator building process for post-event monitoring	Couple of us would go out – we were familiar with the buildings. Yes especially with the aftershocks, and non-standard aftershock patterns;
Use of indicator buildings to see what types of buildings are being impacted in an event and how; what buildings do we have to worry about?	**: Indicator buildings – more from wellington – picking out buildings of certain variety, loading them up with sensors, get an idea of how they respond, what response should be required. ** – buildings of different heights react differently; load them up and see what happens
Geotech database – sharing info between companies during rebuild/insurance claim phase	
When selecting "Indicator" buildings, must select based on period, construction type, and features. Include both highly and less vulnerable land profiles. Select buildings within close proximity of teams to assess quickly.	Indicator buildings help to reduce the reassessment process
Incentive programs for insurers and building owners to participate in pre-event monitoring, etc.	Get the insurance companies involved – monitoring the building, give a 10% rebate on my insurance…. Really good insurance incentives.
Include knowledge of area and geo hazards in deployment and planning.	Access was a real logistic challenge, particularly with slippage, road damage. Very rural area
Need access to background information on buildings	Who actually knows the structural systems of that building actually is.
Need access to background information on buildings	Having the electronic records of building information is really valuable
Indicator building program/sensors	
Measurement of quake magnitude not relevant, use pga 9peak ground acceleration) = can be monitored by pre-installing sensors – link to indicator buildings project, and project map/ID buildings (types/risks) ahead of time	
Need db of building stock, with taxonomy of building types, and ability to develop/add to taxonomy during event.	Problem with that made it difficult to pull out information in the response – wants to make response decisions about tasking engineers – we've heard this style of building has not done well, can you tell us what other buildings like this – difficult to do.
Ideally, should have access to information on buildings over the years.	Responsible for buildings and authority – managing that information, matching to their knowledge of the buildings across the years.
Local authority to have database of contact for owners/tenants – once assessments complete, so they can all be contacted	
Target Building Inspectors to residential and simple buildings. Good use of their expertise.	Did engineers get involved in residential buildings – mostly BI. That was a better use of BI expertise? Yes.

Pre-event planning to include geotechnical hazards	Can identify pre-event neighbourhoods that may have geo tech hazards; do that for the whole region, then pull out the maps you need when the earthquake hits.
Key characteristics of a pre-event monitoring program.	• Need knowledge of your building inventory • Knowledge of modeling of your buildings • Instrumentation of the buildings • Allows targeted monitoring and assessment. • Decision-making processes
Gather info in advance on who the engineer was who designed the building, and what other info can be prepared electronically	This info is valuable for complex buildings and should be easily accessible during an emergency
Pre-event assessment of building/soil types – ideally mapped in GIS (possible grant project; Wellington Smart Seismic city program) – have at risk blogs ready to ID based on quake type	
Ideal: possible to have province-wide GIS map based system to plug into? Or app? (i.e. smaller communities don't have resources for their own)	
Use technology to integrate building surveillance into BA processes, including situational awareness	80 accelerometers around the city now – once it hits the golden number, then will shut down structures;
Use PGA to prioritize DA	EQ magnitude and potential for damage are not correlated. Correlation between the higher level of shaking (magnitude) and the volume of liquefaction. An even greater correlation exists for PGA
Develop indicator building process.	Indicator buildings – we are in favour of that and will be putting something in place In wellington used successfully, narrowed down to 80 buildings that were re-visited Likely to be a small guidance document – 4 pages, as a note rather than a publication, recommending to councils that they do pre scoping and look at categories of buildings in their area, talk to owners about pre-inspection and monitoring;

Appendix 7: Stakeholder Workshop Participants' Worksheet

Thanks for your interest and participation in this project.

This worksheet is a ***Data Collection tool***, as well as a resource for you during the day. We will be asking you, throughout the day, to complete activities and jot down notes using this worksheet.

You will be asked to turn in the worksheet near the end of the day so we can collect your thoughts and input. Please let us know if you would like to keep a copy of your notes – we'll be happy to make and return a copy to you.

Please note that your comments will be anonymous – we will NOT be recording your name or any information that would allow us to identify you or associate you with your comments and input.

Also, please note that each section has a checkbox that you can use to identify sections of notes that you ***DO NOT WISH TO BE PART OF THE PROJECT DATA***. If you check off the box, we will not include the comments from that section in the research study.

If you have any questions or comments, please check in with any of the project team: Ron Bowles, Steven Bibby, Peter Mitchell, Pete Learoyd, Robyn Fenton, Paul Becker, Marguerite Laquinte Francis, or Dawn Ursuliak, or send an email to rbowles@jibc.ca.

Thank you!

Agenda

Time	Activity	Comments/Notes
15 min	Introduction	Formal opening; welcome from partners, etc.
5 Minutes	The Terminology Wall	Overview of terms and definitions exercise.
	Part I: Learning From Others	
15 min	Scenario	Scenario with initial questions: • What would you do? • What would you need? • What do you not know? Or not have (resources)?
45 min	Debrief and Introductions	Participants introduce self, role, interest and one point from scenario exercise
30 min	Project Overview	Introduce Research Team, project overview, findings to date
Rest of morning	Expert Presentations	10 – 15 minute presentations from key national and international experts
	Lunch	
	Part II: Stakeholder Input	
15 min	The Survey	Open discussion on the survey results and comments.
20 min	A Generalized Building Assessment Framework	Overview of generic BDSA model, based primarily on the New Zealand 2014 model
60 minutes	Table/Wall exercise	Carousel exercise. Groups rotate through tables that contain material on key concepts. Groups answer prompt questions, then rotate to the next table. They review what's been written, then add new comments.
30 min	Table Exercise debrief	Summary and discussion.
15 min	Gaps	Things we don't know we don't know.
20 min	Parking Lot discussion	Review Parking Lot issues and prioritize concepts for further investigation
15 min	Next Steps and Wrap	Summary and Next Steps Wrap up

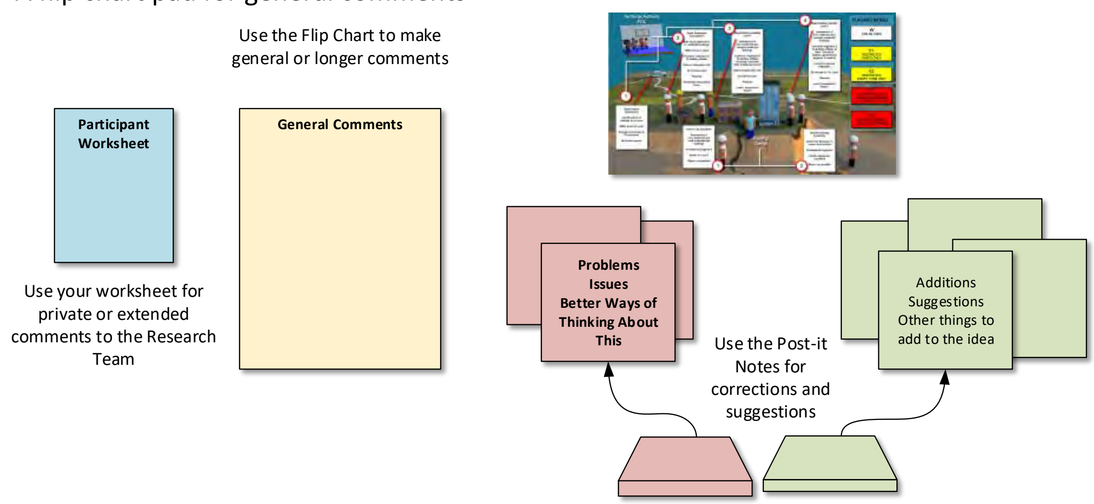
The Words Wall

We have placed a number of posters around the workshop rooms. These posters include descriptions of key terms, concepts, and programs that we have encountered in our research. We've found that various programs use different terms and phrases to refer to similar ideas, and sometimes use the same words to refer to very different concepts. The intent of this activity is to give you some familiarity with the core concepts and key ideas we are working with and to start to work towards a common set of terms and definitions for a BC Building Assessment program.

How to use the Words Wall

We invite you to browse the walls, read the posters, and give us your thoughts, comments, and ideas throughout the day. Each "idea" will generally include:

- A Poster or display that presents a concept, idea, or BA program.
- A set of Red/Orange and Green/Yellow post-it notes and some pens
- A flip chart pad for general comments



Please read and think about the concept or program. You can provide your thoughts in a couple ways:

On the Wall:

- Post your thoughts and comments using the post-it notes! Use Green/Yellow stickies for comments that extend, support, or enrich the ideas. Use Red/Orange stickies to indicate comments that challenge or address problems or issues you see with the concepts.
- Use the Flip Chart pad to make general comments.

Privately:

- Use the following pages to make any comments or notes for the research team that you would rather not provide publically
- Email us your comments and thoughts (both during the workshop and any time in the next week following the workshop) at our Damage Safety Assessment email account: DSA@jibc.ca.
- Speak to any of the project team members

Workshop Opening

Welcome to the BC Building Assessment project workshop.

Our first activity is a chance for you to meet your "table"-mates and consider your personal context for participating in building damage assessment.

We will open with a scenario involving a disaster set in a BC context. At your table, we want to consider the following questions. You can introduce yourself and discuss these with your colleagues, but we ask that you please use the area below to record your answers (as part of our data collection!).

Check the box if you DO NOT want your answer as part of the research data.

Write your answers in this area.

1 Define your roles in a scenario such as. For example, would you be in the EOC (if so, which EOC & in what role), Critical Infrastructure Owner/Agency, potential Building Assessment assessor, etc.)?

☐ **DO NOT Collect as data**

2 What would you, particularly in relationship to building assessment?

☐

DO NOT Collect as data

3. What would you need in order to perform those functions (e.g., training, tools, practice, etc.)?

☐ DO NOT Collect as data

4. What do NOT KNOW? Or what do you NOT HAVE (e.g., resources)?

☐ DO NOT Collect as data

Project Overview

Use this page to record any comments or questions you have for the research team about the overall project itself and the research we are conducting.

1 Notes, Comments or Questions for the Research Team:

☐ DO NOT Collect as data

Expert Presentations

Use this page to record any comments or questions you have for the research team in regards to the expert presentations.

Presenter:

☐

DO NOT Collect as data

Expert Presentations

Use this page to record any comments or questions you have for the research team in regards to the expert presentations.

Presenter:

☐

DO NOT Collect as data

Expert Presentations

Use this page to record any comments or questions you have for the research team in regards to the expert presentations.

Presenter:

☐

DO NOT Collect as data

Expert Presentations

Use this page to record any comments or questions you have for the research team in regards to the expert presentations.

Presenter:

☐

DO NOT Collect as data

Expert Presentations

Use this page to record any comments or questions you have for the research team in regards to the expert presentations.

Presenter:

DO NOT Collect as data

Expert Presentations

Use this page to record any comments or questions you have for the research team in regards to the expert presentations.

Presenter:

DO NOT Collect as data

The Survey

We thank you for taking the time to complete the survey. This session is an opportunity for us to present some initial collation of the data and to have an open discussion about the questions in the survey. Please use the area below to list any questions, comments, or suggestions related to the survey and discussion to the Research Team.

DO NOT Collect as data

In this session, we will present a simplified, generic building damage safety assessment model, based primarily on the New Zealand 2014 model. Please use the area below to pass along your comments, notes, and suggestions to the Research Team.

Expert Presentations

Use this page to record any comments or questions you have for the research team in regards to the expert presentations.

Role of Building Assessment in overall Emergency Management:

☐ DO NOT Collect as data

The Current BC Model:

☐ DO NOT Collect as data

Generic Model – a starting place to build upon:

☐ DO NOT Collect as data

Personnel and Teams – Who should be involved, how should teams be formed?

☐ DO NOT Collect as data

Training and Support:

☐ DO NOT Collect as data

Information Flow and Documentation:

☐ DO NOT Collect as data

Any other comments or thoughts!

☐ DO NOT Collect as data

Stakeholder Input Session

In this session, you will work in groups to review several aspects of building assessment. You will, as a group, record comments and provide input at each station. Please use the following pages to record any personal or private thoughts that you would like to pass along to the research team. Please note the name of each station that you provide notes on.

Station 1:

☐ DO NOT Collect as data

Station 2:

☐ DO NOT Collect as data

Station 3:

☐ DO NOT Collect as data

Station 4:

☐ DO NOT Collect as data

Any other comments related to the Stakeholder Input sessions:

☐ DO NOT Collect as data

Stakeholder Debrief Discussion

Please provide any personal comments or feedback on this session to the Research Team:

☐ DO NOT Collect as data

Gaps

Please provide any personal comments or feedback on this session to the Research Team:

☐ **DO NOT Collect as data**

The Parking Lot Discussion

Please provide any personal comments or feedback on this session to the Research Team:

☐ **DO NOT Collect as data**

Last Thoughts

Please use this page to provide any last thoughts or comment to the Research Team:

☐ **DO NOT Collect as data**

Thank you!

Thank you for your interest and participation in this workshop. We truly value your contributions and appreciate the time and expertise you have brought to the day.

