

The CDEM Group Plan states that a decision to declare a state of civil defence emergency will be publicised in accordance with the Public Information and Media Management Plan. According to this plan, information will be circulated via media releases. These will be available at the Media Management Centre, on the Auckland CDEM website, and faxed or emailed to media organisations and local EOC's. They will also be disseminated to the emergency services, government agencies, lifelines and other entities involved. This existing system is part of the region's warning notification system.

Waitakere City Council has a Warnings and Activation Procedures SOP (SOP 108), which states that local warnings to the public may be issued by the Mayor or the Emergency Services, using Radio NZ or TV if applicable. Police and Fire vehicles have loudspeaker facilities that can be used for localised warnings. This SOP could be further developed to provide information on when these measures should be used.

The Auckland CDEM Group Plan acknowledges that the region consists of many diverse cultures, which has implications for communicating and engaging with these communities. Any warning system will need to take into account this diversity when considering options for notifying the public of an event. This needs to be incorporated into the CDEM Group Public Education Strategy, which includes engaging the public in developing an understanding and knowledge of what to do before, during and after an emergency.

District Plans manage land use within the Auckland region. The Plans do not include a requirement for warning systems to be initiated/installed with any new or existing development. However, warning systems could be considered a mitigation measure in situations where there is a hazard which could affect a development, such as a coastal or flood plain development that could be adversely affected by tsunami, storm surge or flooding. Any warning system would need to be regularly tested, serviced, and an education campaign launched for those residents and visitors within the proposed warning area.

Auckland Region does not have any formal public notification arrangements (Tables 1 and 2).

Plan / Standard Operating Procedure	Status
Rodney District	nil
North Shore City	nil
Waitakere City SOP 108 – Warnings and activation procedures	Complete
SOP 120 – Tsunami warning system	Draft
Auckland City	nil
Manukau City	nil
Papakura District	nil
Franklin District	nil

Table 1 Relevant regional supporting documents (based on Auckland CDEMG website, 2005)

Plan / Standard Operating Procedure	Status
<b>GROUP FUNCTIONAL PLANS AND STRATEGIES</b>	
GFP P2 Group Evacuation Plan	To write
GFP P3 Group Logistic Plan	To write
GFP P4 Public Information and Media Management Plan	In revision
GFP P5 Group Welfare Plan	Complete
GFP P6 Public Education Strategy	Complete
<b>GROUP CONTINGENCY PLANS</b>	
GCP C1 Volcanic Contingency Plan	Complete
GCP C2 Tsunami Contingency Plan	To write
<b>GROUP STANDARD OPERATING PROCEDURES</b>	
<i>GEOC Related</i>	
SOP G101 GEOC Activation Procedure	Complete
SOP G102 GEOC Structure, Staffing and Operations Procedure	Complete
SOP G103 Transition from Response to Recovery	Complete
SOP G104 Impact and Needs Assessment	Not complete
SOP G106 Volunteer Management	Not complete
<i>General</i>	
SOP G201 Operational Planning Group Role, Emerging Threat Planning and Event Training Process	Complete
SOP G202 Regional Warning System	To write, based on this review
SOP G203 Urban Search and Rescue	Complete
SOP G204 Transition from Harbourmaster to CDEM Group for Emergencies in the CMA	Not Complete

## **2.0 EFFECTIVE HAZARD WARNING NOTIFICATION AS PART OF IMPROVED COMMUNITY RESILIENCE**

In this section we examine the role of warning notification systems within the wider context of effective warning systems and the overarching goal of improving community resilience. For the implementation of any notification system strategy to improve overall resilience its role within wider strategies must be carefully considered and compatible with a wider strategy to confront hazard effects. For example, if the warning process can identify the likely scale, consequences and duration of impact, it may allow more time to evaluate available resources and organise them in ways that enhance adaptive capacity. Warnings can be part of an overall strategy to improve community resilience if they are issued to populations capable of acting appropriately on warning information.

### **2.1 Effective warning systems**

Warning notification systems are the components of early warning systems that deliver warning message(s) to users who need to make decisions based upon them (public, organisations, etc.). These are also sometimes referred to as 'alert systems' but 'alert' is also often used as a name for warning messages, so this usage is avoided here. Note that 'public notification' is also used in non-warning-related contexts, such as the public notification of planning documents.

We refer to 'early warning systems' as the hardware, electronics, communications, and planning necessary to generate and notify a hazard warning. An 'effective warning system' is the wider set of actions necessary to make sure that message is delivered and acted upon in an informed way (Figure 1).

Currently there is no single 'best practice' internationally that has been seen to effectively remove most people from harm's way consistently for all hazards. However by drawing together a) evidence from observations of public response to past events internationally, b) empirical studies, and c) common sense best practice, recommendations for developing appropriate and effective response to hazard warnings have been grouped into the components shown in Figure 1 (Consistent with UN/ISDR Platform for the Promotion of Early Warning, and discussed and justified in detail by Johnston et al., 2005; Leonard et al., 2005; Leonard et al., 2004).

<b>RESEARCH: (Sciences of monitoring systems, sources, propagation, inundation, risk assessment, and of awareness, and effective response)</b>	<b>1. EARLY WARNING SYSTEM:</b> Hardware, electronics, communications and planning necessary to effectively detect a hazard, generate warning messages and transmit them to at-risk regions (including any use of public notification hardware).	<b>EFFECTIVENESS EVALUATION</b>
	<b>2. PLANNING:</b> Decision-making tools: thresholds, evacuation routes and maps, inter-organisational relationships and communication channels.	
	<b>3. COOPERATION, DISCUSSION AND COMMUNICATION:</b> Pre-planned and exercised communication between central government agencies, local emergency management agency staff, scientists and community representatives. Renewal of contacts must be regular and permanently sustained, to overcome common high staff turnover.	
	<b>4. EDUCATION:</b> Public education, staff training, maps, and signs.	
	<b>5. EXERCISES:</b> Scenario development and simulations — table-top and full, with observation and feedback.	

Figure 1 A model of components of an effective hazards warning system

To illustrate what is involved in an effective warning system, Table 3 shows the recently reviewed (Webb (compiler), 2005) state of effective warning system arrangements for tsunami within the Auckland region.

**Table 2** Auckland CDEM Group reported arrangements for effective response to tsunami warnings, data reported for the current tsunami preparedness review (Webb (compiler), 2005). Codes w = written, o = oral, p = perception of involvement in notification, but not written arrangement; T = tsunami-specific (doesn't differentiate source distances), g = generic across hazards, \* = participated in the 2003 Coastal Survey (includes tsunami public awareness).

	<b>CDEM Group Plan</b>	<b>Auckland</b>
<b>Early Warning System: Regional Components</b>	Who in Group receives warning	wg
	Where warning comes from	Wg
	Proportion of time can receive warning	Wg
	How warning is received	Wg
	What is done with warning, decisions made	Wt
	Who is contacted once warning received	Wt
	Tsunami warning hardware	-
	Tsunami warning hardware testing	-
	Arrangements for getting info to public	-
	<b>Planning</b>	Sub-group-level plans
Sub-group-level plans were last reviewed		-
Tsunami warning decision preplanning		Wt
Inundation or evacuation mapping		Wt
Evacuation decider/ manager		Og
Role of police		P
Role of Fire Service		-
Role of other key organisations		wg
Arrangements for giving "all-clear"		-
Tsunami warning SOP's		wt
<b>Communications</b>	Communications with other regions	wg
	Media/ communications plans	wg
	Arrangements with radio station(s)	-
<b>Education etc.</b>	Tsunami warning public education	wg
	Tsunami training	wg
	Awareness/ monitoring research	*
	Tsunami-related signs exist	-
<b>Tsunami warning simulations</b>		wg

### 2.1.1 Developing understanding and the capacity to respond

Understanding and response capacity are outcomes of the combined effect of all components of an effective warning system (Figure 1) and wider community resilience.

Identifying who the warning is intended for is a significant issue (see also Sections 3.3). Several recipient groups can be identified, all of which have different needs, expectations and capabilities. When developing warning systems, it is thus appropriate to consider whose needs have to be served. For example, is the warning intended for emergency management agencies, citizens, community groups (e.g., religious), societal institutions (e.g., welfare agencies, charities), and business. Given this diversity, the emphasis should shift from the delivery of warning messages per se to ensuring that each group knows what they mean and that they have a capacity to act upon them. Without developing this end-user capacity to

interpret and respond, a myriad of warning content, media of delivery, and technology of delivery may have to be developed to meet the needs of each group which may not be cost effective. The development of a range of end-users' capacity to understand and respond to a simpler warning message has additional merit in that it could also be adapted to fit the demands of a range of hazard characteristics, and future 'new' hazards.

### **2.1.2 Effective warning messages**

Effective warning messages are an outcome of both the early warning system, and the response planning, components of an effective warning system (Figure 1).

The warning message(s) that need to be conveyed by notification system(s) influence which system(s) are most appropriate. Warning messages must not be confused with information disseminated outside of a warning for the purposes of improving resilience such as the capacity to decide to respond appropriately to warnings. The purpose and content is different.

Research into the effectiveness of warnings system messages has been undertaken for several decades (Mileti and Sorensen, 1990; Sorensen, 2000). Through this sustained social science research effort much is known about what makes warnings effective. Public response to tsunami warnings is most dependent upon the information provided by authorities during the event (Mileti and Sorensen, 1990). The Partnership for Public Warnings (PPW, 2002) concludes that an effective warning system messages should:

- (1) be focused on people at risk;
- (2) be ubiquitous;
- (3) be capable of reaching people irrespective of what they are doing;
- (4) be easy to access and use;
- (5) not create added risk;
- (6) be reliable;
- (7) provide appropriate lead time so people can have a chance to protect themselves; and
- (8) generate authenticated messages.