☐	Please check this box if you would like a copy of your notes.
	Please provide an email address that we can send the copy to:
	OPTIONAL SECTIONS You are under no obligation to agree to any of the following items. There will be no negative consequences to not participating in these sections. You retain the right to withdraw you and your data from the study at any time by notifying the Research Team.
	Optional: Your name. Please note that we will not include your name or any identifying information with your data. Your contributions and participation will be confidential unless you specifically agree to being identified.
☐	**Optional:** Please check here if you would like the Research Team to contact you to discuss any aspects of the workshop or the research with you. We will do our best to get in touch with you in the next week.
	Best contact method and details (e.g., email address, telephone number:
☐	**Optional:** **Please check here IF YOU ARE WILLING TO BE IDENTIFIED AS A PARTICIPANT IN THIS WORKSHOP.**
☐	**Optional:** **Please check here if YOU ARE WILLING TO BE IDENTIFIED AS THE SOURCE OF SPECIFIC QUOTES FROM THIS DATA.**

Appendix 8: Stakeholder Input and Expert Working Group Attendees

Expert Working Group June 26 and 26, 2017		
Name	**Organization**	**Contact Information**
Agostino Goretti, C. Eng., Ph.D. (Travel from Rome)	Seismic and Volcanic Risk Office Civil Protection Department	Via Vitorchiano 4 00189, Rome, Italy Land. +39 06 68204226 Mob. +39 320 4326130 (Whatsapp) skype name: agostino goretti agostino.goretti@protezionecivile.it agostino.goretti@tiscali.it
Satoshi Tanaka (Travel from Tokyo)	Graduate School of Environment and Disaster Research Tokoha University	325 Obuchi Fuji, Shizuoka,417-0801 Japan Tel:+81-545-37-2047 tanaka_s@fj.tokoha-u.ac.jp
Ayse Hortacsu (Travel from California)	Director of Projects Applied Technology Council	201 Redwood Shores Parkway, Suite 240 Redwood City, CA 94065-1175 USA 650/595-1542 Fax 650/593-2320 ayse@atcouncil.org
Fred Turner (Travel from California)	Alfred E. Alquist Seismic Safety Commission Aa public policy advisory agency of State Government	1755 Creekside Oaks Drive #100 Sacramento, CA 95833 USA Land Line 916-263-0583 *Note New Phone Number Fax 916-263-0594 Turner@StateSeismic.com

David Swanson, PE, SE LEED AP, F. SEI (via Skype)	Principal/Director, Structural Engineering Reid Middleton	Washington Office 728 134th Street SW Suite 200 Everett, WA 98204 425-741-5011 | Cell: 425-508-7971 Office: 425-741-3800 | Fax: 425-741-3900 dswanson@reidmiddleton.com
Daniel Stevens	Director of Emergency Management City of Vancouver	453 West 12th Ave Vancouver, BC V5Y 1V4 604-829-4370 daniel.stevens@vancouver.ca
Dr. Carlos Estuardo Ventura, P.E., P.Eng.	Professor and Director of Earthquake Department of Civil Engineering The University of British Columbia	6250 Applied Science Lane Vancouver, B.C, V6T 1Z4 phone: (604) 822-6946 mobile: (604) 319-6946 fax: (604) 822-6901 ventura@civil.ubc.ca
Mike Andrews	Acting Director Emergency Planning Officer North Shore Emergency Management Office	147 E 14 St North Vancouver, BC V7L 2N4 Direct 778 338 6306 mandrews@cnv.org
Arnie van Hattem	Ministry of Transportation and Infrastructure, South Coast Region	Suite 310 – 1500 Woolridge Street Coquitlam, BC V3K 0B8 604-678-4708 / 604-788-2515 Arnie.vanHattem@gov.bc.ca

Glenn Cooper (travel from Victoria)	Team Commander CFB Esquimalt USAR Team |BFC Esquimalt ELSARMU Canadian Forces Base Esquimalt | Base des forces canadiennes Esquimalt National Defence | Défense nationale	PO Box 17000 Stn Forces Victoria, Canada V9A 7N2 Telephone | Téléphone 250-363-2774 Cellular | Cellulaire 250-213-8853 Facsimile | Télécopieur 250-363-7935 Glenn.Cooper@forces.gc.ca

NOTE: Per Informed Consent requirements, names of individual participants are not included in this document. However, the participating organizations and agencies are identified.

Stakeholder Group – June 26, 2017 only		
Name	**Organization**	**Location**
	BC Liquor Distribution Branch	Vancouver, BC
	Emergency Management BC (EMBC)	Victoria, BC
	Emergency Management BC (EMBC)	Victoria, BC
	Earthquake Engineering Research Institute British Columbia Chapter	Vancouver, BC
	Bowen Island	Bowen Island, BC
	BC Hydro: Generation Civil Design	Vancouver, BC
	Vancouver Airport Authority (YVR)	Vancouver, BC
	Chief Building Official City of Vancouver	Vancouver, BC
	Regional Emergency Planner Integrated Partnership for Regional Emergency	Vancouver, BC
	Regional Emergency Planner Integrated Partnership for Regional Emergency	Vancouver, BC
	Shared Services BC	Vancouver, BC
	Structural Engineering Association of BC (SEABC)	Vancouver, BC
	Applied Science Technologists & Technicians of BC	Vancouver, BC

	Building Officials Association of BC	Vancouver, BC
	Hollyburn Properties	North Vancouver
	Health Authority	Vancouver
	Health Authority	Vancouver
	City of Delta	Delta
	City of Port Coquitlam	Port Coquitlam
	City of Port Coquitlam	Port Coquitlam
	BC Housing	Vancouver

Appendix 9: Research Team Members' Goal Statements (Themed)

<table>
<tr><th>Theme</th><th>Statement(s)</th></tr>
<tr><td>Framework and Scope</td><td>Articulate a BC process for PDBA
Provide the system structure to facilitate the implementation of a PDBA programme by authorities
Harmonized program between municipality and provincial and country
An operational damage assessment process in BC
All stakeholders buy-in and participate
Legislation put in place as needed
Communities develop own D.A. programs that harmonize with/provincial programs</td></tr>
<tr><td>Process</td><td>Command and control processes are established
Have process in place for municipality to have authority over placards/assessments from declared emergency response to business as usual. (NZ model)
A process is developed which coordinates the input of credentialed / non-credentialed individuals so building damage assessments are carried out and documented in an appropriate, effective and timely fashion
A framework is provided giving clarity on the types of buildings the various categories of credentialed and non-credentialed people are to focus on so their effectiveness is maximized
Reduce professional liability</td></tr>
<tr><td>Characteristics</td><td>Meet the contractual obligations, while staying within scope
Framework is sustainable, regularly reviewed / updated
Strong foundation
Adaptable to context
Framework is simple / scalable
Scalable and adaptable to both community level and other jurisdictions
Useful resources</td></tr>
<tr><td>Components</td><td>Have a clear framework with definitions, roles, processes that can be implemented easily
Practice guidelines
Models, tools, resources to support (eg. Building taxonomy, personnel matrix)
Create an easy to use tool kit that facilitates emergency response by
Providing communication plan
Outlining plan of attack (and assist with how to prioritize)
Developing a plan that is easy to implement for various emergencies: fire, flood, earthquake etc. and include details related to each
PDBA manual / field guide framework / documents</td></tr>
</table>

	• Have a clear process for development and training • Plan for provincial implementation • Possible draft sample bylaw language

Appendix 10: Research Team Members' Hopes and Dreams Statements (Themed)

<table>
<tr><th>Theme</th><th>Statement(s)</th></tr>
<tr><td>Vision: an Exemplar System that is Scalable, Adaptable and Adopted in Different Jurisdictions/Contexts</td><td>Provincial program expands to become a national standard. Supported and initiated by every province.
Seen as resources / experts
Exemplar system that other countries, regions draw upon
Multiple countries harmonize their D.A programs with Canada to create an international standard for D.A.
Supported by UN (UNDAC), including funding</td></tr>
<tr><td>Awareness, Utility, and Acceptance by Stakeholders</td><td>Usable and seen as usable by BC Stakeholders
Stakeholder buy in / collaboration
Stakeholder both internal and external to local authority i.e. – EMBC, professional organizations etc.
To achieve buy-in from regional stakeholders to facilitate the implementation of a D.A. programme at local authority level
Empowering local abilities to own/run their own DA programme
Enhance disaster response capability in BC</td></tr>
<tr><td>Implementation of a Functional System at Multiple Levels</td><td>Pilot simulation
3-5 year plan for implementation
That a local authority will adapt and validate that system / structure in practice
This program is adopted by municipalities, large and small, and helps them be more prepared/resilient
Community roll out
Leads to rolling out framework across Canada
Emergency response incorporated into plans</td></tr>
<tr><td>Resolution of Issues around Liability and Education</td><td>Liability issues are resolved with clarity
Provincial legislation is changed to indemnify professionals acting in emergency response
Consistent documentation is developed for various types of assessors
Emergency response and damage assess is incorporated / required in professional training university required To embed the framework training within JIBC curriculum with appropriate responders</td></tr>
<tr><td>Sustainability and Enrichment</td><td>Long Term Vision for enrichment / further development
All stakeholders support the framework so it can be implemented and maintained
To explore further funding for important issues that arise that are outside of scope
Sustainability needs to be kept in mind</td></tr>
</table>

	• Connected Phase II sustainability / continuation planning and funding • projects i.e.- building monitoring

Appendix 11: Themes from Key Points and Principles Data Related to Goals and Principles

Table 1: Themes in Key Points related to Overall Goals and Functioning of PDBA

Themes
• Adaptability • Aware and capable • Complex process • Decision-making rationale • Differing needs – e.g. buildings, assessments assessors, etc. • Goals: usability, safety, others • Information collection, organization, distribution • Information Validity • Intelligence – gathering and keeping current • Legal: can handle (no need for emergency powers), emergency powers, business as usual • Local vs external personnel and processes • Logistics • Overlap with other EM and Local Authority processes • Pre-planning • Process, guidelines and Interpretation • Situational Awareness

Table 2: Themes in Principles related to Overall Goals and Functioning of PDBA

Themes
• This is about information management • This is about situational awareness • This is about adaptation to local need and context • Remember this is a formal process: legalities, evidence, documentation • PDBA is an ongoing process that changes over time • Fools rush in – take the time to set up procedures and infrastructure before sending people in • Assessments are complex and overlapping (BA and EM and LA) • Keep things as pragmatic, practical, and simple as possible • Building efficiencies with other processes and assessments • Plan for multiple events (both in framework and on the ground) • Need to adapt to BC context • More known and preplanned the better • Develop taxonomies of buildings, requirements, goals, assessments, assessors • Solid guidelines and frameworks, with adaptation and agility in implementation is critical • Allow emergence and adaptation of decision-making and thresholds • Assessments change over time • Be sensitive to time and efficient (as goal) • Stay focused on the goals of the project and the framework (compare with overlapping processes)

Appendix 12: Discussion notes on Principles

Themes emerging as principles:

- This is about information management
    - Need to stress that this is important both before, during and after.
    - In scope and out of scope – there will be information processes that we develop, but need to outline how that interacts with out of scope processes. Need to be aware what we include, what we exclude (but identify for the next project).
    - Always underestimating the resources required to process data in a timely way that allows meaningful decisions for the next day.
    - Is there a distinction between manual and digital – digital could be processed more quickly.
    - If we have processes, how will people be able to implement those – how do we tie those together – need to make sure what we create can be used across the board.
    - Scalability – need to support both small municipality and large scale organizations.
    - Need to be aware that information management will be both manual and digital depending on the context/municipality
- This is about situational awareness
    - Resources important -= will never have enough resources, need to target – need to know the need, before you can target
    - How we fit with ICS and other EM processes
    - Knowing where buildings were, what the risk is what type of damage – some comments in there; matching personnel to type and amount of damage
    - ? where did you get the SA from? How do we share info to make purposeful choices
    - Recommendations for what you can do ahead of time. Identify critical buildings ahead of time
    - Have building managers and owners preplan/assess, allows resources to be allocated elsewhere
    - Challenge is applying the human element to this – is it really a strategy that we want to identify with heavy emphasis on elements of the framework.
    - Preassess, register all parts of what we are doing, but what is in scope and what's out. What's missing is the overall strategy.
    - Every community will be slightly different – but strategy can apply to all. E.g. FN on GIS might not show up in maps.
    - ***Consider reframing framework as a series of layered strategies, rather than as hardwired resources and processes***
- This is about adaptation to local need and context
    - Also about the resources that are available at the time and the relevant threat
    - Scalability, ability to meet needs of small and large communities
    - Tools need to be accessible
    - What comes out has to be adaptable – has to be able to be used in multiple contexts – or utility will be low.

  - Take into consideration the training level as well – develop exercises that are targeted to the participants in each community
  - RACI model – way of implementing; are we responsible for this element or just informing it
  - Responsible, accountable, consulted, informed
  - ***Strategy is generalizable, framework is customized or customizable to specific types of communities or situations; this is what has to be done, this is what is expected of me,***
  - Prescriptive with an example or make it **performance based**. Upper level strategy, way of how to implement it. framework, implementation is customizable to situation or users.
  - Training could become each community building its own plan; course on overall strategy (same language); second focuses on framework – implementation at local level
  - Common definitions and starting points; but allow flexibility for implementation; need to brief and make aware each day;
  - ***Difference safety and usability; this puts this into context; safety is not interpretive – it is defined through the framework; usability may be a community based discussion and decision.*** Prescriptive about safety; performance – discussion on other topics. Here's an example of how you could do it, adapt to your situation.
  - Who makes those decisions? We specify what the role would be, and what would be expected.
  - Not about acceptable level of risk – guidelines need to be developed around level of risk you will use in this event.
  - Can't be too open – need examples and prescription where needed.
  - Adjacent communities, including FN's, need to be aware of the actions that each other will be taking
  - Is it role of government to tell you not to go back into your house?
  - Remember this is a formal process: legalities, evidence, documentation

- PDBA is an ongoing process that changes over time
  - Community should have the ability to decide usability safety levels/overlap;
  - Need strategy to provide resources to help communities to make those decisions
  - Use examples to avoid going too far down the rabbit hole rather than recommending technical solutions
  - Safety – govt needs to look into; usability is more context dependent
  - Need to look at how changes over time
  - One thing you need to decide is how far out in time your process will go
  - Or tie to discussions with types of assessments
  - Can have flexibility in your local setting
  - How far out in assessments will your process go – through to rebuild, or just get them out of the rain
  - Give examples for each category – may have suggestions/examples for types of assessment;