Research has also highlighted the critical importance of the message itself (Mileti and Sorensen, 1990) Mileti & O'Brien 1992). For warning messages to be effective they need to be clear and understandable; accurate; frequent; credible; specific to the situation of the recipient (and user) and give specific advice on what the effect will be and what to do to reduce the risk from the impending hazard event (Aguirre, 2004; Mileti and Sorensen, 1990; Sorensen, 2000). Even with a well designed and implemented system, when delivering sound warning messages a number of factors may conspire to reduce its ultimate effectiveness (Aguirre, 2004).

Human response to warnings has been found to relate to factors such as: age, ethnicity, gender, social status, previous experience of hazards and/or past warnings, proximity to the hazard, physical cues in the environment and responses of others receiving the same warning (Sorensen, 2000). The recipients of warnings may be from a number of user groups and have a range of needs, roles and responsibilities and thus respond in different ways (Aguirre, 2004).

Groups with responsibilities to initiate measures to protect the public may include the emergency services, emergency management agencies, mass media, and industry users (e.g. tourism operators). The issue of whether or not to issue a tsunami warning is always a difficult decision. To develop capacity to respond effectively and make appropriate decisions by those with warning roles and responsibilities it is essential consideration is given to training, exercises and drills.

The at-risk public, who are often targeted recipients of warnings delivered by the fore mentioned groups, are not themselves a homogenous group. Differing subpopulations with our society (e.g. young, older, the poor, new immigrants, tourists, those in institutions etc) have differing levels of vulnerability and have been shown to respond in different ways to warnings (Aguirre, 2004; Drabek, 1994; Drabek, 1996; Paton and Johnston, 2001).

Although research has consistently shown information provided during an event is the key to an effective response, pre-event education is also important. There has been limited research into the role pre-event public education has in improving warning response (Sorensen, 2000) but the evidence supports that well designed public education initiatives will increase response. The warnings and emergency public information during an event Miletic (2004) suggests that public education should at least address:

- Who will issue the warning message(s)
- What the warning message(s) could say
- How the warning message(s) will be issued
- What communication media will be used and how to access them.

It is also important to include in each message:

- What should be done in response to that warning message.

### **2.1.3 Importance of the 'all-clear' message**

It is essential to plan to give the all-clear message, and on what basis this all-clear should be initiated (see Hawai'i examples, Appendix 2).

#### 2.1.4 Part of a wider goal: Improved community resilience

The 'effective warning system' model given in Figure 1 provides a set of practical components that may, if designed to integrate with measures beyond a warning system, improve resilience, i.e. the capacity of community members for self-reliance. Two issues are relevant in this context: the reception of warning messages, and the relationship between warnings and capacity to respond.

It is generally assumed by emergency management agencies responsible for developing warnings that they are intended to inform people of potentially threatening events, and that these warnings will be treated at face value, accepted and acted upon. This assumption is not, however, always justified. For example, recent research on tsunami warnings (Johnston, Paton, Crawford, Ronan, Bürgelt and Houghton, 2005) found that people may choose not to respond to warnings for several reasons. For example, some believe the warnings are inadequate because they fail to discriminate between local and distant tsunami and do not provide sufficient time to perform relevant actions such as evacuating. Some don't respond because evacuating conflicts with concerns about being trapped in their car (e.g., roads blocked by the volume of fleeing traffic) or because they place higher value on locating family members than on acting in the manner intended on receipt of the warning. Some residents think that because government authorities put economic and political concerns ahead of their safety (e.g., authorities believe warning information and signs adversely affect tourism/business development), that warning systems are inadequate, reducing their willingness to act. Some people are reluctant to respond because they do not wish to appear foolish if they evacuate and it proved to be a false alarm or they assume others will come to their rescue no matter what happens.

Given that some warnings may occur within close timing of the actual event, getting people to act on receiving the warning is a key aspect of an effective warning process. While the examples of barriers to warning response given above are specific to a given population, they highlight the need to consider the needs and expectations of the intended recipients of warnings. A failure to do so reduces the effectiveness of the warning and increases the demands on emergency management agencies who have to deal with emergent problems resulting from people acting in ways that are inconsistent with expectations.

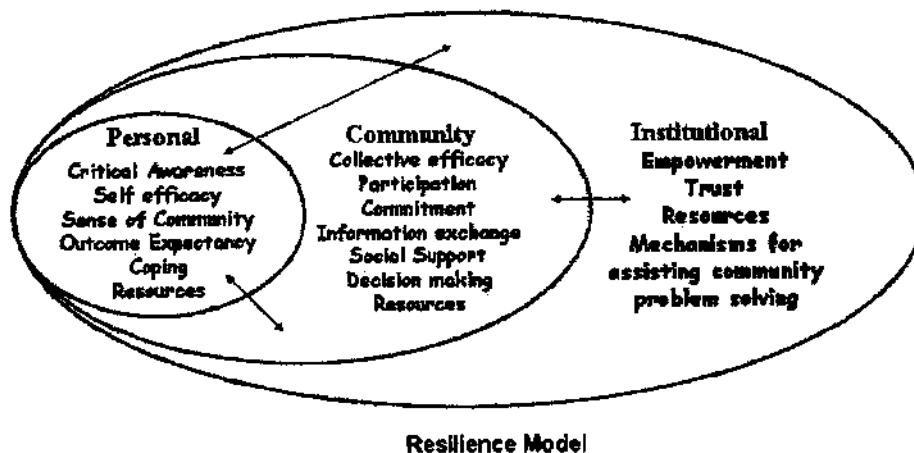
Resilience requires that warnings are developed through community engagement. Beyond motivating response to a warning, the second issue that links resilience research with warnings development concerns the core goal of resilience to ensure an intrinsic capacity for community action, ensuring they are prepared for what happens after they respond to the warning.

### **2.1.5 Hazard resilience research within the Auckland region**

Improved community resilience is the underlying goal of hazard mitigation options in the Auckland Region, and is the focus of a parallel inter-related research project currently underway. The goals of this research project, which is FRST-funded through GNS Science in conjunction with Auckland CDEM Group and MCDEM, are the development of resilience predictors, and the establishment of their validity and reliability, that will be tested in subsequent research. Building on this research 'Measuring and Monitoring Resilience' (for which the data collection is Auckland CDEM Group funded), aims to ensure that strategic objectives of the Group, as outlined in the CDEMG Plan, are being progressed towards the achievement of CDEMG Plan targets in an efficient manner.

This work has direct relevance for dealing with issues raised in Section 3. The resilience project is not only developing the means to assess capacity for effective response to warnings, it is doing so within a community engagement framework that will allow community needs and expectations to be articulated, and their relevance for warning effectiveness to be evaluated and accommodated. This project will, firstly, identify the resources that communities, their members, businesses and societal institutions must possess (e.g., emergency plans, business continuity plans) that are required to safeguard their safety and ensure the continuity of core societal functions. Secondly, it will identify the competencies (e.g., self-efficacy, community competence, trained staff) required to respond to warnings by mobilizing, organizing and using their resources to confront the problems encountered and use them to adapt to hazard consequences. A resilient community will be better placed to organize and mobilize its response quickly.

The resilience research project will consider the planning and development strategies required to ensure the sustained availability of these resources and the competencies required to use them over time and against a background of hazard quiescence and changing community membership and functions. This work is developing a multi-level model that can be used to assess warnings issues at these different levels. That is, it will provide a framework to develop individual, community and societal level capacity. These elements are depicted in Figure 2.



**Figure 2** Community resilience model based on Paton and Johnston (2001).

### 2.1.6 Limitations of early warning systems

An early warning system only activates a decision-making process. The quality of the decision-making is the true measure of the effectiveness of a warning system therefore building the capacity to make effective decisions is the key challenge. There are many historic examples where at-risk populations in full or in part have failed to respond to official warnings, even when a well resourced (and what was considered well planned) warning system was operating (e.g. Biever and Hecht, 2005; Gregg et al., (submitted); Handmer, 2002; Pfister, 2002; Voight, 1990). Many of these failures have resulted from a lack of understanding of the need for a holistic approach linking various elements into an integrated system (Handmer, 2002; Leonard, Johnston and Paton, 2005).

#### ***Realistic effectiveness***

No early warning system will be 100% effective at mitigating risk, because people make risk-acceptance decisions based on the interaction between their needs/expectations and the warning messages, and some of those decisions will lead to no, or only partial, reduction of the risk. As outlined above, this can lead to warnings being ignored. In some situations there is difficulty notifying diffuse populations. For example, in rural remote coastal or wilderness areas you may never reach all farmers, let alone trampers and surf-casters etc. Systems must be appropriate to population density, and be available to the majority of people as a priority.

#### ***Planning for system failure***

No warning system is foolproof and all systems have a potential for failure. For example on the 14th June 2005 a Tsunami Warning was issued for Washington, Oregon, and California, following a magnitude 7.4 earthquake off shore in northern California. The response to the warning was variable and a number of hardware and procedural problems were experienced

(Biever and Hecht, 2005). Public response was also inconsistent across the communities that received warnings. To reduce the chances of failure a holistic approach to warnings must be adopted.

#### ***Potential to reduce community resilience***

The existence of a public notification system, or even just a report outlining system options and recommendations, may in fact reduce a community's resilience due to individuals' transfer of responsibility for managing the risk to the authorities promoting the warning system (Ballantyne et al., 2000); this is especially true if it is not specifically designed as part of a wider programme to improve resilience (Paton and Johnston, 2001).