  - Steven's map – origin is inside scope; retrofit/rebuild probably out of scope – mentioned/guidelines at outer side
  - Remember retrofit
- Fools rush in – take the time to set up procedures and infrastructure before sending people in
- Assessments are complex and overlapping (BA and EM and LA)
  - See wall map
  - Tensions between complexity and keep as simple as possible
  - Wall map – identify considerations in each segment – keeps simple and tight at that level, while overall diagram/model/strategies incorporate the complexity of the overall.
  - Not necessarily overlapping, more progressive and tied to time and resources
  - In terms of big picture, current levels of training – level 1, 2, 3 – at level one, just go do it; at level 2 focus on admin, 3rd level coordinates – use leveling to manage simplicity and complexity
  - What is in and out of scope at each level as key point
  - Added: govt regulated vs market driven – in terms of complexity
  - ICS – simple structure with complex tasks underneath it – layered presentation of information and content
  - Where the simplicity comes in is that I know my role, where I fit, what is expected of me.
- Keep things as pragmatic, practical, and simple as possible
  - Tool kit to allow different communities to meet objectives of strategy
  - Identifying the aspects that form the framework; farthest we go down – what are the considerations you need in developing/implementing at your level, then some examples.
  - Slightly offset on some topics – some boxes more in scope, others less in scope – e.g. placards may be mostly in scope, while setting up teams might be at strategic level
  - More universal goes in the box
  - Will cut down a lot of the red tape – commonality of strategy but freedom to implement locally
- Building efficiencies with other processes and assessments
  - BCH draft summary of other assessments performed post fire
- Plan for multiple events (both in framework and on the ground)
  - Indicator building concept – define simply – include in your plan or not
  - Strategies or suggestions to consider at local level
  - Goals – will this withstand another similar shock? This date this time this building right now – not valid for another event; clear definition of what does this assessment mean (community defines or us) what is responsibility of owner after placarding; what is authority of ????/LA to enforce that. (e.g. Emergency to CERA to BAU)
  - On one side: earthquakes and aftershocks; on the other, large geographic area where you have multiple types of damage assessments; floods, fires, earthquakes
  - At earthquake level, include indicator buildings – need agreed upon typology – doesn't exist, so strategy has guidelines for developing a typology, etc. may be as far as we can go at this time.
  - Could use examples of strategies from NZ

  - In framework/strategy, scalable – eg. Use registry to identify who can go to different events or use for overall
- Need to adapt to BC context
  - Keep strategies at the more generic level, but use examples from the BC context
  - Speak to how it is scalable to small community or national level in each section; BC needs to do this, this, this; in absence of provincial level, municipality must do bylaw for ….
  - Include BC terminology; for scalability, have to consider what other provinces or communities have to do
  - Identify where different levels of authority are already set that are different than BC
  - At front of document, statement and dictionary of terms; we are using …., you have to search for the similar authorities or organizations within your context
  - We can't address all the variability in municipal context, but need to identify "needs" – what you have to do; from a Canadian context, deal with naming conventions;
- More known and preplanned the better
  - id critical ahead of time
  - Have preplan assessments available at the time of event
  - What goes in is strategies – you should preplan as much as possible, then provide examples
- Develop taxonomies of buildings, requirements, goals, assessments, assessors
  - Tools and resources –
  - Create BC typology, scalable outside BC by other groups
  - Suggestions/strategies for other jurisdictions to adapt to their own settings
  - When we say safety, we mean; when we say damage, we mean… people can harmonize or adapt to their own settings.
  - Provide rationale and background to development of typologies and tools; based on EM processes, etc. Safety most crucial, then usability, then damage… etc.
  - Important as professional groups looking at the highest standard – need to rationalize why non-credentialed may be performing some forms of assessment before others are available at the scene, etc. need to include these rationales.
- Solid guidelines and frameworks, with adaptation and agility in implementation as critical
  - Strategy in scope – strict guidelines will depend on topic
  - Some may be minimum standards; others more open ended
  - Change to solid strategies, with adaptation and agility
  - Safety is less flexible; usability is more flexible
  - Issues of cost are addressed in BC by separate team (e.g. insurance, damage, repair costs – two different levels; BC different teams, in some jurisdictions may be part of original team) include in rationale
- Allow emergence and adaptation of decision-making and thresholds
- Assessments change over time
- Be sensitive to time and efficient (as goal)
  - Use the wall model – efficiency vs depth is going to vary on the context of the situation, the time in the event, the scope and area of the damage
  - Safety easy – that's efficiency

- Usability more about quality of information
- Strategy must present this as one of the discussions to have at the local level, at the beginning

- Stay focused on the goals of the project and the framework (compare with overlapping processes)

Images from the workshop:

Figure A8. Changing Goals and Resources.

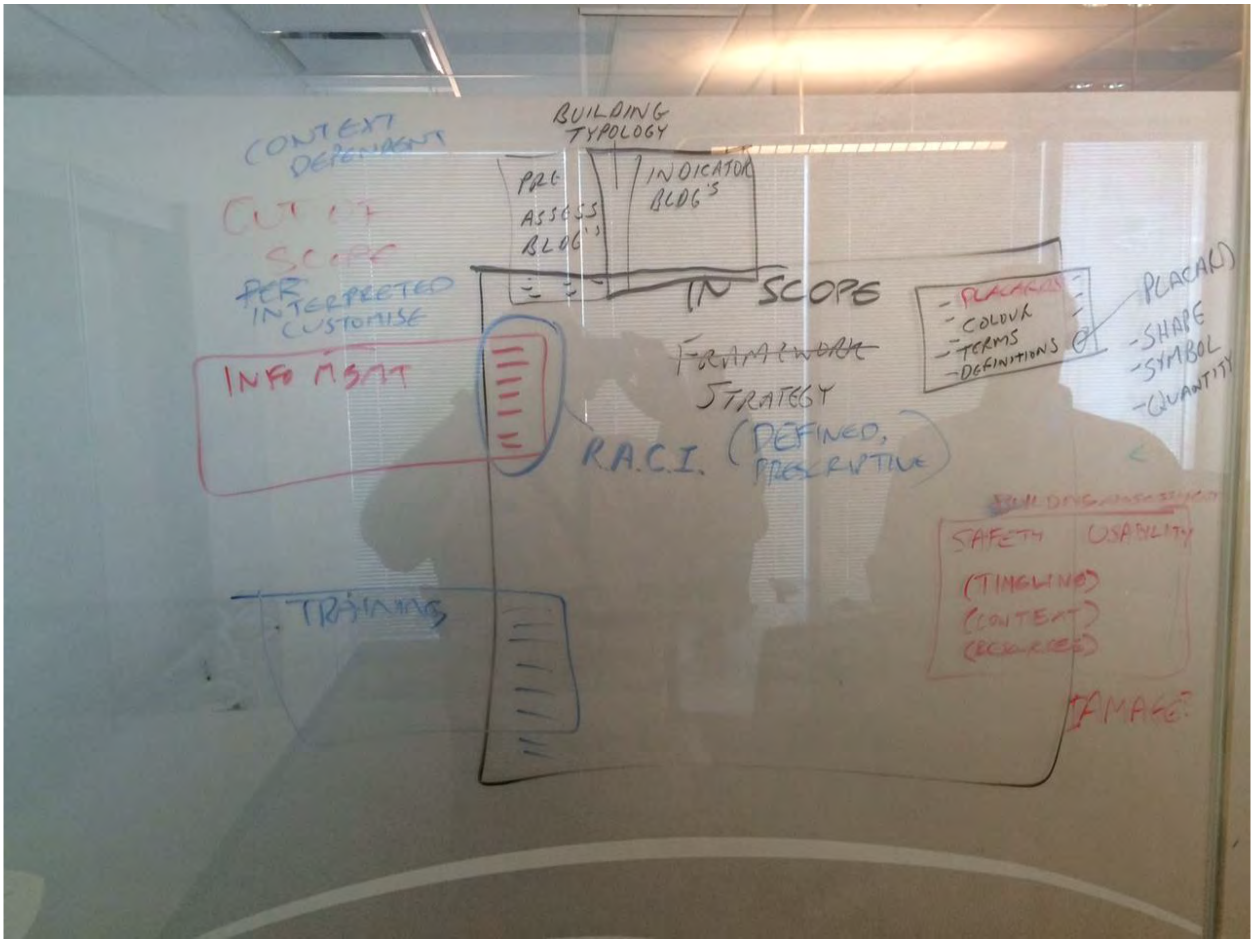


Figure A9. In and Out of Scope.

Appendix 13: Framework Needs and Requirements

	Note	Context	Colour	Priority	Depend-ency	Core Concept
SC056	Goals map/matrix: safety, usability, damage, vs time		orange	1	1	1
SC044	Taxonomy - buildings - delineate types of building stock		orange	1	1	1
SC019	Levels Provincial Regional Municipal Neighbourhood Local	Cherry pick from list of requirements to meet local need; "consider these types of things"	red	1	1	1
SC009	Scalability is related to: level of risk tolerance complexity of event availability of resources time/events over time geography/local ->municipal->region x-factors: weather, etc.	Model or taxonomy that supports scalability as a principle throughout framework		1	1	1
SC045	what is reasonable for different levels - e.g. neighbourhood response vs municipal	look at aspect matrix - may have this.	orange	1	1	2
SC051	Models and concepts Types of Assessment Term Goal(s) Outcomes Who (required capabilities)		orange	1	1	2
SC058	Concept of Building Status as central concept changing status over time Process is not about "A" placard, but rather on the current status of a building based on what we know about it at a given point in time.		orange	1	1	2
SC007	Overarching Concept: need guidelines on how to make things scalable for community - scalability factors	Framework, Guiding Principles	yellow	1	1	2

	Note	Context	Colour	Priority	Depend-ency	Core Concept
SC025	Terms/Definitions credentialed/non-cred define each, identify core capabilities for each in relationship to DA at high level		yellow	1	1	2
SC052	Levels of assessment pre-event, area/windshield, safety, usability, damage, repair, building permitting Definition and considerations, examples, expertise required to perform that type of assessment		yellow	1	1	2
SC049	DSA Algorithm		green	1	1	3
SC002	Develop a list of Aspects by "level"; not all levels will have all aspects, but use common framework	Basic format for presenting framework as a matrix	yellow	1	1	3
SC055	Need Common Engineering Approach address private with poor criteria - to get back into business - DA, private to retrofit - ? Tie in to Peter's project		yellow	1	1	3
SC047	Taxonomy building across horizontal assessment, type of people vertically		green	1	2	2
SC010	Need Model of Stakeholders with roles, mandates, responsibilities: Prov Reg Local NGO Privates Professional bodies etc	Model or taxonomy for identifying roles, responsibilities, etc of different stakeholder groups - NOTE different than the Event layers model (need name for this) regulators vs govt vs education	yellow	1	2	2
SC059	Definitions for placards		green	1	2	3
SC042	Assessment process per building type identify types of buildings that require specific info on assessment - be cautious of scope creep		orange	1	2	3

	Note	Context	Colour	Priority	Depend-ency	Core Concept
SC001	N,P,R, M, N: vs Aspect Considerations, Guidelines/evidence examples, and comments	Basic format for presenting framework as a matrix	yellow	1	2	3
SC053	Methods of identifying Building Status: placards - USAR, permits, markings use, importance, role, now recorded, how status is monitored, how these relate to each other		yellow	1	2	3
SC015	Terminology: credentialed, non-credentialed who: architects engineers (what types) building officials/building inspectors other?	Need glossary	red	1	3	1
SC054	Potential Tool or Requirements for Building Status record Like a medical Chart matrix: time across horizontal 6 or 8 pieces of info that should be tracked over time highlight importance at different times		green	1	3	3
SC005	How does event change all aspects? Do we do an All Hazards framework, or do earthquake and then adapt for floods, fires, etc.	Decision required	Red	1	3	3
SC036	Event to emerg to business as normal transition legal, administration, placarding and permitting issues exist		yellow	1	3	3
SC024	Roles: considerations, functions and requirements for different roles, e.g. BA manager, team leader, assessor, info manager, trainer		green	2	2	2

	Note	Context	Colour	Priority	Depend-ency	Core Concept
SC041	Roadmap - Matrix 6 easy steps "quick easy" for newby to rich, nuanced system for manual for ?metro		green	2	2	3
SC062	Timeline and perspective linkages between pre- and post monitoring, assessing, return to normal		orange	2	3	2
SC032	BA Admin guidelines and process recommendations		green	2	3	3
SC033	BA Teams - select, assign, get and give info		green	2	3	3
SC034	Deployment concepts, guidelines for deployments areas types of buildings sequence or priority how to match to resources		green	2	3	3
SC046	Assessment forms recommend content, considerations, examples ?tweak vs?static		green	2	3	3
SC050	Field Manuals recommendations - teams, models What's in: checklists, algorithms, contents do we produce? Probably not		green	2	3	3
SC043	Manuals and Tools focus - nuance/contextual simplified or both credentialed, non-cred		orange	2	3	3
SC063	Placards - customize in use, what can be customized vs what should "firm"		orange	2		
SC064	Placard definitions colours, levels, simplicity vs nuance - e.g. Nz experience		orange	2		
SC065	Other related assessments and their relationship to DSA - List, def, relationship - e.g. USAR, geotech		orange	2		

	Note	Context	Colour	Priority	Depend-ency	Core Concept
SC003	Check contract and SOW for level of detail required of framework	Task	Red	2		
SC004	Usig seismic for worst case scenario. Have to ensure that we incorporate other hazards and events as well.	Decision required	Red	2		
SC021	Need to address local/neighbourhood teams/needs, but outside scope of this project: Principles and recommendations		Red	2		
SC011	Overall process at Provincial level is about how DA works, how different Das interact: who has leadership? What does leadership look like at different levels? Leadership over what things? What impact does this have on other aspects of framework?	Governance questions	Yellow	2		
SC016	Critical Information Requirements what information is critical from an assessment? How to match info with who it should be shared with?	List	yellow	2		
SC026	Tiers of People, Levels of training, tiered capabilities, level of expertise - similar to NZ Tier 1, 2, 3		yellow	2		
SC030	Linkages between BA & EOC		yellow	2		
SC031	Model for validating level and quality of information type or level of assessor how long is info valid? Esp if outside formal LA process		yellow	2		
SC037	Non- Local Authority Info has assessment been done, if so by what level assessor and what was outcome		yellow	2		
SC039	Situational Awareness dealing with pieces of data from various places what data, where coming from, data in and out - e.g. $ for my house		yellow	2		