#### ***Business and politic resistance to warning systems***

Many proposals for establishing warning systems and disseminating public information about hazards (e.g. erecting signs) are met with opposition from members of the community, fearing negative impacts on business development and tourism. Recent examples in New Zealand have seen several councils reject the installation of tsunami warning signs (e.g. Gisborne, Wellington and Kaikoura). However, a number of studies have shown that initial fears of negative consequences prove to be unfounded with no long-term business impacts occurring as a result of improved warning systems and public information (Yeo 2003; Johnston et al. 2002; Johnston et al. 2005).

#### ***Realistic ongoing costs and commitment***

Many warnings systems are developed without a realistic understanding of ongoing costs. These may exceed the initial cost of a hardware-based warning system. Ongoing and regular testing, maintenance, simulation exercises and effectiveness evaluation must be budgeted for and these must be an ongoing commitment to maintain such activities. There is a need for all components to be present, exercised and evaluated (regular and ongoing) to achieve and be able to state a level of effectiveness.

## **2.2 Auckland region emergency experience, exercising**

There has been little experience of a district- or region-wide emergency in the Auckland region in the last few decades. The last declared emergency within the region was the Waitakere city flooding in the early 1980s. The 1994/95 water shortages and 1998 power crisis have come the closest to a declaration since this time (Stockley, 2000).

Prior to these episodes, probably the last major event that was a declared emergency event was the Parnell Fumes Crisis in 1973 that resulted in the establishment of ESCC's due to the lack of co-ordination in dealing with that incident (CIPCDE, 1973).

There is an annual CDEM Group exercise, in addition to annual exercises conducted by TLA Civil Defence /EMO's.

The CDEM Group Exercise generally includes senior level staff from Group organisations, whereas the local TLA exercises encourage the involvement of operational managers (Sergeants and Senior Sergeants) from the Police and allied organisations. The police, for example, seldom have regular exercising for the wider operational staff; these staff instead rely on 5-weekly training days.

Table top exercises are a rarity although small specific-role groups within the police regularly exercise (e.g. the AOS, STG, and SAR). The Auckland CDEM exercising will be enhanced by the adoption of the National Exercise Programme.

### **3.0 WARNING NOTIFICATION NEEDS IN AUCKLAND REGION**

This section lays out the variety of social, geographic and hazard situations within the Auckland region and how these need to be accommodated in the selection of an optimum set of warning notification arrangements.

There are a wide range of public notification systems available (Section 4, Appendix 3), internationally most commonly including sirens and media announcements. Within New Zealand there is a wide variety of current and planned approaches. It is frequently asked "What is the best system?". International research shows that the most appropriate system will vary between communities and should be tailored around the specific nature of the location, society, and hazard (Mileti and Sorensen, 1990; OEM&ODGAMI, 2001; Sorensen, 2000).

The early warning system, of which public notification is a key component, can vary widely depending upon (modified from Tierney, 2000):

- Technology employed to detect hazard events
- Reliability of event detection technology and understanding
- Length of time needed to achieve accuracy in forecasts
- Reliance on human mediation
- Types of warning systems and devices used
- Channels employed to issue warnings
- Familiarity, routinisation and institutionalisation of early warning procedures
- Settings in which systems are used
- System goals and objectives

The audience will vary in terms of demographic characteristics and function (e.g., welfare agencies, commercial businesses). The activities they are conducting when a notification is given will also be variable and may vary for the same person at different times. For example the notification needed for tourists in a motel will be different to that of a permanent resident

on the street, or even in that same motel. For the public notification system to be assured as reliable in the event there must be redundancy, permanently ongoing testing and maintenance, battery back up (Darienzo et al., 2005; Gruntfest and Huber, 1989; OEM&ODGAMI, 2001).

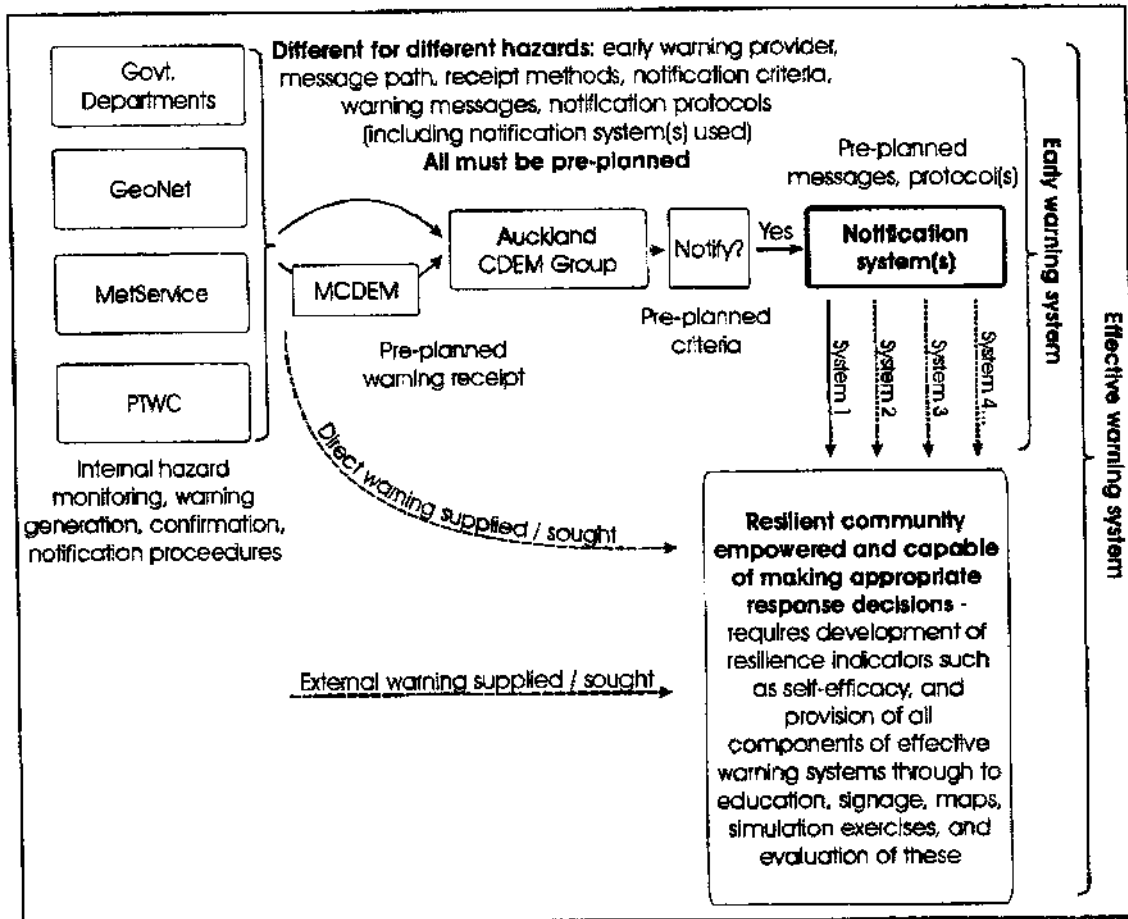
Warning processes do not operate within a social vacuum. People are not passive recipients of information, even when it is intended to inform them about significant issues in their environment (Paton and Johnston, 2001). People make judgements about the information presented to them and actively interpret it within frames of reference. The public's frames of reference can differ systematically from their scientific and civic counterparts, who are responsible for developing and delivering risk messages. People interpret information in a context defined by their social context (e.g., social norms, cultural beliefs), their expectations, their past experience, and their beliefs and misconceptions about hazards and how to respond to them. Because people actively evaluate the relevance of warnings information for them, this can result in their being disinclined to attend to information or to interpret it in ways that differ from that intended by civic agencies. Hence, to pursue the wider goal of encouraging effective understanding of and response to warnings, it is important to understand how people interpret their relationship with hazards, how they interpret hazard and warning information, and to identify which factors influence the interpretive process (Paton and Johnston, 2001). The starting point is to consider the sources of warning information.

### **3.1 Sources of warning messages and information**

While emergency management agencies are the primary source of warnings information (Fig. 3), they are not necessarily the most important from the perspective of understanding warnings issues (Paton and Johnston, 2001). They are but one source of information. Information is also available, to civic agencies and citizens alike, from the media. In many cases, the media are the more active source, particularly when it comes to reporting warnings, as well as the response and recovery efforts that follow them. They constitute a significant influence on people's perceptions of hazard characteristics and their consequences and can exercise a strong influence on people's beliefs and attitudes to warnings.

The importance of the media can also be attributed to the fact that it often delivers information that is filtered, processed and interpreted to varying extents and with varying degrees of accuracy. Furthermore, the information the media make available often extends well beyond the hazards issues per se to include their interpretation of the credibility of the sources of mitigation plans and the quality of their efforts (Paton and Johnston, 2001). Media analyses are usually post hoc. Given the fundamental uncertainty associated with the periods in which warning processes are activated, this is a fertile area for misinterpretation. Not all those who receive media coverage will be able to weave their way through the maze

of issues required to construct an objective view of the warning issues and their implications. Thus, how the media treat hazard complexity and uncertainty can influence levels of trust in information sources (e.g., emergency management, civic and scientific agencies). If this trust is broken, the future integrity of warning systems may be compromised.



**Figure 3** Flow diagram for warning messages into, and public notifications from, Auckland CDEMG, and the way in which warnings reach (or are sought by) the community.

### 3.2 Hazards to warn for

The Auckland CDEM Plan lists 28 distinct hazards (Table 4); with so many it is worth considering focusing public notification system development on those with higher priority first. The Plan identifies 8 higher, 10 moderate and 10 lower priority hazards. This classification is based on the SMUG prioritisation model, being seriousness, manageability, urgency and growth. It is limited by how much is known about the risk from each hazard. For example distantly-generated and locally-generated tsunami are considered moderate and lower priority, respectively, but new tsunami risk modelling may well change this status (Auckland CDEM Group, pers comm., 2005).

It is important to note that ranking hazards high, medium and low priority poses difficulties for CDEM Groups, as often very little resourcing will be directed towards the low and some of the moderate hazards.

**Table 3** CDEM Group Plan hazard priorities (Auckland CDEMG, 2005) and hazard characteristics (modified after unpublished work of the Federal Emergency Management Agency, 2001)

	Hazard	Predictability	Detectability	Certainty	Lead Time	Duration of event	Visibility to majority of the public		
Higher Priority	Biological – animal disease/epidemic	M	H	M	Days	Days	Visible		
	Biological – human epidemic*	M	H	M	Days				
	Cyclone*	H	H	M	Days				
	Earthquake	L	H	L	Seconds				
	Lifeline utility failure*	L	M	L	Variable			Hours to days	
	Major crash – aircraft	L	M	L	Minutes			Minutes	Limited
	Volcanic – Auckland Volcanic Field	L	H	L	Variable			Hours to days	Visible
	Volcanic – distant volcanic eruption	M	H	M	Variable			Hours to days	Visible
Moderate Priority	Biological – introduced species/pests*	M	M	M	Hours	Hours to days	Visible		
	Coastal – beach erosion and flooding*	H	H	M	Variable	Minutes	Visible		
	Coastal – cliff erosion/coastal instability*	H	M	M	-				
	Coastal – sea level rise*	M	M	M	Hours				
	Coastal – tsunami – distantly generated	M	M	M	Seconds				
	Computer systems failure	M	M	L	Variable				
	Criminal acts	L	M	M	Variable			Hours to days	Visible
	Fire – catastrophic wildfire	L	M	M	Minutes			Minutes to days	Limited
	Fire – urban structure fire	L	M	M	Minutes			Minutes to days	Limited
	Hazardous substances	L	M	L	Minutes			Minutes to days	Limited
Lower Priority	Coastal – tsunami – locally generated	M	M	M	Minutes			Minutes	Visible
	Dam failure	L	M	L	Minutes	Hours	Visible		
	Drought – agricultural drought*	H	H	M	Days	Days	Visible		
	Drought – water supply drought*	M	H	L	Variable				
	Flooding*	H	H	M	Hours				
	Land instability*	L	M	L	Hours				
	Major crash – rail	L	M	M	Minutes			Seconds	Limited
	Major crash – road	L	M	M	Minutes			Seconds	Visible
	Major collision – marine	L	M	M	Minutes			Seconds	Limited
	Tornado*	M	M	L	Minutes			Short	Some

\*potential to be exacerbated by climate change

The above matrix describes the characteristics of various hazards. The easiest hazards to issue warnings for are those with a high level of predictability, detectability, and certainty, that have long lead times and are visible. The most difficult are those with the opposite characteristics: low level of predictability, detectability, and certainty and with short lead times and no visibility. Such hazards require rapid response and notification capabilities. Long duration events require plans to frequently update warning information.

Table 4 Potential secondary hazards resulting from specific primary hazard events

Primary Event	Biological – animal disease/epidemic	Biological – human epidemic*	Cyclone*	Earthquake	Lifeline utility failure*	Major crash – aircraft	Volcanic – Auckland Volcanic Field	Volcanic – distant volcanic eruption	Biological – introduced species/pests*	Coastal – beach erosion and flooding*	Coastal – cliff erosion/coastal instability*	Coastal – tsunami – distantly generated	Computer systems failure	Criminal acts	Fire – catastrophic wildfire	Fire – urban structure fire	Hazardous substances	Coastal – tsunami – locally generated	Dam failure	Drought – agricultural drought*	Drought – water supply drought*	Flooding*	Land instability*	Major crash – rail	Major crash – road	Major collision – marine	Tornado*
<b>'Higher Priority'</b>																											
Biological – animal disease/epidemic	X																										
Biological – human epidemic*					X																						
Cyclone*					X					X	X																
Earthquake					X																						
Lifeline utility failure*					X								X	X													
Major crash – aircraft						X	X						X	X	X	X	X		X								
Volcanic – Auckland Volcanic Field					X	X							X	X	X	X	X		X								
Volcanic – distant volcanic eruption					X	X							X														
<b>'Moderate Priority'</b>																											
Biological – introduced species/pests*	X																										
Coastal – beach erosion and flooding*					X						X						X					X	X				
Coastal – cliff erosion/coastal instability*					X					X													X				
Coastal – sea level rise*					X																						
Coastal – tsunami – distantly generated					X					X	X						X					X	X				
Computer systems failure					X								X												X		
Criminal acts													X														
Fire – catastrophic wildfire					X												X										
Fire – urban structure fire					X												X										
Hazardous substances																X	X										
<b>'Lower Priority'</b>																											
Coastal – tsunami – locally generated					X					X	X			X		X	X					X	X				
Dam failure					X																	X	X				
Drought – agricultural drought*															X						X						
Drought – water supply drought*															X	X											
Flooding*					X																						
Land instability*										X	X		X	X									X				
Major crash – rail																											
Major crash – road																											
Major collision – marine																											
Tornado*					X								X	X		X											

Any all-hazard public notification system needs also to recognise the possibility of multiple hazard events occurring concurrently, possibly with one or more secondary hazards being caused by a primary hazard event (Table 5).

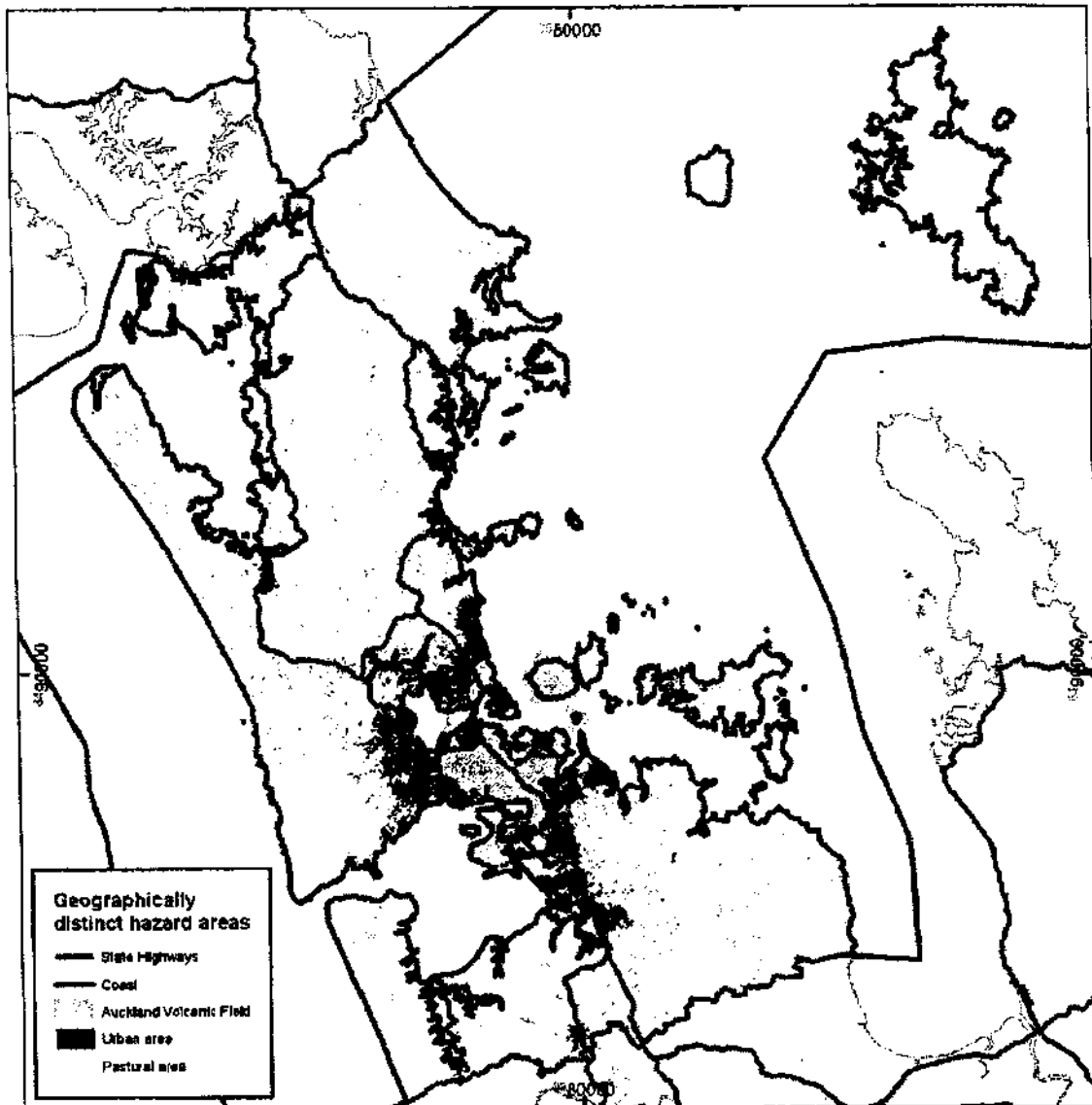
### **3.2.1 Spatially varied hazards**

Hazards events potentially affecting the Auckland region (Tables 4 & 5) have varied possible spatial extents within the region. As an example Figure 4 demonstrates the difference in the locations of coastal hazards (erosion, sea level rise, tsunami, inundation/flooding), local Auckland Volcanic Field eruption hazards, pastoral hazards (animal disease outbreak, catastrophic wildfire) and the state highway system (major road crash with or without hazardous substance discharge), lifeline failure, needed for evacuation in some other hazard events. Flooding and slope instability can affect specific areas over most of the region.