	Note	Context	Colour	Priority	Depend-ency	Core Concept
SC040	Overlay of DSA with other L.A. Processes - e.g. CI, school, private, owner		yellow	2		
SC060	What are alternatives to placards for non-LA processes - e.g., private or owner assessments, informal assessments - how to distinguish "official" from other placards/info		yellow	2		
SC066	Consecrations for leveraging overlapping assessments e.g. S.S., geotech, USAR - guidelines for this should be developed - careful of scope creep		yellow	2		
SC067	Expand concept of building status and markings other, USAR, Geo to Placard to permitting process for transition of ownership & process over time		yellow	2		
SC017	Information Input and Output model	Graphic with definitions. What information is coming into BA process. What should be done with that info? What info should be coming back out and where should it go?		2		
SC020	Tool Kits	performance standards by context (e.g., levels) and examples		2		
SC018	What everybody needs: from EOC to Individual pre-prepared kits daily "top ups" - disposables basic supplies assessment equipment safety considerations	contents of kits for various tasks and personnel - pre-built and ready to go, or with list of what's to be added. Refer to scalability matrix.	green	3		
SC023	Appendix: List of Stuff you Need by levels matrix - items down vertical, LAMRP across top		green	3		

	Note	Context	Colour	Priority	Depend-ency	Core Concept
SC006	For some aspects, only key points, but for others may have more specific examples, resources, descriptions	Framework	Red	3		
SC027	Identify types of data that may come in, list type of info, what is available, what is required: DSA, USAR, Building Surveillance, owners' assessments		yellow	3		
SC035	Training procedures - BA coordinator		yellow	3		
SC048	Dynamic assessment scalable allocation of resources and impact on assessment types and strategies		yellow	3		
SC061	Guidelines for changing building status - changing placards		Yellow	3		
SC008	Stay high level - cannot get too detailed !!!!!	Guiding Principles	Red			
SC012	Situational Awareness: what data did you use what data did you want how did you use data to make dx how to develop & maintain Situational Awareness: tied to each level from EOC to Prov/National	Situational Awareness	Red			
SC022	Overall process should be similar - don't go too far in providing criteria - need to find appropriate level of detail - specify "types" but not content	scope creep	Red			
SC028	Various stakeholders or groups to what degree do we incorporate and provide guidance for each? E.g. private owners, property managers, CI		Red			
SC038	how elements of neighbourhood, school district, building owner assessments relate to Local Authority processes		Red			

	Note	Context	Colour	Priority	Depend-ency	Core Concept
SC013	Future Data entries - type f assessment - outcome what were categories people used to allocate resources? What was important data? What were people recording?		yellow			
SC014	Process: how formal? who owns? What can change at different levels?		Yellow			
SC029	Need: Sources of info: Seismic sensors		yellow			
SC057	Acceptable level of risk for a community may place different levels of emphasis on life safety, usability, damage, etc, and personnel required to assess that		yellow			

Appendix 14: Framework Structure and Table of Contents

	Aspect	Considerations	Guidance								
TOC			General	System	Provincial	Regional	Community	Team/ Assessors	Building	Comments	Resources/ Tools /Artefacts
Core Concepts											
Definitions											
Guiding Principles											
Governance											
Administration											
Strategy											
Operations											
Information Management											
Assessors											
Assessment											
Building Status											
Placards											
Training											
Personnel											

Table A2. Framework Structure and Table of Contents.

Appendix 15: Validation Workshop Agenda

May 15, 2018 – 9am to 4pm

Registration and Coffee at 8:30am

Justice Institute of BC, New Westminster – Room: NWCL304

<table>
<tr><th>Time</th><th>Item</th><th></th></tr>
<tr><td>8:30-9:00</td><td>Registration, coffee and snacks</td><td></td></tr>
<tr><td>9:00-9:30</td><td>Welcome and Introductions</td><td>RON | STEVEN</td></tr>
<tr><td>9:30-10:15</td><td>Overview of PDBA project and framework</td><td></td></tr>
<tr><td>10:15-10:30</td><td>Coffee break</td><td></td></tr>
<tr><td>10:30–11:30</td><td>PDBA Assessment Matrix

Questions for consideration
1. Building types, assessment types, assessor types?
2. Did we miss anything? Are there any gaps?
3. Is this applicable to your community/organisation? Can you see using this?

PDBA Assessment Debrief</td><td>ROBYN | PETER</td></tr>
<tr><td>11:30 –11:45</td><td>PDBA Organization and Operations – Overview

Brief presentation on research projects findings related to:
1. PDBA Support/EOC Structure
2. Roles and Responsibilities
3. Team Structures and Assignment Considerations
4. Deployment Considerations</td><td>PETE | RON</td></tr>
<tr><td>11:45-2:00

(3 rotations plus lunch)</td><td>Rotation #1: EOC/Support Structure, Roles and Responsibilities

Questions to consider:
1. In what ways do the research findings align with your community/organizations requirements?</td><td></td></tr>
</table>

	2. What PDBA EOC organizational model (and communication/reporting lines) are you considering for your community/organization? 3. What PDBA management/support roles and primary responsibilities is your community/organization considering?	
12:15-1:00	Lunch	
	Rotation #2: Team Structures and Assignment Considerations Questions to consider: 1. In what ways do the research findings align with your community/organizations requirements? 2. What considerations are you using when determining the make-up of your individual PDBA teams? (i.e., size of team, knowledge/skills of members, local knowledge, organizational knowledge, third-party groups…) 3. What factors or considerations have you identified when determining initial and ongoing daily PDBA team assignments? (i.e., who will go where and do what?)	Tables: Peter | Robyn
	Rotation #3: Deployment Considerations Questions to consider: 1. In what ways do the research findings align with your community/organizations requirements? (View provided research documents prior to workshop) 2. What type of structure/content would you include in a daily briefing for PDBA teams? 3. What measures has your community/organization considered around the health and safety of personnel when deployed into an emergency/disaster zone?	Tables: Ron | Jim
2:00-2:15	Organization and Operations Debrief	
2:15-2:45	Placards, Forms and Documentation Questions to consider: 1. Do we allow white and green simultaneous? 2. Authority to post/remove? 3. Are the same placards/forms sufficient for pre/post emergency? 4. Do we need a working group to manage these in future?	**STEVEN | JIM**

2:45-3:00	Coffee break	
3:00-3:30	Transitioning Between Pre-event, Response, & Recovery: Questions to consider: 1. Is there an existing or planned data management system? 2. How will assessment processes and authority transition from emergency powers to business-as-usual? 3. Does the pre-event data collection adequately address the LA needs? 4. Does the framework work well with the way your org. functions? 5. Does the framework sufficiently address liability protection during and after the emergency?	
3:30-4:00	Summary, Next Steps and Wrap Up 1. Review 2. Parking Lot 3. Next Steps 4. Wrap Up	**RON | STEVEN**

Appendix 16: Validation Workshop Attendees' Organizational Affiliations

NOTE: Participant names removed per research project's Informed Consent provisions.

Stakeholders											
		ACADEMIC	CI	LOCAL AUTHORITIES	PROFESSIONAL BODIES	GOVT	MILITARY	OTHER DA STAKEHOLDERS	DA PROGRAMS	PRIVATE SECTOR	Indigenous
	Health Emergency Management BC					1			1		
	Department of Civil Engineering | UBC	1									
	PhD | PE - CEng MICE (Works with Carlos Ventura at UBC)	1									
	Emergency Management BC (EMBC)					1					
	Richmond School District No. 38					1			1		
	Applied Science Technologists & Technicians of BC				1						
	Bowen Island Municipality			1					1		
	Vancouver Airport Authority (YVR)		1						1		
	City of Vancouver			1					1		
	City of Vancouver					1					
	Indigenous Services Canada (ISC)					1					1
	Saanich - few minutes late			1							
	North Shore Emergency Management Office			1					1		
	Soda Creek Band			1							1
	Insurance Bureau of Canada				1					1	
	Hollyburn Properties							1	1	1	
	Emergency Management BC (EMBC)					1					
	City of Vancouver			1							
	City of Port Coquitlam			1					1		
	Building Officials of BC				1						
	"CFB Esquimalt USAR Team						1				
	BC Housing					1			1		
	Building and Safety Standards Branch Office of Housing and Construction Standards Ministry of Municipal Affairs and Housing					1					

6.9.1e TECHNICAL REPORT
APPENDIX 16: VALIDATION WORKSHOP ATTENDEES' ORGANIZATIONAL AFFILIATIONS

		2	1	7	3	8	1	1	9	2	2

Team											
		ACADEMIC	CI	LOCAL AUTHORITIES	PROFESSIONAL BODIES	GOVT	MILITARY	OTHER DA STAKEHOLDERS	DA PROGRAMS	PRIVATE SECTOR	Indigenous
Ron Bowles	Justice Institute of BC	1									
Cindy Moran	BC Housing					1					
Dawn Ursuliak	Justice Institute of BC	1									
Jim Forrest	BC Housing					1					
Pete Learoyd	Justice Institute of BC	1									
Peter Mitchel	Association of Professional Engineers & Geoscientists of BC				1						
Robyn Fenton	Architectural Institute of BC (AIBC)				1						
Steven Bibby	BC Housing					1			1		
Joseph Huynh	BC Housing					1					
Marguerite Laquinte Francis	Architectural Institute of BC (AIBC)				1						
Team Totals		3	0	0	3	4		0	1	0	0
		ACADEMIC	CI	LOCAL AUTHORITIES	PROFESSIONAL BODIES	GOVT	MILITARY	OTHER DA STAKEHOLDERS	DA PROGRAMS	PRIVATE SECTOR	Indigenous
Totals		5	1	7	6	12	1	1	10	2	2

Table A3. Validation Workshop Attendees Organizational Affiliation.

Appendix 17: Draft PDBA Assessment Matrix

A key component of PDBA operations is the community-level formation of assessment teams, and – more directly – ensuring that assessment teams have the skills and capabilities required to function effectively. The PDBA Assessment Matrix provides an example of how communities can assemble teams of credentialed and non-credentialed personnel to effectively engage in post disaster building assessment.

Communities consist of a number of types of building, ranging in complexity by location, size, construction material, construction type, and other factors. Similarly, communities have a variety of different credentialed or professional personnel who may be involved in PDBA assessment, including structural engineers, architects, and other engineers. In addition, communities may have non-credentialed personnel who, with additional training, may participate in building assessment.

The PDBA Assessment Matrix is an example of a tool that communities may use to better understand what types of building stock are in their community and who can assess those buildings after a disaster.

***NOTE: The following matrix is an example only** – it is not intended to be a definitive tool, but rather a starting point which communities can adapt based on their own unique needs and capabilities. Please see the example provided after the generic matrix for how a small community might adapt the matrix to meet its own needs.*

Definitions and descriptions

The Matrix relates three elements: building type, assessment type, and assessor type.

Building Type: The matrix lists a variety of buildings types, based on a standardized building taxonomy from the University of British Columbia. Communities should edit and adapt this taxonomy (e.g., delete building types that are not in the community, or add/adapt for other/specialized types of buildings) to reflect their current and planned building types.

Assessment Type: The assessment types in this matrix are based on the generic PDBA assessment algorithm in this PDBA Framework document. Communities are encouraged to adopt common PDBA processes to foster compatibility of processes and information between communities.

- Area is a general assessment of a community to determine what areas are damaged and to what extent. This assessment is often performed by first responders or designated local government personnel (e.g., a windshield assessment) and do not require PDBA assessors.
- Rapid Ext corresponds to a rapid (approximately 15 minute) exterior assessment.
- Rapid Ext/Int involves a rapid (approximately 15 – 20 minute) exterior and interior assessment.
- Detailed assessments are longer and more comprehensive (2 to 4 hour) structural assessments involving interior and exterior inspection.
- Engineering assessments involve comprehensive structural and functional assessment of a building to identify requirements for demolition or repair and reoccupation of a building.

Options for this process could include developing an "all hazards" matrix, or matrices for different types of events.

Assessor Type: Note that the examples given in this matrix are based on a seismic event. Communities are encouraged to consider the types of personnel that will be available to their community and also how the matrix would have to change to meet the impact of different types of events, such as flooding or wild fire.

Responsibility refers to what stakeholder group has the responsibility for completing building assessments. Stakeholders identify in the example matrix include Local Government (LG), Local Government and/or Building Owner LG/OWNER, and building owner (OWNER).

Authority refers to who has the authority to conduct PDBA assessments, usually the Authority Having Jurisdiction (AHJ).

As noted above, the following example is based on the work of the PDBA research team. We would expect each of the elements in this matrix and process to be further developed by the newly formed British Columbia Post-Disaster Building Assessment (PDBA) Advisory Committee.

Assessor Categories

The following categories of personnel for performing specific assessments are proposed for this example matrix. Communities should revise as required based on their analysis of hazard and building types.

Level 3: Non-credentialed personnel with relevant experience, such as contractors, construction tradespersons, or building managers. Level 3 assessors require formal PDBA assessor training, such as ATC 20/45 or equivalent.

Level 2: Building officials, architects, or engineers of any background. Level 2 assessors require formal PDBA assessor training, such as ATC 20/45 or equivalent.

Level 1: Structural engineers with formal PDBA assessor training, such as ATC 20/45 or equivalent.

Team Composition Requirements

Each community must develop its own team composition requirements, similar to the following:

- Exterior teams may consist of a minimum of two personnel.
- Interior assessment teams should have a minimum of three personnel, one of whom remains outside during the assessment.
- The matrix identifies the minimum levels of personnel required for each type of assessment and type of building. Teams may have higher levels of expertise (e.g., an assessment listed as Level 3 may be conducted by teams including credentialed personnel or structural engineers), but not lower.
- Additional team members (e.g., fourth team members) may have any relevant background.
- Teams may be augmented by specialty members (e.g., geotechnical engineers, USAR members, ESS personnel) as required.

6.9.1e TECHNICAL REPORT
APPENDIX 17: DRAFT PDBA ASSESSMENT MATRIX

Post Damage Building Assessment Matrix: Sample "Generic" Matrix

BUILDING TYPE	Taxonomy	Description	Area	Rapid ext only	Rapid ext/int	Detailed	Engineering
		RESPONSIBILITY	LG	LG	LG	LG/OWNER	OWNER
		AUTHORITY		AHJ	AHJ	AHJ	AHJ
			Emergency Response				
						Return to Function	
		ASSESSMENT TYPE	Area	Rapid ext only	Rapid ext/int	Detailed	Engineering
TYPE A, SPECIALISED/ HIGHL COMPLEX	C1H	Reinforced Concrete Moment Resisting Frames (C1)-High-Rise (more than 8 stories)		2	1	1	1
	C2H	Concrete Shear Walls (C2)- High-Rise (more than 8 stories)		2	2	1	1
	C3H	Concrete Frame Buildings with Unreinforced Masonry Infill Walls (C3)-High-Rise (more than 8 storie		2	2	1	1
	PC2H	Precast Concrete Frames with Concrete Shear Walls (PC2)-High-Rise (more than 8 stories)		2	1	1	1
	RM2H	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms (RM2) - High-Rise (more than 8 stories)		2	1	1	1
	S1H	Steel Moment Frame (S1) - High-Rise (more than 8 stories)		2	2	1	1
	S2H	Steel Braced Frame (S2) - High-Rise (more than 8 stories)		2	2	1	1
	S4H	Steel Frame with Cast-In-Place Concrete Shear Walls (S4) - High-Rise (more than 8 stories)		2	2	1	1
	S5H	Steel Frame with Unreinforced Masonry Infill Walls (S5)- High-Rise (more than 8 stories)		2	2	1	1
TYPE B (COMPLEX)	C1L	Reinforced Concrete Moment Resisting Frames (C1)-Low-Rise (range between 1-3 stories)		2	1	1	1
	C1M	Reinforced Concrete Moment Resisting Frames (C1)- Mid-Rise (range between 4 -7 stories)		2	1	1	1
	C2L	Concrete Shear Walls (C2)- Low-Rise (range between 1-3 stories)		2	2	1	1
	C2M	Concrete Shear Walls (C2)- Mid-Rise (range between 4 -7 stories)		2	2	1	1
	C3L	Concrete Frame Buildings with Unreinforced Masonry Infill Walls (C3)-Low-Rise (range between 1-3		2	2	1	1
	C3M	Concrete Frame Buildings with Unreinforced Masonry Infill Walls (C3)-Mid-Rise (range between 4 -7		2	2	1	1
	PC1	Precast Concrete Tilt-Up Walls (PC1)		2	2	1	1
	PC2L	Precast Concrete Frames with Concrete Shear Walls (PC2)-Low-Rise (range between 1-3 stories)		2	2	1	1
	PC2M	Precast Concrete Frames with Concrete Shear Walls (PC2)-Mid-Rise (range between 4 -7 stories)		2	1	1	1
	RM1L	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms (RM1)- Low-Rise (range between 1-3 stories)		2	2	1	1
	RM1M	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms (RM1)- Mid-Rise (more than 4 stories)		2	1	1	1
	RM2L	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms (RM2)- Low-Rise (range between 1-3 stories)		2	2	1	1
	RM2M	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms (RM2)- Mid-Rise (range between 4 -7 stories)		2	1	1	1
	S1L	Steel Moment Frame (S1) - Low-Rise (range between 1-3 stories)		1	2	2	1
	S1M	Steel Moment Frame (S1) - Mid-Rise (range between 4 -7 stories)		2	2	1	1
	S2L	Steel Braced Frame (S2) - Low-Rise (range between 1-3 stories)		2	2	2	1
	S2M	Steel Braced Frame (S2) - Mid-Rise (range between 4 -7 stories)		2	2	2	1
	S4L	Steel Frame with Cast-In-Place Concrete Shear Walls (S4)- Low-Rise (range between 1-3 stories)		2	2	2	1
	S4M	Steel Frame with Cast-In-Place Concrete Shear Walls (S4)- Mid-Rise (range between 4 -7 stories)		2	2	2	1
	S5L	Steel Frame with Unreinforced Masonry Infill Walls (S5)- Low-Rise (range between 1-3 stories)		2	2	2	1
	S5M	Steel Frame with Unreinforced Masonry Infill Walls (S5)- Mid-Rise (range between 4 -7 stories)		2	2	1	1
	URML	Unreinforced Masonry Bearing Walls (URM) - Low-Rise (range between 1-2 stories)		2	2	1	1
	URMM	Unreinforced Masonry Bearing Walls (URM)- Mid-Rise (more than 3 stories)		2	2	1	1
TYPE C (SIMPLE NON-COMPLEX	W1	Wood, Light Frame (W1)		3	3	3	2
	W2	Wood, Greater than 5,000 Sq. Ft. (W2)		3	2	2	1
	WPB	Wood Post & Beam		3	2	2	1
	MH	Mobile Homes (MH)		3	3	3	2
	S3	Steel Light Frame (S3)		3	2	2	1

Table A3. Draft PDBA Assessment Matrix

Post Damage Building Assessment Matrix – Sample Small Community

The following is a sample created by a small community in British Columbia. It is provided as an example of how a smaller community might adapt the more comprehensive generic Matrix based on the community's needs.

			RESPONSIBILITY	LG	LG	LG	LG/OWNER	OWNER
			AUTHORITY		AHJ	AHJ	AHJ	AHJ
				Emergency Response				
							Return to Function	
			ASSESSMENT TYPE	Area	Rapid ext only	Rapid ext/int	Detailed	Engineering
BUILDING TYPE		Taxonomy	Description					
	TYPE B (COMPLEX)	C1L	Reinforced Concrete Moment Resisting Frames (C1)-Low-Rise (range between 1-3 stories)		2	1	1	1
		C2L	Concrete Shear Walls (C2)- Low-Rise (range between 1-3 stories)		2	2	1	1
		C3L	Concrete Frame Buildings with Unreinforced Masonry Infill Walls (C3)-Low-Rise (range between 1-3		2	2	1	1
		PC1	Precast Concrete Tilt-Up Walls (PC1)		2	2	1	1
		PC2L	Precast Concrete Frames with Concrete Shear Walls (PC2)-Low-Rise (range between 1-3 stories)		2	2	1	1
		S1L	Steel Moment Frame (S1) - Low-Rise (range between 1-3 stories)		1	2	2	1
		URML	Unreinforced Masonry Bearing Walls (URM)		2	2	1	1
	TYPE C (SIMPLE NON-COMPLEX	W1	Wood, Light Frame (W1)		3	3	3	2
		W2	Wood, Greater than 5,000 Sq. Ft. (W2)		3	2	2	1
		WPB	Wood Post & Beam		3	2	2	1
		MH	Mobile Homes (MH)		3	3	3	2
		S3	Steel Light Frame (S3)		3	2	2	1

Table A4. Sample Building Assessment Matrix for a Small Community

Appendix 18: Validation Workshop Data and Findings

Data was gathered from notes and flip charts in the various activities and table groups. This data was sorted by activity and is presented below. Recommendations will be extracted from this data and used to inform revisions to the draft PDBA Framework and supporting resources.

General Notes	
Roadmap for doing this planning	Need a holistic roadmap for helping a community put together a DA plan. Need a parallel roadmap for agencies and private organizations Need a layered roadmap for everyone – what are the overlaps and linkages between planning at various levels/stakeholders

Activity 1: The Assessment Matrix	
RF Notes	Note: Use term 'Local Government" instead of "Local Authority" as it is inclusive of first nation communities. AHJ = Authority having jurisdiction
1. Where to geo-tech engineers fit in the matrix?	a. Coordinating their assessments
2. Detailed assessment: should be mostly 3 or have relevant expertise	
3. BCsims.ca	a. Provincial Website available with seismic info b. Ensure Local Gov't know about it
4. Seismic sensors can give situational awareness	a. Who in EOC can analyse this info? b. Can BCH/schools share this info? a. Who in EOC can analyse this info? b. Can BCH/schools share this info?
5. Inventory of protective assets (dykes, retaining walls, etc.)	
6. Assessment Types	a. Good to have ext only separate from int/ext b. Provide link to 'engineered' report criteria being developed by EGBC? c. Provide more realistic guidance on time for assessments: i. ext only 15mins ii. ext/int single house 15mins

	iii. ext/int on midrise building 30-45mins iv. ext/int on larger building 1hr+
7. Guidance on coordination, to include in PDBA plan:	a. How do you allocate resources b. What are triggers (magnitude?) c. Is every building inspected, who decides this? d. Include reference to examples that exist
Assessment matrix	Consider deeper/richer matrix: add % of building stock. Criticality. 20 min, 24 situational awareness 29 ops Consider adding DSA training to initial programs for trades and professional Set criteria for retraining- BCH 3, 3-5 years; NZ annual? Establish own tables of assessors per category. Include local/specific types of people – e.g. facilities personnel – what other training will they need to be effective? Lot of work for LA to do – how to plan for all this.
Roadmap for doing this planning	Need a holistic roadmap for helping a community put together a DA plan. Need a parallel roadmap for agencies and private organizations Need a layered roadmap for everyone – what are the overlaps and linkages between planning at various levels/stakeholders
Placard colours	No. one or the other – not white AND green. White might be a little more coautionary. Colour is less important than what is on them. I kind of disagree. If I lost my cat, I'd put up a white sign. Walking down the street, might miss white placard. Prefer green. Sun will bleach out the colours anyway. Think about white.
Placards	Guidelines for placement of placards is needed – how many, where, etc. Important that the same language is in the documentation AND the placards. Placards will fade/get lost – need to know what was on the placard.
Can same forms be used for building	Be careful of complacency – if it doesn't stand out in the emergency, people might not pay attention

inspection and emergency	
Legal	LA inform, not enforce. Not sure LA has authority to deny access?
Who can remove?	Can this be delegated? Need to explore more.
	Lots of platforms, but trick is to find systems that allow BA info to be shared/accessed by other systems.

#2 Team Structure

1) Team composition
   a) Capacity
   b) Expertise
   c) Hazard specific
   d) Ideal to have type 3 in every team, but not realistic

1) Safety
   a) 3rd person as safety, stays outside when team inside, etc. incl. radio communications
   b) NSEM has plan to have uniform presence in neighbourhoods, with public info

2) Composition will change as resources become available

3) Security concerns for staff/volunteers (looting/violence)

4) Support person with team to address public/home owner:
   a) ESS if possible, Disaster Social Services
   b) Possible insurance info
   c) Flyer/door hanger
   d) Daily briefing should include current ESS available

5) Guidance on minimum team composition, not ideal

6) Data – highly recommend GIS system

7) Worker support, OHS

8) Transport – work with what you have, carpooling, walking

9) Issue ID card for assessors, to avoid confusion/distrust

10) ensure PPE for tram members

11) EOC: coordination, how to tackle areas, based on area assessment – preplan and reactive

12) Have a type 3 assessor in EOC as coordination/advisory role

13) Geographical: preplan
    a) Identify hazards
    b) Prioritise
    c) Impact on transport/infrastructure
14) Assessor Training:
    a) Basic training
    b) Renewed at interval (1,2,3 years?) with refresher course
    c) Exercise as part of training
    d) Make training more current and relevant, realistic examples
    e) Need more than 4hr ATC to feel confident as team lead
    f) Tiered training: 1 day basic, ½ day refresh, more for team lead/coordinator roles
    g) Include:
    i) Media training, how to / not to speak to media in field
    ii) safety in field (dogs in building, non-cooperative homeowner), clarify extent of authority and when to call in other resources
    iii) radio?
    iv) How to handle unofficial request fro the public/others that are outside scope
    v) Expectation and extent of authority
    (1) Not to enforce, but inform
    (2) Not to break into locked buildings
    (3) Not assessing fro code compliance
    (a) A building may have been non-code compliant pre-event, and shouldn't be placarded for that
15) Consider developing system/printed icons and symbols for common phrases
    a) address language barriers

b) look to ESS and Whistler for examples

16) Resolve Liability issue with Credentialed assessors

17) Amount of time credentialed volunteers will volunteer,

a) 3days? How many hours per day?
b) Transition to paid work?
c) Are they deputised as building officials?
i) How does this happen from Local Gov't view? Bylaw?

d) Reciprocity with other provinces/US, precedents: (mutual aid agreement)

i) Wildfire
ii) PNEMA agreement

18) International and out-of-province teams

a) have local person on team
b) work under ICS
c) pre-plan managing them and logistics:
i) accommodation
ii) food
iii) technology
iv) PPE
v) Transport

19) International teams:

a) Some will be here to help
b) Some to observe and gather data
c) Create guidelines for what they can/can't do
d) And ensure local government knows

20) Training in small /remote communities

a) online available for remote communities
b) just-in-time training
i) can we empower local communities to train, post-event on as-need basis?

ii) Build capacity in real-time, situation specific
iii) Provide support/resources for expertise
iv) Can training include intro to geo-hazards

21) Just-in-time training modules:

a) team members
b) team lead
c) EOC coordinator

22) Should Property owners assess themselves? Serious concerns with this

23) Public training module
   a) what does placard mean
   b) could they be aware of basic hazards
   c) Port Coquitlam has a program in place

24) Manage emergent volunteers
   a) how do we screen volunteers on arrival
   b) how do we know they are prepared/trained – > BCH database

25) page 28 – indicator buildings – have this as a story / case study / lesson learned to more clearly explain – current is not clear

26) EOC roles
   a) engineers and building officials as coordinators
   b) support roles:
   i) GIS
   ii) Data entry
   iii) Photos from devices
   iv) Equipment and food prep
   v) Charging technology
   vi) Responding to home owner inquiries on placard status

27) Technology – for EOC, portable tablets/surfaces

28) legalities of data sharing?
   a) Is any personal data gathered? Shared? That PIPA applies
   b) Who owns the data?
   c) How do home owners get the info on their home (ie. They have been evacuated)
   d) Cross-link data