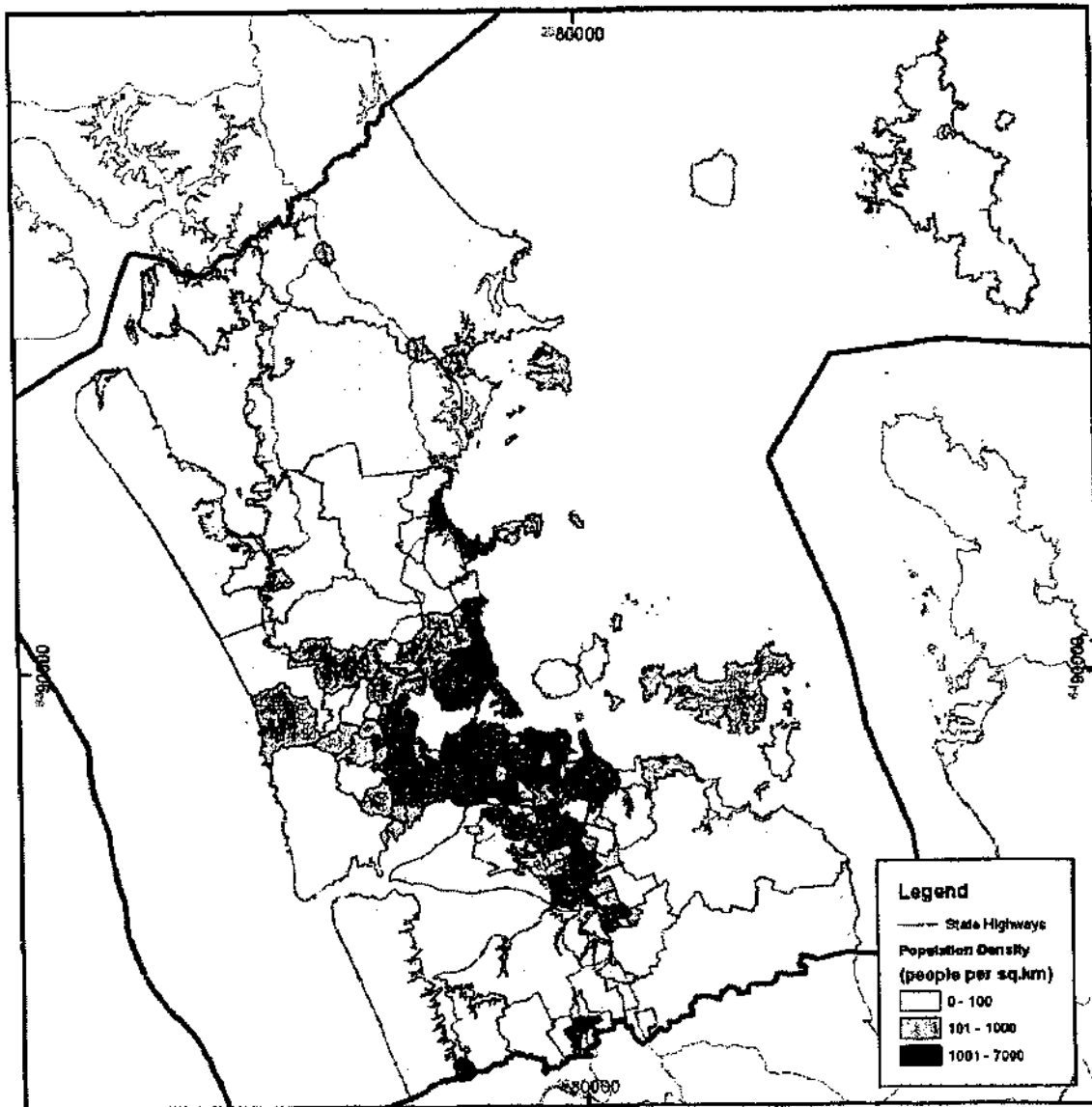
In contrast several hazards can potentially affect any part of the region equally (far-source volcanic ash fall, drought, human disease epidemic, cyclone, tornado, earthquake (although secondary earthquake effects such as liquefaction, amplified shaking and slope instability affect specific areas distributed across the region). The Auckland metropolitan area is the most likely locus of large scale urban fires.

### **3.2.2 Varied hazard warning time-frames**

Issues to be considered here include the means by which a potential problem is detected. That is, what monitoring capability exists for each hazard, who monitors, and is it monitored 24/7? A second issue concerns the criteria for determining what constitutes a problem or potential problem and who make this call. The next issue concerns issuing a warning and the content/media etc used. When doing so, is it intended to signal a 'watch' or a 'warning'. Other issues: How is the time frame between detecting to warning to impact handled? How are long precursory periods handled? How to ensure warnings are received against a backdrop of activity (e.g., volcano warning in Auckland against several weeks of seismic experience)? How to handle escalation and diminution of hazard activity? How to handle false alarms? Refer to Table 4 outlining different warning lead-times for hazards.



**Figure 4** Map of Auckland region displaying five locations of potential hazard events, to illustrate the large variation in spatial distribution between hazards. Pastoral area is assumed to be that not in urban, bush, forest or scrub classes.



**Figure 5** Residential population density (people per square kilometre) for Auckland region based on the 2001 census area units. Brown represents densities below 100, green from 100 to 1000 and blue from 1001 to 7000.

### 3.3 Warning system end-users and purpose

An issue in the application of warnings research concerns the assumptions that underpin its development. When developing a warning system it is pertinent to ask who it is intended for. For example, is the warning intended for emergency response groups, citizens, or business, or is it intended to reach all sectors of society? Because these groups differ with respect to their needs, expectations, capabilities and objectives. A second question relates to the function a warning is intended to fulfil. For example, is it intended to signal a need for evacuation, or to signal a need for people to stay where they are? Considering this issue

introduces a need to consider not just the warning system but also the intended objectives of a warning and the capacity of its intended recipients to act in the anticipated manner. It is also pertinent to consider what it is that a warning is intended to warn people of. For example, warnings for volcanic hazards cover ash, lava, gas, not to mention the impacts of these hazards on infrastructure, health etc. The effectiveness may require clear understanding of the consequences that people/businesses must protect themselves from. It is thus important to link warnings with the capability to understand the implications of warning and the capacity to act in an appropriate way. Furthermore, given that the distribution of hazard consequences can change with topographic and meteorological conditions, identifying the objectives of warnings, with regard to informing recipients, is challenging.

### **3.3.1 Spatially varied end-users - Rural vs. City**

Urban and rural community populations (high and low population densities, Figure 5) lend themselves to group notification through such means as PA loudspeakers and sirens more easily than rural diffuse populations. There are also locations that have populations that swell at specific times (holiday areas, beaches) and remote populations on the water around the Auckland region. Therefore, more than one notification system is likely to be necessary to reach the majority of the region's population.

### **3.3.2 Different end-user types**

The target audience for a warning can vary greatly, and many people will have different needs and undertake different actions on the receipt of the same warning. Therefore, notification systems and the warnings they disseminate will need to be tailored to the community that is being warned. For example, urban populations are generally less self-sufficient than rural populations and in warnings expect 'someone will take care of it'. Rural populations often have high self-sufficiency and in warnings may have higher awareness of personal responsibility, both in detecting a natural/official warning, and in responding to it. Understanding the make-up of the at-risk population is important in deciding what type of systems are required and how to operate them.

The activities individuals are doing at the time can also greatly affect how quickly they receive a warning and also their response (e.g. are they at home, work or school?; is it a week day or weekend?; are they sleeping, listening to the radio, watching TV or out shopping?). This also needs to be accounted for in the planning and type of notification systems adopted.

Another issue is the spatial and temporal variations in population in high risk zones. Much emergency management planning is based around residential populations; however at times at-risk populations can increase markedly in certain locations (e.g. coastal motor camps in summer, crowds at sports events etc).

### ***Institutional populations***

An important group are those in institutions. Institutional populations include schools, hospitals, nursing homes, prisons and other facilities with client populations (this includes tourists). Research has shown that many of these institutions, despite low preparedness, are very adaptive responding to warnings and moving their clients if required (Vogt, 1990). However many difficulties have been encountered highlighting the need for pre-event planning with these institutions (Mileti and Sorensen, 1990; Ronan and Johnston, 2005; Sorensen, 2000).

### ***Elderly and Disabled Populations***

Recent research has shown that a number of age-related deficits in the abilities of older adults can potentially impact on their response to warnings (Mayhorn, 2005). Mayhorn highlights that perceptual changes in older adults can impair their ability to notice warnings during the alerting phase whereas limitations in cognitive abilities such as text comprehension and memory might limit understanding in the decision making and response phase. These issues also apply to other disabled groups, as well as issues around physical disabilities. Those responsible for the care of such people need to ensure that appropriate information and support is provided during a warning notification for an appropriate response to be undertaken.

### ***Schools***

A number of issues specific to schools need to be addressed in the implementation of an effective warning notification system. All schools in New Zealand are required to have detailed plans on how to respond to a range of incidents and have procedures in place for both evacuation and sheltering within the school. It is important that schools understand the nature and type of warnings they will receive in their local environment and link those closely with their response plans (Ronan and Johnston, 2005). During any warning phase the separation of children from parents and caregivers is a cause of much anxiety. Experience has shown that if schools are in evacuation zones the movement of parents and caregivers to collect children, often moving in from outside an evacuation zone, can cause traffic congestion and hinder the evacuation process (Johnston, Paton, Crawford, Ronan, Burgett and Houghton, 2005; Ronan and Johnston, 2005). This needs to be accommodated in the planning process.

### ***Tourists and other transient populations***

Research conducted during the last decade has highlighted the difficulty in preparing tourists and other transient populations to effectively respond to warning messages (Drabek, 1996; Drabek, 2000; Leonard, Johnston and Paton, 2005; Leonard, Johnston, Paton and Kelman, 2004; Sorensen, 2000). Issues around lack of knowledge of the hazards, warning systems, evacuation procedures; language and cultural differences and being in an unfamiliar

environment all reduce the effectiveness of warnings. The research highlights the important role of staff training as they most often provide key guidance during a warning notification. Lack of this training has been shown to be a significant issue (Johnston et al., in press).