29) First Nations Communities
   a) Cultural sensitivities
   b) Cultural context
   c) Respecting cultural rights (if told not to go in a building or place, to respect this)
   d) Consideration for Hierarchy of decision making – will be different in all communities

i) Some decisions are EOC, some are chief and council

ii) Recommend each community create a document within their emergency plan, outlining the hierarchy and decision making responsibility/authority

(1) Template could be created
(2) In-coming teams should know to ask for this document

PDBA Assessment -

1. Thresholds
2. Local access of resources and shape maps
3. Front loading information – building knowledge upfront so it might allow lesser credentialed folks to assess
4. Looking at threats outside
5. Shortage of structural engineers
6. Good description of building – FEMA 151, Curriculum development /
7. Practically – flow chart building types for assessors
8. Non engineer/engineered / multiple building types
9. Too much of a seismic lens vs all hazard
10. Assessor types – 123 – work that is involved between professional bodies, training they need to be able to do this. What do professional bodies need to define within their groups
11. Provide example in plain language, assessment types, types of buildings,
12. Local types of people to go out and do things—baseline list of assessors within communities
13. Real time information available – shaking, performance of building codes – make it available on real time basis – help to triage / prioritise … these buildings have suffered, this area has suffered
14. Challenge to credential non-staff – legal liability issues for city teams,
15. Number 1 assessors on list - / most types of houses
16. All hazards approach not just seismic
17. How does flooding and sewage affect vs just structural?
18. How do you manage duelling assessment processes?
19. Non-credentials -- facilities,
20. Training for both trades/professional groups – 1 day

21. Matrix – bigger – adding columns to show how much building stock in each category. To show % and criticality

22. How do you ensure assessor qualification?

OPERATIONS

1. EOC Support Structure Roles and responsibilities – page 20 (admin), 24 (sit awareness), 29 (ops)
2. Team structures and assignment considerations
3. Deployment considerations

DEPLOYMENT

1. Initial deployment based on sensor, modelling, per-event situational awareness – ground composition, priorities, CI,

2. Set up a satellite site with cache supplies, intermediate level of information coming in
3. All damage information on common operating platform that shows up in EOC – includes damage assessment

4. Web-based common operating – Lightship creating common operating picture

5. Need information on areas you are deploying too | situational information, how to access, how to get there,

6. What resources you available to get there – bikes, helicopter, car

7. Infrastructure to use technology
8. 1 person to: security -- Information/communications/security person – bylaws, search and rescue, intro to DA but to provide security and communications

9. Different teams for different areas
10. Collaboration of teams – team lead as reporting point, safety officer to make a call on moving forward, -- need specific roles per (by law officers)

11. Comprehensive assessments – many different teams – hydro, insurance, fortis,

12. Insurance wants to be involved
13. Each group should have their own reporting piece and then keep it into the EOC.

14. Debriefing: structure, roles, other assessors, expectations of buildings per day. Cursory look the day before – so they can do that area quickly. Per-deployment safety briefing – immediate reporting demands, routes, potential hazards, what else to look for, perspective on other things going on, language / interpreter, information on resources available to help

15. Strategy for aftershock, do you continue, go back to reassess. || Indicator building
16. Data Analysis – person… || people to assess – phone, web, manage all the information, phone calls
17. SEMAC– structure of information – understanding information,

18. Dynamics – not in the training – what to do if… no address, house has already been assessed,
19. Language
20. Daylight
21. Everyone has a role – one does placards, scribes,

DEPLOYMENT – STEVEN NOTES

1. Team assignment briefing form (SAR) uses the SMEAC format

a. Situation, mission, execution, admin, communications.

2. "reporting back" from field (delta has new form)
3. DA needs to be part of mgmt. briefing in EOC
4. Page 34 –daily briefings is really good
5. Clearly describe DA in daylight / darkness
6. Initially based on models, sensors and know building/land compositions – known priorities – indicator buildings

7. Teams (size) would overwhelm EOC space, while use satellite spaces

8. Need software and training to ensue DA information can be shared remotely w/EOC (lightship software in NSEMO)

9. Know information of deployment area needed prior to deployment (environmental, chemical, other risk)

10. pre-deployment briefings – update daily, include prior day learnings

11. Team composition
a. include a "safety officer" – security, communications, in uniform,

b. psychosocial
c. differs in industrial areas, specialists required
d. local resident, speaks the language
12. coordinate members of team, comprehensive vs multiple assessments (e.g. Hydro, gas, environment, fire, etc.. insurance, utilities)

13. realistic expectations of team workload (e.g. - # buildings/hours/per day)

14. information package for residents/occupants

15. Instructions for team on aftershocks, continue? New priorities, OHS/Safety instructions
16. Record credibility of information sources (due to information inundation.)

17. Keep same teams together? Change members daily or less frequent? Resource availability may dictate
18. how to manage deployment to area within complex building and several non-complex; one team for all
19. protocol for teams discovering existing placard on their building

20. LA's may not be aware of which other buildings or agencies will initiate own DA in community; will complicate prioritization schedule

21. Can we share data? Do we need to?
22. Equipment checks and checklists
23. Identification authority
24. Maps
25. Objective (e.g. Radio / safety)

ORGNAIZATION MGMT

1. EOC school district at each site – self-contained,
2. Property mgmt. group – zones, by bridges – assigned roles by credentialed, but then learned that they weren't the best leaders so more free flowing

3. Port Coquitlam – amateur radio is main communication – can send email within community but not within levels

4. COV – 6 zones, pre-stocked containers, EOC coordinators for 2 zones, consolidate and then share uphill. DA teams play multiple roles

5. Overlap between groups – need to communicate more

6. Property mgmt. – want to do more coordination between industry

7. Port Coquitlam – leaders, trained volunteers, groups of 2,

8. Do they want dedicated GIS on team?? (data analysis)

9. Community plan vs just the field guides – for NZ???

10. Property Mgmt. stocked in the field / restocked bins (radios, safety,

11. Hard to have deployment out of EOC – need it out somewhere else.

12. Common operating software- need GIS done in a simple way. GIS has role but want the practitioner to be able to be on map from beginning.

13. Moved damage assessment into operations – and then they put what needs to be on the EOC map (EOC doesn't need to see all the green dots) operations only puts applicable colours/information up for EOC

14. Operations – building rep/DA rep -- are an engineering and building rep (infrastructure facilities)
15. Use volunteers – not ESS but block watch, community volunteers, = they have all been trained – disaster support up. Each zone has

16. Insurance – Engaging stakeholders to overlap and coordinate information

17. Crisis communication plan – level authority – is there prescribed information that can be broadcasted to community on BA. BCH does has announcement. NS may have something. Are you able to disseminate emergency based communication to technical folks to mobilize them?

18. DA on waterfront may become lifeline as it is port jurisdiction, no regular relationship, port of Vancouver, -- can they aggregate DA on waterfront and distribute information out to different jurisdiction

19. Regional planning through IPRIM – regional disaster – make sure point/linkages

20. Indigenous communities – band ownership of land /building. Jurisdiction – when can they enter not enter. IRAP funding for engineers to look at DA. EMBC now responsible for EM for first nation's community's vs ISC. Band council resolutions not required.

21. Different embedment within structures depending on group/municipality

a. Rally points / stations/ zones
22. Communications – how to deal with GIS – best way to deal with it in process

a. In process, external, one layer down – users are putting information in. don't rely on external person not available

23. How do you distribute information (port example – access to port – coordinate work with other jurisdictions)

24. Lots done on buildings, local authorities – need more work done on the stakeholder side // coordination – big picture how all the players

RB notes Organization

School District – have EOC in each school, which are set to run autonomously. In a larger event, each becomes a local centre under direction from central EOC.

Property Management firm: areas by geography – specifically bridges – assume there will not be ability to move across bridge/water boundaries

Initial training and roles based on credentials. With exercise/drill, found that it was better to be flexible in assigning leadership roles – best credentials not always the best leaders

Port Coq: two areas, north/south because of rail.
PoCo: using amateur radio for communications. Set up to send email between units within community. Issue in not having common format or forum to allow communication between communities and above.

PoCO: pre established equipment stashes at Fire/Municipal Annex.

PoCo: staff would respond to check pre-established CI for windshield assessment, then report for further deployment as required.

Vancouver: 6 zones. BA unit in EOC, 3 coordinators – 2 zones each. Info flows to coordinators who consolidate then pass along data as appropriate.

Vancouver: pre-established containers that have equipment and also serve as rally points and command/control points.

Overlap between private organizations (e.g., property managers, provincial agencies) and LA. Are there communication/agreements in place? Not yet, PC and Vcr, though both in planning.

Property management in discussions with several municipalities – suggest working through professional associations, e.g. Landlords BC to allow better coverage- avoid having multiple agreements between specific companies/owners and governments.

Consider adding as stakeholder for provincial agency.
Biggest challenge in agreements/collaboration between any group is the communications. Need mechanisms to share and protect information as required.

Question on accessing/embedding GIS. Three models: GIS person in BA unit – advantage that they can be "owned" rather than pulled away; in Planning, to centralize service and have access to more resources. Third option is to have GIS "under" what is done and have access to input and output with the users. That way, able to get info when and as and how needed rather than waiting to access specialized services.

Importance of redundancy in roles – have org chart, but have left names off as we don't know who will actually show up. Have multiple personnel who can assume roles. Have ways that people can assume roles "just in time."

Importance of finding someone like you who has been through this – e.g. property management firm talked with NZ property management firm of similar size. Invaluable information.

Need to check with CCC, Kaikoura, Wellington on what their emergency and building assessment plans look like NOW. How did they change things? Why?

North van – prepared positions, but equipment only. Vancouver has fairly well distributed population. North shore varies from deep cove to horseshoe bay – pockets of population/resources.

When using app – amount of green dots overwhelmed. Needed way to limit or change what was displayed.
Mapping needs to be in the hands of the practitioners, who have varying needs for different problems. Ideal is to have tools that allow users to adjust and adapt as required.

Insurance and other stakeholders not directly involved in BA operations. However, play important roles. Insurance assessments overlap with BA. Need way to leverage and build on each other's work.

Consider pre-scripted crisis communications – e.g. social media; around safety of buildings. Develop pre-established messages that can be easily implemented.

Need strategies for stakeholders and professional groups to connect with LA, then to communicate to their members for mobilization

? self-registering database for volunteers with their capabilities and communications

Waterfront for NV will be lifeline – yet authority rests with port of Vancouver and assessments done by industries themselves. Need way to coordinate, collaborate, access info

Need a better bigger picture of how things work at the provincial/federal levels.

Need process map – turtle map
Need to understand how professional and private organizations and agencies fit in and how to support and mobilize

Need if, then that reach outside the framework If uninhabitable, then links to other social services, etc. if debris, then…. Tie to regional disaster planning.

If band land, does that change authority and responsibility for entry evacuation, etc. Different levels even locally. Need to consider indigenous lens

Health Authorities – have own staff to do internal assessment, then to HA, then to HA EOC. Challenge with difference HA even in same buildings.

Goes to provincial health coordination Centre, then to PREOC if appropriate.

Confidentiality and privacy – will not share information.
Need mechanisms to share and ensure privacy and confidentiality.

YVR – self contained – has robust system, including manuals for assessment of major buildings. Working towards manuals for ALL buildings.

TEAM STRUCTURE

1. Logistical support – feed, clothe, transport, technology, accommodation, PPE, proper identification for volunteers

2. Time in field – 2-3 days / transition to being paid, how long in the day,

3. Volunteer suitability / assessment for walk ins
4. Building/Facilities roles for DA – other roles – geo spatial, social media, filling in forms, data analysis
5. Safety officer – key messaging, safety, RDA training
6. Guidelines for media on the field
7. When to source other resources to take over – trouble houses/people/hard to deal with…
8. Technology logistics for at least EOC staff should be portable for maximum

9. Data sharing – Information FIPPA / PIPPA– cross linking data – legalities – permissions for sharing information, who owns data collecting – how does home owner get their information,

10. Cross linked data –

11. International support – (support from Seattle / Alberta) for DA and the group for data gathering. Guidelines on what they are allowed to do. AKA teams in the field may be requested to do more work than they – unofficial requests. (I know

12. Language of team – across language and disability – using pictures – (ESS model – whistler has done a great job here)

13. Parameters of authority – inform not inforce
14. Cultural sensitivity/competency – FN – respecting cultural rights.

15. Dealing with houses not to code pre-event – what happens when they are red-tagged but nothing to do with event.

16. How do duty to report not to code.
17. FN – levels authorities – who can make the call.
18. Relevant training – exercises
19. Dealing guidelines for training
20. How long do they work for – transition into paid work

21. Managing volunteers
22. Logistics
23. Support roles
24. Legalities of data sharing
25. Language skills – icons/symbols

PDBA Documentation and Transitions

Placards – GREEN AND WHJITE and YELLOW / transitions from EM to BAU

1. White is better than Green – a little more

Colour vs information (more information)

2. Green more distinctive
3. Red vs green – go / safe / mixing with EMBC safety
4. Sun vs water resistant
5. Full back adhesive
6. Also hand out stickers on recovery centre information and put on corner of placard
7. Template to explain which will be left on door handle – FAQ – to share

8. Bilingual
9. Guidelines on placement of placards //
10. Placard vs assessment forms must be the same
11. Take a picture of the placard for reporting

Placards good for pre-post emergency

1. Keep for post disaster
2. Problem with complacency if they see them all the time

3. Need to different
4. Different goals / different processes
5. Post-earthquake
6. BAU – you put a date on it – so there is a limitation.

7. Reds in place until removed by municipal building person

Who can take it down?

1. Whoever put it up?
2. Municipality responsibility – Chief building official
3. Anyone who can put it up should be able to take it down

4. Municipality can get a 3rd party / delegated contractor to advise on removal

RB Notes

Placard colours	No. one or the other – not white AND green. White might be a little more cautionary. Colour is less important than what is on them. I kind of disagree. If I lost my cat, I'd put up a white sign. Walking down the street, might miss white placard. Prefer green. Sun will bleach out the colours anyway. Think about white.
Placards	Guidelines for placement of placards is needed – how many, where, etc. Important that the same language is in the documentation AND the placards. Placards will fade/get lost – need to know what was on the placard.
Can same forms be used for building inspection and emergency	Be careful of complacency – if it doesn't stand out in the emergency, people might not pay attention
Legal	LA inform, not enforce. Not sure LA has authority to deny access?
Who can remove?	Can this be delegated? Need to explore more.

Round Table 1 – Placards, Forms and Documentation

Must be one or the other colour placard. Leaning towards white for same reason as NZ; whereas some people noted that a white placard might look like any other unrelated posting (e.g. missing cat notice)

Colour is less important that what the placard says (content over colour). Colour placards help to avoid complacency.

Some communities have made the entire back of the placard a sticker

Should there be pre-made stickers describing the recovery location, and it could be stuck on the placards. One community has a template that they can pre-populate with info of the day and print it on the placard

Bi-lingual placards are recommended

Guidelines on the placard placement/location should be provided in the training (e.g. how many to post; the building locations

Ensuring that whatever is written on a placard is written verbatim on the report

Require DA personnel to take a picture of the placard when it's posted

Cannot use the same forms used by building inspectors (BAU) as a post disaster form

DA is an "estimation" of how sensitive the building is to an earthquake, which is a different goal from a typical building assessment

LA's have plans in place to transition from EQ to BAU? One recommendation is that a deadline date be included on the placard for the building owner to perform their follow up action.

Must ensure that owners/occupants have info on placards so that they know what action is required

There should be a mechanism to identify in advance, who can remove the placards. It should likely be the municipal authority who removes them. Could have contractors who are pre-authorized to remove them

Round Table 2 – Transitioning Between Pre-Event, Response and Recovery:

NSEM is developing a common operating picture database. Challenge is how to make it communicate with existing municipal software systems

NRCan is developing the EQ model, and it may serve as an appropriate database/clearing house for the building information. BC Assessment Authority is the source of data being fed into the NRCan system. It's based on ArcGIS. This work could work alongside of the Disaster Debris Mgmt. processes.

Shocking that there is no legislation now for professional liability protection.

Transitioning between pre-event, response and recovery

Is there an existing or planned data mgmt. system

1. Building registry to tack the BA information
2. Common EM software system – for municipal software to put into the municipal software –
3. Common terminologies between assessors

Does the pre-event data collection adequately address the LA needs?

1. Building registries, building records,
2. Building information booklet for bigger buildings – online / physically printed?
3. NRCAN – blow out earthquake model – for scenarios, building, tracking, (37 building..?? system)
4. BC Assessment – to catalogue buildings (UBC is mapping to build of data) Victoria did this combined with cataloguing information and scenario information
5. GIS tools – scenarios there, buildings identified …. Just need to add field data for event data

Does the framework work well with the way your org. functions?

Does the framework sufficiently address liability protection during and after the emergency?

1. Stressed to have in place before you send out folks
2. How do you protect – why get involved if not insured

Two or three take-aways for them

1. Drafting bylaws
2. Connecting networks
3. Data collection
4. Transition to BAU
5. Exercises – designed for practice
6. Templates for sample policy/bylaws

Two or three take-aways for us.

1. Liability
2. Volunteers
3. Legislation for placards – BAU post emergency
4. Scale to small community
5. Mostly rural no business building
6. Understanding of first nation community

7. Build something to use to build DA Plan and then flex once in place

8. Close the box for now
9. Finalize the green vs white placards
10. Indigenous Lands – who owns what – complexity
11. Liability – current state in book
12. Training competency of assessors
13. Get the Recommendations out there – build the common framework and people can adapt.
14. Mindful of language around local authorities vs indigenous communities

Parking Lot

Overlap of private/other DA and local authority processes

What role(s) =, opportunities are there for senior government

Need a separate document to explore the "why"
#NAME?
More guidelines info organization, admin, data management, structures,

Issues: data, bylaws more transition, exercises, placards, volunteers, liability

Scale down for small and rural communities – more residential than other communities for example
Understanding and inclusion of language supportive of first nations and indigenous communities
Get it out so we can use it. Then do more.
Green white placard issue needs more discussion
Issues around indigenous land – e.g. ownership, authority

Liability – what is current practice – can we have examples to build from

More on training competencies for assessors
Get it out then next steps

Appendix 19: Additional Recommendations

The data in Appendix 18 was analyzed to identify the following recommendations for inclusion in the PDBA Framework document.

System/Element	Recommendations
Global	Replace Local Authority with Local Government - more inclusive term that acknowledges indigenous governments.
Assessment Matrix	add to Legend for matrix
Assessment Matrix	Consider development of new matrix or adaption to include geotech engineers in the assessment matrix. - RB: not sure about this one- seems more a strategic or integration issue, than one for the assessment matrix itself.
Assessment Matrix	Detailed assessments should probably be 3 or relevant expertise
Situational Awareness	RESOURCE: Bcsims.ca provincial website with seismic info
Situational Awareness - pre-event Intelligence	add to list in EOC 1. pre-event strategy for gathering and maintaining: Inventory of protective assets (dykes, retaining walls, etc.)
? Info management, assessment matrix	RESOURCE: Provide link to 'engineered' report criteria being developed by EGBC?
Assessment Matrix, Assessment Procedures	modify time frames for assessments i. ext only 15mins ii. ext/int single house 15mins iii. ext/int on midrise building 30-45mins iv. ext/int on larger building 1hr+

APPENDIX 19: ADDITIONAL RECOMMENDATIONS

System/Element	Recommendations
Operations	7. Guidance on coordination, to include in PDBA plan: a. How do you allocate resources b. What are triggers (magnitude?) c. Is every building inspected, who decides this? d. Include reference to examples that exist
Training	Consider adding DSA training to initial programs for trades and professional
Training	Establish initial and retraining timeframes RESOURCE: Set criteria for retraining- BCH 3, 3-5 years; NZ annual?
Resources - assessment matrix	Establish own tables of assessors per category. Include local/specific types of people – e.g. facilities personnel – what other training will they need to be effective? Guideline or example for community on using matrix to develop local matrix
Resources - assessment matrix	Lot of work for LA to do – how to plan for all this. Guideline or example for community on using matrix to develop local matrix
Overall	RESOURCE: Need a holistic roadmap for helping a community put together a DA plan.
Overall	RESOURCE: Need a parallel roadmap for agencies and private organizations

6.9.1e TECHNICAL REPORT
APPENDIX 19: ADDITIONAL RECOMMENDATIONS

System/Element	Recommendations
Overall	RESOURCE: Need a layered roadmap for everyone – what are the overlaps and linkages between planning at various levels/stakeholders
Placards	RESOURCE: Make firm recommendation
Placards	Guidelines for placement of placards is needed – how many, where, etc.
Placards	Important that the same language is in the documentation AND the placards.
Placards	Placards will fade/get lost – need to know what was on the placard.
Placards	? Recommendation or resource? consider
Placards	LA inform, not enforce. Not sure LA has authority to deny access? need to explore, determine if recommendation should be included
Placards	Can this be delegated? Need to explore more. need to explore, determine if recommendation should be included
Information Systems	Create list of potential information systems that PDBA could work with - what can be used? What can be shared/accessed by other systems?
Assessment Teams	Ideally, teams should have a minimum of 3 personnel. However, this may not always be necessary or possible in some situations.
Assessment Teams	Team Safety - at least one person must always remain outside and have radio/other communications to support the team.
Assessment Teams	Principles and guidelines are required to support making up team composition as resources and nature of assessment requirements change over time.

6.9.1e TECHNICAL REPORT
APPENDIX 19: ADDITIONAL RECOMMENDATIONS

System/Element	Recommendations
Assessment Teams	Processes and guidelines are required to ensure team safety in terms of potential violence and/or looting.
Assessment Teams	Supplement teams with ESS if possible
Assessment Teams	Teams should have standard information available to owners regarding insurance and LA concerns.
Assessment Teams	An information package should be designed, perhaps as a door hanger or flyer, to be left for owners.
Assessment Teams	Daily briefings should include current ESS availability
Administration	Worker safety processes and procedures, along with support for all workers involved in PDBA must be in place.
Logistics	Ensure that transportation is available for teams both to get to and from their areas, and for movement within their assigned areas.
Logistics	Develop ID system, including card/identification for assessors.
Team	Ensure that proper PPE is available for all team members
Situational Awareness	LA should develop deployment plans based on both pre-planned and reactive factors.
Operations	EOC PDBA coordinator should have training equivalent to NZ Tier 3 or have coordinator training.
Situational awareness	LA should develop a geographic preplan based on known/likely hazards, impact on transportation and infrastructure.
Training	Assessor training should be renewed or updated at regular intervals (e.g., annually refresher and re-training every 3 years?)

6.9.1e TECHNICAL REPORT
APPENDIX 19: ADDITIONAL RECOMMENDATIONS

System/Element	Recommendations
Training	Training should include exercising - both opportunity to conduct assessments and also to exercise as part of larger scenario.
Training	Team leaders should have additional training above basic assessor training.
Training	Suggest tiered training: e.g. 1 day basic assessment additional for team leaders additional for PDBA coordinators annual refresher regular retraining
Training	Assessor training should include: i) Media training, how to / not to speak to media in field ii) safety in field (dogs in building, non-cooperative homeowner), clarify extent of authority and when to call in other resources iii) radio? iv) How to handle unofficial request fro the public/others that are outside scope v) Expectation and extent of authority (1) Not to enforce, but inform (2) Not to break into locked buildings (3) Not assessing fro code compliance (a) A building may have been non-code compliant pre-event, and shouldn't be placarded for that
Placards; forms	All placards, forms, documentation should include strategies for dealing with multiple languages that are common in an area/community - see ESS and Whistler for examples.
Operations: Staff Rotation	LA should establish guidelines for length of time that volunteers are expected to work: hours per day, number of days, etc.
Assessment personnel: ? Sustained operations	Guidelines should be in place to establish a transition from volunteer responses in the immediate aftermath to paid work on an ongoing basis.

6.9.1e TECHNICAL REPORT
APPENDIX 19: ADDITIONAL RECOMMENDATIONS

System/Element	Recommendations
Assessment Personnel: legal and liability	LA and provincial governments must consider how certification, indemnity, etc will be affected in large scale events - what is impact for mutual aid, reciprocity.
Operations: Team Formation	Teams must always have a local person.
Assessment Teams: Housing, Transportation, & Support ? Non-local resources?	International and non-local team members will require transportation in/out of the site, accommodation, food, PPE, etc.
Operations: Non-local Resources	Local Authorities should have guidelines for working with non-local teams and personnel. Note that teams may be seeking to provide assistance; others may be seeking to gather data and observe operations.
Operations: Non-local Resources	Local Authorities should develop guidelines for assessing capabilities of non-local resources and have pre-determined tasks/functions that these teams and personnel can assume.
Operations: Non-local Resources	Communication and documentation guidelines must be in place to ensure that all levels of government and related authorities are aware of the presence and activities of non-local resources and personnel.
Training: NEW: Scalability	Training programs must be scalable, and have multiple methods of delivery to ensure accessibility by personnel in remote, rural, and urban communities.
Training: Responsibility	Training programs should be developed with the goal of allowing local communities to provide adequate and effective training to personnel post-event on an as-needed basis.
Training: Just in Time	Consider training and/or communication mechanisms to allow the capacity to "learn in real time" regarding specific situations.
Training: Core Curriculum Principles	Training should include an introduction to geo-hazards.
Training: Just in Time	Just in time training should include modules and/or content for team members, team leaders, and PDBA coordinators.

6.9.1e TECHNICAL REPORT
APPENDIX 19: ADDITIONAL RECOMMENDATIONS

System/Element	Recommendations
Governance: ????	Consider whether or not property owners should be allow to conduct their own assessments.
	Training should include a component for general public including topics such
Assessment Personnel: registries and rosters	Develop process for screening, supporting, tracking emergent volunteers
Assessment personnel Recruitment, education, background, experience	Identify training and experience of emergent volunteers; have way of tracking/identifying training
Situational Awareness: Indicator Buildings	Have case study and/or resources to support use of indicator buildings
Administration: Operational structure	Use engineers and/or building officials as coordinators
Administration: Operational structure	Consider EOC support roles: GIS, Data entry, photo/media management, equipment and food prep, charging technology, responding to home owner inquiries
Information Management: Sharing and integration	Relationship of PIPA, other legal constraints on collection and use of data
Information Management: Sharing and integration	System for owners/occupants to get info on buildings
Information Management: Sharing and integration	Look for opportunities to cross-link data
NEW: Considerations and Special Situations: FN/Indigenous Communities	Develop plans for identifying and honouring culturally sensitive areas/buildings/practices in area: respect cultural practices/rights (e.g. no entry);

6.9.1e TECHNICAL REPORT
APPENDIX 19: ADDITIONAL RECOMMENDATIONS

System/Element	Recommendations
NEW: Considerations and Special Situations: FN/Indigenous Communities	Identify and preplan integration of FN/Indig leadership with LA
NEW: Considerations and Special Situations: FN/Indigenous Communities	Create a document within their emergency plan, outlining the hierarchy and decision making responsibility/authority
NEW: Considerations and Special Situations: FN/Indigenous Communities	Ensure teams are aware of cultural sensitivities in areas they are dispatched to
Operations: Pre-planning	Predetermine needs for assessment - may allow lesser credentialed team to perform assessments.
Building Assessment Procedures: Specific Assessments	Develop graphics/flowcharts to support identifying types of buildings/assessor requirements
Building Assessment Procedures: Descriptions of Assessment Procedures	Ensure supporting documents use plain language, graphics
Assessment Personnel: Registries and Rosters	Identify local assessors, including sources of "just in time" personnel who may be trained on the job
Information Management: Sharing and Integration of data	Collect, organize, and make available information, including background info such as shaking, performance of building types, areas damaged, etc. available in real time to support area planning, team priorities and operational assessment of buildings