### 3.4 Cost limitations

Relative magnitudes of start-up and ongoing cost are estimated in Table 6 for each reviewed option, with the basis explained in Appendix 3. These are based on known examples where available, or are assumed. Table 6 highlights the different cost categories that must be considered.

**Table 5** Start-up and ongoing cost considerations for warning systems

	<b>Financial cost</b>	<b>Labour costs</b> (has an associated \$ value for commercial organisations, time for volunteers)
<b>Initial start-up</b>	\$ one-off	Effort one-off
<b>Ongoing</b> (will in total exceed start-up cost at some stage)	\$ per year	Effort per year

In contrast, 'benefit' (reduction in loss, Table 7) is difficult to quantify until a wide range of hazard events have occurred to test the system effectiveness in terms of type of loss.

**Table 6** Categories of loss that can be reduced, i.e. benefit

<b>Measurement</b>	<b>Type of loss</b>	
	<b>Direct</b> (Physical damage)	<b>Indirect</b> (Flow-on consequences)
<b>Tangible</b> (Monetary values)	Damage to infrastructure, buildings and contents, vehicles, etc.	Production losses, lost salaries and wages, clean-up costs.
<b>Intangible</b> (Non-monetary values)	Death, loss of memorabilia.	Disruption of social services, incl schooling. Stress-induced illness.

Evaluated exercises conducted on an ongoing and regular basis will provide some estimation of effectiveness in the interim, and can and should be fed back into the system design to continue to increase effectiveness in terms of the cost-benefit relationship.

## **4.0 AUCKLAND REGION PUBLIC WARNING NOTIFICATION OPTIONS**

This section summarises the relative merits of the 26 public notification system options reviewed, and compares these against the requirements for recommending system(s) laid out in Section 1. This section focuses on public notification of warnings, but must be considered in the context of the wider issues and components associated with effective warning and community resilience outlined in previous sections. Notification options are presented in Section 4.6 as a matrix for easy relative comparison, but care should be taken not to rely upon that table alone, as it necessarily simplifies aspects of the systems. More detailed analysis of each option is given in Appendix 3.

The options are summarised and compared under the following five categories:

- Natural warning notification
- Notification via structured organisations and groups to the public
- Notification via institutional staff to those in their care
- Notification to public using third-party organisation hardware
- Notification using warning-dedicated hardware

It is clear that no single system will fulfil all requirements and needs, so the reader should keep in mind a combination of systems when reading these summaries. A combination also provides redundancy in case of individual system failure. The key is the integration of all the systems and resources into one manageable procedure to effect a warning within an identified time period. Any procedures will need to be part of the National Warning System.

### **4.1 Natural warning notification**

Natural warnings may accompany most hazards. For example disturbance and noise in the ocean may precede a tsunami, tremor or ground deformation may precede a volcanic eruption, smoke indicates a fire, etc. Natural warnings should be heeded, not discounted in the absence of an 'official warning'. This is a community resilience issue, and awareness of the potential for multiple warning sources comes with an aware and empowered community (Section 2).

Public education campaigns to promote awareness of natural hazards should include information regarding appropriate response to natural warnings, as well as details of any official notification system(s). Similarly education material associated with an official notification system should include material on the contribution, or otherwise, of any other notification systems, including natural warnings.

## 4.2 Notification via structured organisations and groups to the public

Using structured organisations and groups with self-maintaining contact networks can be effective if the message conveyed is accurate (seen with Australian flood warnings, Appendix 2). However, they can also easily disseminate disinformation. The initial source of warnings to these groups can be natural or hardware-based (via the CDEM Group or direct).

For this concept to be maximally effective, resilience work is important, raising communities' ability to decide what information is useful, correct etc.. The general process for assimilation of information is positively influenced as community resilience improves. This is especially important for prolonged warning situations such as volcanic eruptions – in this case, for example, media interpretations and dissemination of ongoing messages may result in incorrect information available to structured organisations and groups, as well as to the general public.

Use of these networks is only as reliable as the communication methods which they employ. Loss or overloading of phone lines may render some of these networks ineffective. Reliance on, or expectations of warnings from, these networks by the public may decrease resilience in the event of the network failing, if other complementary notification systems have not been implemented, or are ignored.

Surf clubs, with 1,500 volunteers in the region in 2005, rural fire with over 200 staff<sup>2</sup> and volunteers on call, St Johns, the Department of Conservation (DoC), Ambulance, Transit and Council staff are all particularly well suited because they have members 'on-duty' at some or all times, and are used to rapid communication across their networks. Appendix 3 includes details of surf lifesaving as a case study.

## 4.3 Volunteer and community organisations

- Surf clubs
- Neighbourhood support
- Rural fire
- Royal New Zealand Volunteer Coastguard
- St Johns
- Red Cross
- Salvation Army
- 1<sup>st</sup> response call trees in remote areas (Piha)

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<sup>2</sup> A large proportion of the rural fire staff on call are derived from the Department of Conservation

#### **4.4 Government organisations**

- DoC
- Army / defence
- Ambulance
- Transit
- Council staff (operational)

#### **4.5 Notification via large companies and institutional staff to those in their care**

In many instances, tourism operators, those in institutional care (hospitals, retirement homes etc.) and those working in large companies (factories, port companies etc.) have an obligation to provide for the safety of those in their care or custody. A list of those large companies/institutions is provided below as an example of where direct notification to them will potentially affect large numbers of people:

- Tourism and hospitality operators, especially for transient populations
- Schools
- Hospitals
- Retirement homes
- Department of Conservation – those using the conservation estate
- Factories
- Port Companies

#### **4.6 Notification to public using third-party organisation hardware**

This requires using their hardware and communications systems, which is a reliability, coverage and maintenance issue; it is also potentially a cost-sharing issue. All of these third-parties will also need to commit some level of staff time as well as hardware. Detailed analysis of each option is given in Appendix 3. Development of existing organisation's roles through detailed agreements and planning will probably be the most readily achieved (Police, Fire, Radio, Television). Cell broadcasting, radio and television provide the ability to warn the most quickly, especially if automatic 'break-in' hardware were installed with radio and television (as is required by law in the USA). Pagers, telephone land-line-based systems and SMS systems are limited by the need for a list of contacts to be maintained. High traffic requirements also limits land-line and SMS text message further. Door-to-door route alerts are commonly used overseas, but again only reach a limited number of people per minute.

Systems that rely on end-user hardware, such as websites, radio, phone, email, phone-line messaging etc, will always be limited by the number of users with that equipment and whether they are in a position to be warned by it.

Aircraft have substantial equipment, pilot and craft availability limitations, and billboards would require a substantial time (hours to days) to have any effect. Both of these systems require substantial pre-planning and will probably only reach a minority of the urban and rural populations.

By relying on third-party(s) the CDEM Group would be introducing another 'link' in the warning chain, and consideration must be given to failure of this link. This may be at the stage of communication to the third party, if applicable, or in a failure in planning and/or hardware within that third party.

#### Warning to end-user groups

- New Zealand Police (mobile PA loud-speakers)
- New Zealand Fire Service (mobile PA loud-speakers)
- Radio and television stations
- Aircraft
- Websites
- Amateur radio
- Billboards
- Travel Advisory Radio
- Call-in phone line
- Radio data systems

#### Individual end-user receives warning

- Police (door-to-door route alert)
- New Zealand Fire Service (door-to-door route alert)
- Telephone (call lists, auto-dial, telephone trees)
- Pagers
- Cell broadcasting
- SMS text messaging
- E-mails
- Power line messaging

### **4.7 Notification using warning-dedicated hardware**

These systems all notify groups of end-users at one time. Systems which can notify individuals directly are all owned by third part organisations (listed above). Dedicated systems include:

- Sirens
- Fixed PA Loud-speaker announcements
- Mobile loud speakers
- Flares, explosives
- Tone-activated alert radio

Sirens, Fixed PA loud-speaker systems and Tone-activated alert radio have the potential to reach the majority of the population, but cost (quickly reaching millions of dollars) and complexity of the systems (and thus ongoing maintenance and testing; and intensive awareness issues in the case of sirens) are likely to be the major limiting factors.

Sirens are the most commonly suggested form of public notification, however developing understanding and response, and maintenance and testing requirements, make sirens a relatively difficult option to make effective. Existing siren infrastructure provides a valuable complement to other options that can more easily be made effective by themselves. Such sirens already present within the community are also imbedded within the culture and awareness of that community; they have a valuable part to play in supporting warning notification – they should be maintained (with public education and testing) as part of a wider set of systems, not disestablished. However, within a constrained spending environment the provision of new sirens should probably be well down the list of priorities for new expenditure.

#### **4.8 Relative merits of reviewed notification systems**

Table 8 is a summary guideline, it should be read in conjunction with the more detailed analysis in Appendix 3 and all options must be considered in the context of effective warning systems and community resilience improvement (Section 2). Both must be read with caution, because more structured work is required to both investigate the feasibility of individual options in detail, and develop the capacity of the community to respond to warnings delivered by these system(s) with appropriate decisions.

Table 7 Summary of relative merits of warning public notification system options reviewed in more detail in Appendix 3.