APPENDIX 19: ADDITIONAL RECOMMENDATIONS

System/Element	Recommendations
? Ops preplanning? Or Assessment Personnel: Recruitment…, sustained operations	Pre-develop ideal requirements for types/mix of assessors to meet needs within specific areas of a community.
Situational Awareness: Leveraging other EM personnel and processes	Consider overlap of resources and activities in "dueling assessments."
Situational Awareness: Pre-event intelligence	Expand building/assessor matrix to include #/type of building stock in each category - show # and criticality
SA - Developing an Overall Strategy	Factors to consider in initial deployment strategies: sensor, modelling pre-event SA, ground composition, priority buildings/areas, CI
Administration: Equipment and Resources	Consider pre-established satellite sites with cache supplies, communications, etc.
Administration: Equipment and Resources	If possible, use common operating system for all data and communications.
Operations: Logistics	Identify transportation options and availability for moving teams to/from and within operational areas.
Assessment Teams: ? NEW: Roles	Establish roles for team members: team lead, communication, safety/security officer, etc.
	Team collaboration - ensure key activities are established within specific personnel: e.g., reporting, communication, continue/withdraw from buildings, etc.
Operations: Team formation	Identify types of buildings that require specialized teams - e.g. Hydro, Fortis, other CI; pre-establish processes for working with CI owners

APPENDIX 19: ADDITIONAL RECOMMENDATIONS

System/Element	Recommendations
Assessment Teams: Briefing and Debriefing	RESOURCE for DEBRIEFING to include: structure, roles, other assessors, expectations of buildings per day. Cursory look the day before – so they can do that area quickly. Per-deployment safety briefing – immediate reporting demands, routes, potential hazards, what else to look for, perspective on other things going on, language / interpreter, information on resources available to help
Assessment Teams: Briefing	RESOURCE: SMEAC briefing form: Situation, Mission, Admin, Communications
Assessment Teams: Briefing	RESOURCE: Delta has new form for "reporting back from the field."
Operations: Logistics	Consider size of space for DA operations and teams - use satellite locations if too much for EOC
Operations: Pre-Event intelligence	Information on areas such as environmental, chemical, other hazards should be known prior to event.
Assessment Teams: Briefings	Daily briefings should contain lessons and learnings from prior day.
	already captured above
Operations: Team Formation	Include psychosocial personnel on teams if available and appropriate.
Operations: Logistics	Establish realistic expectations of team workload: e.g., # buildings, hours/shift, days in a row, etc.
Operations: Logistics	Ensure procedures and instructions are developed for teams re safety issues such as aftershocks, building collapse, other OSH issues.
Placards: Overlap with other EM assessments	Have procedure for dealing with existing placards or documentation found on buildings by teams.

6.9.1e TECHNICAL REPORT
APPENDIX 19: ADDITIONAL RECOMMENDATIONS

System/Element	Recommendations
Situational Awareness: Leveraging other EM pesonnel & processes	Consider other DA processes in place by other building owners, agencies, CI, etc. and how these will affect prioritization of LA efforts
Operations: Communications	RESOUCES: PoCo amateur radio is main communication.
Administration: Operational Structure	RESOUCES: Case: COV – 6 zones, pre-stocked containers, EOC coordinators for 2 zones, consolidate and then share uphill. DA teams play multiple roles
Operations: Team Formation and Personnel Management	RESOURCE: POCO : leaders, trained volunteers, groups of 2
Situational Awareness: Developing an Overall Strategy.	Identify key locations and lifelines, such as waterfront/port
Governance Special Considerations	Collaboration is required between LA, provincial, national, and indigenous governments to ensure that responsibilities and practices for DA are integrated.
Governance: Authority? Administration: relationship with other EM?	Ensure that there is collaboration and integration between local authorities and other stakeholders - e.g. CI owners, building owners.
Administration: relationship with other EM	RESOURCES: Examples of other EM and DA systems
Administration: relationship with other EM	RESOURCES: Examples of other EM and DA systems
Training: Pre-Event Training	RESOURCES: Case examples
Operations: Communications	RESOURCES: Example communications

6.9.1e TECHNICAL REPORT
APPENDIX 19: ADDITIONAL RECOMMENDATIONS

System/Element	Recommendations
Situational Awareness: Developing an Overall Strategy	RESOURCES: Example of setting up zones
Operations: ? Activation? SA: Developing an Overall Strategy?	RESOUCES: case example of ad hoc phase
Situational Awareness: Developing an Overall Strategy	RESOURCES: Example of setting up zones
Operations: Equipment and Resources	RESOURCES: example of pre-situated equipment cache
Administration: relationship with other EM	Note that CI, Property management, etc. not based on LA boundaries. LA should connect with provincial associations to develop relationships with other DA stakeholders - e.g. property management, CI.
Administration: Relationship with other EM, DA	Ensure that agreements between partners include mechanisms for effective and ongoing communication.
Information Management: Use of Technology	RESOURCE: discussion on GIS.
Administration: Administrative Structure	RESOURCE: case study on org charts - need to identify LA
????	RESOURCE: Case or example of setting up a program
Operations: Equipment and Resources	RESOURCES: example of pre-situated equipment cache

6.9.1e TECHNICAL REPORT
APPENDIX 19: ADDITIONAL RECOMMENDATIONS

System/Element	Recommendations
Information Management: Use of Technology	Ideally, tools should be adaptable and usable by practitioners closest to assessment.
Administration: relationship with other EM	Insurance and other stakeholders not directly involved in BA operations. However, play important roles. Insurance assessments overlap with BA. Need way to leverage and build on each other’s work.
Assessment Personnel: Registries and Rosters? Operations: ? New on Personnel Management?	Consider development of self-registration process and/or database for volunteers, which identifies their capabilities, training, experience, and methods to communicate with them.
	RESOURCE: need map/graphic for providing context in developing BA plans at LA level; ALSO need map/graphic for showing linkages between various elements of a functional system.
Operations: Pre-planning	Plan should include links to support occupants who's buildings are uninhabitable - e.g., social services; also tie to debris plan, regional disaster planning, etc.
Administration: relationship with other EM	RESOURCES: Examples of other EM and DA systems
Administration: relationship with other EM	RESOURCES: Examples of other EM and DA systems

Appendix 20: Inaugural Consortium Meeting Agenda

Time	Item
8:30-9:00	Registration, coffee and snacks
9:00-9:30	Welcome and Introductions (Steven & Ron)
9:30-10:00	Overview of PDBA project and framework (Ron)
10:00-10:30	Committee Draft Terms of Reference (Steven)
10:30-10:45	Coffee break
10:45–11:15	PDBA Development Streams/Potential Working Groups (Pete)
11:15-11:45	BC Assessment Authority/Geo BC Presentation (Steven/Gurdeep)
11:45 –12:00	Next Steps - Meeting frequency, location, dates (Steven)
12:00 – 1:00	Lunch Provided

Appendix 21: Inaugural Consortium Workshop Attendees' Affiliations

NOTE: Participant names have been removed per the research project's Informed Consent provisions.

NAME:	ORGANIZATION:	Attended
	Richmond School District #38	1
	Structural Engineering Association of BC	1
	Health Emergency Management BC	1
	Technical Safety BC (BC Safety Authority)	X
	Department of Civil Engineering | UBC	X
	University of BC	1
	Technical Safety BC (BC Safety Authority)	1
	Building Officials Association of BC	X
	Justice Institute of BC	1
	Emergency Management BC (EMBC)	1
	Geo BC (FLNRO)	1
	BC Assessment Authority	1
	Applied Science Technologists & Technicians of BC	1
	Earthquake Engineering and Research Institute (EERI) - BC Chapter	1
	Vancouver Airport Authority (YVR)	X
	City of Vancouver; Mgr, Building Review Branch	1
	Indigenous Services Canada (ISC)	1
	District of Saanich	X
	North Shore Emergency Management	1
	Soda Creek Band	1
	Insurance Bureau of Canada	1
	Hollyburn Properties	1
	Justice Institute of BC	1
	Engineers & Geoscientists BC	1
	Architectural Institute of BC (AIBC)	1
	Justice Institute of BC	1
	BC Housing	1
	BC Hydro	X
	BC Safety Authority	X
	BC Assessment Authority	X
	CSSP Project	X
	Building and Safety Standards Branch Office of Housing and Construction Standards Ministry of Municipal Affairs and Housing	X
	Real Estate Services	X
	RJC	X

	City of Vancouver	X
	PHSA	X
	Architectural Institute of BC (AIBC)	X

Table A5. Inaugural Consortium Workshop Attendees' Affiliations.

Appendix 22: BC PDBA Advisory Committee Terms of Reference

British Columbia
Post-Disaster Building Assessment (PDBA) Advisory Committee

TERMS OF REFERENCE – Adopted 13 September 2018

BACKGROUND

In support of enhanced Post-Disaster Building Assessment (PDBA) in the province, BC Housing, Justice Institute of BC, Engineers and Geoscientists BC, and the Architectural Institute of BC partnered in a research project funded by the Department of National Defence to explore and develop a framework for post-disaster building assessment.

One of the outputs of this project was recognition of the importance of a broad stakeholder group that would further support and advance development of a provincial system.

The Province of British Columbia "BC Earthquake Immediate Response Plan" (July 2015) identifies that the role of BC Housing in a catastrophic earthquake will be to:

- Establish and lead the Building Damage Assessment Branch at the PECC/PERRC
- Provide rapid damage assessment teams, prioritize and coordinate rapid damage assessment of provincial and other key facilities
- Provide rapid damage assessment training, assessment coordination, action plans, response/recovery priorities and authority to access and restrict access to government housing property

MISSION

The mission of the committee will be to recommend, develop, and enhance standards, processes and guidelines for the effective implementation and the sustainable management of a post-disaster building assessment system for the province of British Columbia. The PDBA Advisory Committee has been formed to facilitate the ongoing coordination, and for sharing of stakeholders' collective knowledge and resources in this area and to make this information available to stakeholders.

MANDATE

In support of this mission, the committee will:

- provide advice on all matters within the Advisory Committee areas of responsibility to coordinate post-disaster building assessments,
- draw on the committee's collective expertise to assist the Advisory Committee to identify new and emerging issues and opportunities in building assessment, and to strengthen the provincial PDBA framework.

GOALS

- Develop and promote standards, processes and guidelines for a province-wide integrated PDBA system.
- Advise on the development, maintenance, training and exercising of PDBA systems, plans and procedures.
- Provide recommendations on cross government and cross organizational issues related to post-disaster building assessments.
- Promote integration and consistency between the Province's PDBA system, including all levels of government and non-government organizations.

MEMBERSHIP

PDBA Advisory Committee membership will be comprised of representatives from the government of British Columbia and non-government stakeholder organizations involved in and with an interest in PDBA. Where possible, representation will include Associations such as the Architectural Institute of BC, Engineers and Geoscientists BC, Building Officials Association of BC, and others. When possible, participant organizations will include one representative from the parties identified within the BC Earthquake IRP as having a role in critical infrastructure and/or subject matter expertise, including all of the stakeholders identified in Appendix "A".

PDBA Advisory Committee membership may also include ad-hoc participation as required.

ADMINISTRATION

- A representative from BC Housing will chair the initial PDBA Advisory Committee, and will also provide basic administrative support and funding to support baseline activities. The committee will establish an ongoing process for determining the Chair
- Additional expenditures (e.g. contract work in support of PDBA activities) will be subject to funding, in a manner agreed to by members.
- As a voluntary committee, there will be no remuneration paid to members for the attendance of meetings or the time associated with the completion of projects.

WORKING GROUPS:

- Working groups (standing or temporary) struck to support PDBA, will each have an identified lead, and will report to the PDBA Advisory Committee through the Chair.
- Working Groups will be asked to develop and adhere to work plans approved by the Advisory Committee, and to meet as and when required.
- Organizations may choose to designate individuals other than their primary PDBA Advisory Committee representative to resource these working groups, in order to provide for the appropriate subject matter knowledge.

MEETINGS AND AGENDAS

- The PDBA Advisory Committee will meet at least two times per year or at the call of the Chair, either in person, or by teleconference.
- Agendas shall be distributed in advance of meetings whenever possible, and minutes will be kept and distributed for each meeting.

- A record of decisions shall be prepared and maintained at all meetings.

Appendix "A" – PDBA Advisory Committee Membership List Participating Organizations as at 13 September 2018 **REPRESENTATIVE:**

Applied Science Technologists & Technicians of BC
Architectural Institute of BC (AIBC)
BC Assessment Authority
BC Housing
City of Vancouver
Earthquake Engineering and Research Institute (EERI) - BC Chapter
Emergency Management BC (EMBC)
Engineers & Geoscientists BC
Geo BC (FLNRO)
Health Emergency Management BC
Hollyburn Properties
Indigenous Services Canada (ISC)
Insurance Bureau of Canada
Justice Institute of BC
Justice Institute of BC
Justice Institute of BC
North Shore Emergency Management
Richmond School District #38
Soda Creek Band
Structural Engineering Association of BC
Technical Safety BC (BC Safety Authority)
University of BC

Organizations Which Have Expressed Interest, or Have Been Identified as Potential Participants

BC Ferries
BC Hydro
BC Transit
Building and Safety Standards Branch Office of Housing and Construction
Standards Ministry of Municipal Affairs and Housing
Building Officials Association of BC
District of Saanich
Fortis BC
Ministry of Advanced Education
Ministry of Forest, Land and Natural Resource Operations
Ministry of Justice· Liquor Distribution Branch
Ministry of Transportation and Infrastructure
PHSA
Shared Services BC - Real Estate Services
Translink
Vancouver Airport Authority (YVR)

6.9.1e TECHNICAL REPORT
APPENDIX 22: BC PDBA ADVISORY COMMITTEE TERMS OF REFERENCE

BC HOUSING

JUSTICE INSTITUTE of BRITISH COLUMBIA

ENGINEERS & GEOSCIENTISTS BRITISH COLUMBIA

AIBC
ARCHITECTURAL INSTITUTE OF BRITISH COLUMBIA