	Limitations / considerations	Time-range to reach 'first and total pool of end-users'	Method/effectiveness reference(s)	Ongoing institutional effort required	Start-up institutional effort required	Start-up Cost rural communities (\$)	Start-up Cost urban (\$)	Start-up Cost rural diffuse (\$)	be based on examples of best practice	be easy to understand/interpret	be suitable to Auckland hazard context	be applied consistently throughout NZ	target to specific geographic audiences	are cost effective	can be implemented quickly and easily	address social behaviour models
Via natural warnings	M.E.T.P.T	S-H		L	M	M	M	M	H	X	X	?	?	?	?	?
	P.T.T.P	MH		L	M	L	L	L	M							
	P.T.T	MH		L	M	L	L	L	M							
Via institutional staff to those in their care	P.T.T	MH		L	M	L	L	L	M							
	E.T.X.A.P	MH		L	M	L	L	L	M							
	E	S-M		L	M	L	L	L	M							
	T.E.A	H-W		L	M	L	L	L	M							
	E.T.M.S	M-W		L	M	L	L	L	M							
	S.X.A.P.C?	MH		L	M	L	L	L	M							
	T.S.L.E	M-H		L	M	L	L	L	M							
	T.S.L.E.C?	MH		L	M	L	L	L	M							
	T.E.P.S	MH		L	M	L	L	L	M							
	X.A.E.S.P.D	78-H		L	M	L	L	L	M							
Via 3rd Party hardware and/or staff	A.C?E.T.S.P	MH		L	M	L	L	L	M							
	X.A.C?E.S.P	S-M		L	M	L	L	L	M							
	A.F.T.P.T	H-D		L	M	L	L	L	M							
	T.S.L.E.C.X	M-H		L	M	L	L	L	M							
	T.S.L.E	H-D		L	M	L	L	L	M							
	T.S.L.E	H-D		L	M	L	L	L	M							
	A.P.C?E.T.S	M-H		L	M	L	L	L	M							
	C.E.A.S.P.C?	MH		L	M	L	L	L	M							
	T.E.M.S	D-W		L	M	L	L	L	M							
	C.X.P	S		L	M	L	L	L	M							
Dedicated hardware	E.M.P	M		L	M	L	L	L	M							
	T.E.P.C	MH		L	M	L	L	L	M							
	C.X.P.M	S		L	M	L	L	L	M							
	C.E.M	S		L	M	L	L	L	M							
		S		L	M	L	L	L	M							

Legend to Table 8 (previous page)

**MEETS REQUIREMENT?**

- ✓ Meets requirement well
- Doesn't meet requirement well  
[Blank cell] Doesn't meet requirement
- ? Uncertain - would require detailed scoping in the Auckland context

**SUITABILITY TO HAZARD**

- ✓ Suited
- May be suited in longer lead-time situations if system works well and quickly  
[Blank cell] Not suitable
- \* Would potentially create inappropriate response
- A Requires a long term awareness and education campaign
- ? Uncertain relationship - would require detailed scoping in the Auckland context

**COST**

- 0 No cost
- L Low cost (less than \$10k?)
- M Moderate cost (\$10k to \$100k?)
- H High cost (\$100k to \$1M+ ?)
- HI Very high cost (\$10M+ ?)

**SOCIAL & INSTITUTIONAL EFFORT REQUIRED**

- L Low - fit within existing work load?
- M Moderate - substantial work load increase for one person?
- H High - substantial multi-person

Limitations: System comple(X)ity, (M)eaning awareness, (A)greements required, (E)xposure to public, (L)ist availability, (T)imeframe, external (S)ystem-reliance, (P)lanning, (C)ost, (Tr)aining

Time-range to reach the first end-users and total pool of end-users capable of receiving warning by this notification system: (S)econds, (M)inutes, (H)ours, (D)ays, (W)eeks

Notes for hazard names:

\* potential to be exacerbated by climate change

Notes for notification system options:

† May need separate local, regional and/or national level arrangements for events at these different scales,

<sup>1</sup> Assumes free transmission agreement, expensive option for automated 'transmission break-in' system,

<sup>2</sup> Assumes material costs only (free advertising agreement – possibly feasible for days, but would likely have to pay advertising for longer period warnings), A – Awareness campaign rather than typical 'warning'

## **4.9 Options compared to review requirements and other considerations**

### **4.9.1 'Best practice'**

Basing the analysis on examples of best practice from elsewhere in New Zealand and overseas is limited by a lack of 'best practice' for all hazard public notification, let alone effective warning systems. This report has highlighted options that have achieved some success here and overseas, and reviews that evidence.

International examples are given in more detail in Appendix 2, but come from:

- Australia (flood warnings, media, telephone and community organisations)
- Hong Kong (mobile phones)
- Japan (Television-integrated messaging, tsunami)
- New Zealand (Sirens, loud-speakers, radio, planning for response)
- Mexico (seismic alert)
- USA (Mainland and Hawaii, all systems summarised above in Table 8)
- UK (Flood alert systems, cell broadcasting)

### **4.9.2 Public understanding of notifications**

The ease with which a public notification system may be correctly understood or interpreted depends on the capacity developed within the community, and the message methodology (Section 2.1.2). Some notification systems make this capacity development easier – especially those that can carry a detailed and hazard/location specific message – sirens score poorly against this criteria.

It is critical to expect and plan for unofficial warnings as well: especially via the media and direct phone calls and personal contact.

### **4.9.3 Suitability to Auckland hazard context**

All of the reviewed options are to some extent suitable to the Auckland hazard context (as summarised in Section 3.2), but those which can be applied in a spatially varied way, and can contain varied and detailed messages lend themselves best to multiple geographically varied hazards and populations that exist in the Auckland region context.

#### *Multiple systems in combination*

A combination of systems can realistically be expected to be needed to effectively cover most of the population in most hazard instances. The use of multiple systems also provides redundancy in the event that one or more fails.

Multiple notification systems expected by the public to be active in a single warning may, however, reduce response if one or more fail. Include in education the message that people should respond if one or more system relays a message, or even if natural signs indicate a response is suitable and the official system has not activated at all.

#### 4.9.4 Timeframes for notification options within effective warnings

The time taken by all components of an effective warning system (Figure 1), including the notification system, directly affects the amount of time left for mitigation actions (warning response) to be taken (Figure 6). Therefore, the shorter time-frame notification systems options are most appropriate for the widest range of hazards facing the Auckland region. However, longer lead-time systems are still capable of being effective for hazards with a greater lead-time, and also in reinforcing and providing redundancy for shorter lead-time systems if in combination (multiple systems suggested above).

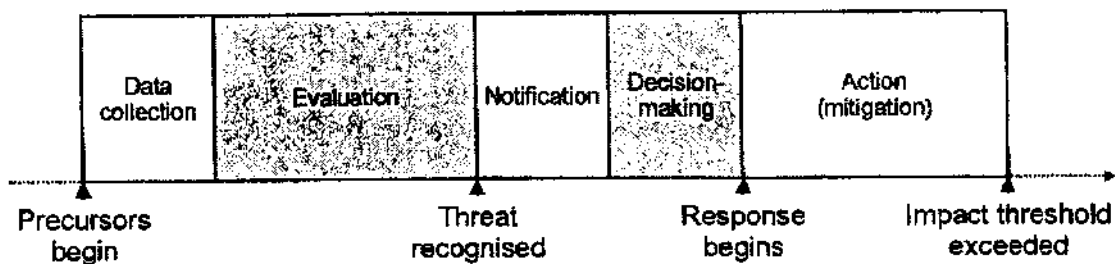


Figure 6 Warning timeline (modified from Carsell, 2004).

#### *Resilience: faster and more appropriate end-user decision-making*

The Decision-making step that the end-user goes through also affects their time available for action. Community resilience is important here. The more resilient an end-user is (the more able to expect, understand and act upon warning messages) the faster this decision-making process, the more likely the action taken will be appropriate, and the more time available for this action.

#### *Speed of initial data collection and evaluation*

This action time is also influenced by the data collection and evaluation stages within the CDEM Group, and for National Warning System sourced warnings an additional earlier iteration of these two steps at MCDEM level. Therefore the speed and reliability of the early warning system prior to public notification (and thus also the planning, communication and exercising of that system), are as critical to the time available for action as the speed and reliability of the notification system itself.

#### 4.9.5 Ability to apply nationally

The ability to apply recommended notification options consistently throughout New Zealand depends on the appropriateness of the system to the national hazard profile, the capacity of the nation's CDEM Groups to implement it and the capacity for communities to make appropriate decisions and effectively respond. The options recommended here for Auckland are applicable to the nations hazards, because (a) Auckland has identified for review most or all hazards that threaten New Zealand as a whole, and (b) this review has had to consider all

of these somewhat equally because criteria for hazard ranking is somewhat arbitrary even within the Auckland region alone. Capacity of CDEM Groups to implement options is heavily influenced by the cost, complexity and ability to maintain them. Therefore the cheapest, simplest options will be most easily implemented nationally.

#### **4.9.6 Targeting specific geographic audiences**

The coverage of some reviewed notification systems could be physically targeted to specific geographic audiences (sirens, loudspeakers, cell broadcast etc.), whereas the remaining options with a single region-wide application (radio, TV, internet etc.) are able to contain area-specific messages.

#### **4.9.7 Cost-effectiveness**

Each option reviewed has different cost-benefit parameters (Section 3.4, Appendix 3), making this a highly variable criteria and comparison highly subjective; it is difficult to forecast effectiveness quantitatively for comparison against a system cost. A system cost must include implementation cost, ongoing maintenance costs and effort/labour, and any social costs around the community having capacity to respond to the system (physical impact of presence of equipment, disruption from exercises, level of awareness needed).

#### **4.9.8 Speed of Implementation**

The level to which systems can be implemented quickly and easily varies, so this requirement could affect the chosen options heavily if it is given a strong weighting. Development of existing notification system options (awareness of natural warnings, media, Police and Fire, volunteer organisation networks) will likely have some improved effectiveness in the shortest time-frame. Effectiveness of these systems should continue to improve with continued and ongoing planning, application, exercising, evaluation and iterative improvement. In the medium term new technologies with very short lead-times, detailed message content, and wide reach may be implemented if they are still seen to be cost effective based on detailed scoping (cell broadcast, tone alert radio etc.). Longer lead-time options with a similar detailed message and varied audiences may also be considered to augment other systems (e.g. websites, email, telephone auto-diallers). Some of the resilience-building initiatives will be very effective in the long term, but are not as fast or technically easy as bolting up hardware. Therefore recommendations are given for three broad time-frames with different, complementary, options and expected outcomes within each.

### **5.0 RECOMMENDATIONS**

Recommendations for public notification of warnings in the Auckland region are made for the short, medium and long term. This allows for (a) some substantial improvement in terms of effectiveness within as little time as one year, (b) detailed cost benefit analysis of potential

new options in the medium term and (c) community resilience improvements that can be seen over decades, rather than years.

*Short term (as little as 1 year)*

- Develop the potential of existing notification systems within the Auckland region. This requires mostly planning, not expensive new equipment. Any advances here will support and enhance new equipment/systems that may or may not be deemed suitable based on detailed analysis in the medium term (below)
  - Natural warnings
  - Via third-party organisations' staff and hardware: Radio and TV broadcast stations; Police and Fire mobile PA loud-speaker announcements, and/or route-alert door-to-door.
  - Via community/volunteer organisations' existing networks to the public (e.g. Surf Lifesaving, Rural Fire, Neighbourhood support)
  - Via institutions to those in their care (e.g. hospitals, large companies such as ports and airports, tourism, Department of Conservation)
- Develop effective warning components (response planning; communications and discussion; education, maps and signage; exercising; underpinning research and effectiveness evaluation) to respond to this (Section 2). Education includes: maps, signage, printed material (posters, brochures etc.), public meetings, community groups support. Note that exercises also act as education. Education materials should contain: The range of hazards and their timeframes, natural warning signs, official warning channels, warning types and content, existence of multiple, warning channels, and that some may fail, what to do in response to warnings, location-specific information (More details within
- Further investigate and plan for improved resilience, including ability to understand and make decisions upon, and the motivation to act upon, warning messages (refer to the parallel community resilience project underway in the region).

*Medium term (1 to 5 years)*

- Detailed feasibility analysis of new technologies should be carried out to determine if the cost-benefit is acceptable. Effective response to such systems would require a more resilient community with greater awareness of hazards, warning systems, potential warning messages and appropriate response to them; without this, panic and other inappropriate decisions based on receipt of a warning message may produce a worse response than would occur without implementation of any new technologies. Bimodal population density means group notification may not be the most efficient, or even possible, for rural diffuse-population areas; whereas individual notification may not be as fast or practical for high-density urban areas. The best available new technologies to directly reach the large majority of the population are cell-broadcast and/or tone-alert radio for rural diffuse areas, and these two and/or radio-activated PA loud-hailers for urban areas, but all are cost-limited (see also 'Time-lag', below). This must carefully consider the limitations of hardware warning systems and allow for ongoing costs and

effort required to maintain the system as effective (this must be exercised and evaluated). Suggested options for priority detailed scoping are:

- Cell broadcasting (or similar) – The technology to notify the large majority of the population with a detailed message exists, the best method currently available seems to be cell broadcasting, at this stage of investigation. However, it is noted that cell broadcasting capability is not present in all consumer handsets (see Appendix 3). We recommend a national working group between CDEM Group representatives, MCDEM, communication providers and warning supply agencies to brainstorm this option and other new mobile communications technologies possibly on the horizon. Using existing mobile technologies is likely to be the most cost-effective method of delivering detailed warning messages to the majority of the population.
- Fixed PA loud-speaker announcements are a feasible, fast and effective option for communities that could also be analysed in detail as a priority. The cost is likely to be orders of magnitude higher than using mobile communication technologies. This is not practical for rural diffuse populations, and requires substantial ongoing maintenance and exercise work.
- Tone-alert radio is feasible for all populations, including rural diffuse, but again the cost and complexity is high, and it relies on end-user hardware. Nevertheless, beyond mobile communication technologies it is another technology that would warrant detailed analysis.
- Implement refined methods of improving community resilience that are outcomes of the current resilience project.

#### *Long term (5 to 10+ years)*

- Target wider community resilience. Improved resilience reduces the impacts of natural hazards through several community-driven means including, but not limited to, the ability and motivation to receive, understand and make decisions based on early warning messages. Such changes to the awareness motivation of the community take place over decades rather than years.

### **5.1 Time-lag**

The time-lag between initiation of notification and receipt by all available end-users is the critical success factor for a major new all-hazard technology-based system. It needs to accommodate as best as possible short time-frame hazards such as earthquake (seconds – limited implementation in Mexico City, possibly never feasible in New Zealand); and dam failure, tornado, local or regional source tsunami (minutes). The criticality of time-lag means that the time taken to initiate an early warning prior to notification, and for people to respond, should also be a focus of effort by the CDEM Group.

It is unclear whether mobile communications technologies such as cell broadcast can, with full automation of the system, notify all end-users in seconds, but minutes is certainly feasible. Technological advances in the next few years may well improve this. Development of a major dedicated hardware system such as tone-alert radio or fixed PA loudspeakers

may take years, and then in short order be superseded by cheaper and faster mobile communications as the optimum system.

## 5.2 Implementation

The Group Controller is responsible for ensuring that the following recommendations are implemented. The people listed below will lead implementation, but may require additional support or assistance.

Task	Person Responsible
<b>1 year+</b>	
<i>Consider additions to list of channels that currently exist for warning, starting with those detailed above under: Third party organisations' staff and hardware; Community/volunteer organisations' networks; Institutions with others in their care.</i>	Warning Systems Working Group
<i>Contact and develop protocols with each willing group, including procedure documents</i>	Group Controller
<i>Write effective warning system response planning including operational details to address all aspects of the effective warning system model (Figure 1) for the Auckland Region. Consider effective warning message content requirements (Sections 2.1.2 &amp; 3.2) and planning for the 'all-clear'. Consider the limitations of early warnings (Section 2.1.6). Allow for operation protocols, including message content, trigger situations, etc.. As well as the early warning system itself includes planning and ongoing regular maintenance of the following tasks:</i>	Group Controller
<i>Foster regular communication amongst all people involved in effective warning notification and response. Exercising plays a big part in this, but we suggest additional regular communication building relationships and communicating individual expectations in a warning event.</i>	CDOs
<i>Develop public education, maps and signage as detailed above to improving warning response</i>	Public Education Group
<i>Develop an exercise schedule maximising involvement of all agencies and community, with highest acceptable frequency</i>	Group Controller
<i>Design evaluation of exercises, warning effectiveness and levels of public awareness of hazards and warning procedures</i>	EMO
<i>Evaluate level of underpinning hazard and risk knowledge and plan research programmes to improve this, supporting nationwide research underway where it exists and applies to the Auckland region</i>	ARC
<i>Feed back results to improved protocols</i>	Group Controller
<i>Discuss needs for warning response with resilience steering group and align outputs of both projects, considering warning system end-users and purpose (Section 3.3)</i>	EMO
<i>Push setting up, and participate in, a national working group on mobile communication warning notification</i>	EMO
<b>&lt;5 years</b>	
<i>Review Appendix 2 options and confirm the CDEM Group is in agreement with the recommendation of loudspeaker announcement systems and tone alert radio systems as the two most suitable warning-dedicated hardware options to scope in detail.</i>	Warning Systems Working Group
<i>Contact current operators of loudspeaker and tone alert radio systems and discuss their experiences</i>	National Working Group
<i>Contact and further research hardware suppliers to get a cost basis for these systems that the CDEM Group is comfortable with</i>	National Working Group

<i>Cost regional deployment</i> using on this cost basis and experience from discussions with users of existing systems elsewhere	National Working Group
<i>Decide</i> if either recommended system is acceptable in terms of cost vs. benefit	Warning Systems Working Group
<i>Plan and implement</i> , for any dedicated hardware system deemed acceptable: Purchase and installation Ongoing and regular maintenance of hardware and effective response And all of the tasks from "Write effective response planning..." to "Feed back results of evaluation" under "1 year+" tasks above.	Group Controller and CDOs
<i>Exercise the full warning system</i> (including multiple notification channels) regularly with effectiveness evaluation and feedback to improve response	Group Controller
<i>Maintain hardware and public education</i> regularly and in an ongoing fashion	Group Controller, CDOs and Public Education Group
<i>Implement recommendations from resilience project</i> that relate to improving warning response	CDOs
<b>5+ years</b>	
<i>Exercise the full warning system</i> (including multiple notification channels) in an ongoing regular fashion with evaluation and feedback to improve response	Group Controller
<i>Maintain hardware and public education</i> regularly and in an ongoing fashion	Group Controller, CDOs and Public Education Group
<i>Evaluate resilience indicators</i> that relate to warning response and feed results back to modify the long-term approach to improving resilience in the Auckland Region.	EMO

## 6.0 ACKNOWLEDGEMENTS

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## 7.0 REFERENCES

### 7.1 Publications

- Aguirre, B.E., 2004. Homeland security warnings: lessons learned and unlearned. *International Journal of Mass Emergencies and Disasters*, 22: 103-115.
- Ballantyne, M., Paton, D., Johnston, D., Kozuch, M. and Daly, M., 2000. Information on volcanic and earthquake hazards: the impact on awareness and preparation. 2002/2, Institute of Geological & Nuclear Sciences Limited, Wellington.
- Biever, C. and Hecht, J., 2005. Alarm bells ringing over US response to tsunami scare, *New Scientist*, pp. 8-9.
- (CIPCDE), C.o.I.i.t.P.C.D.E., 1973. Report of the Commission of Inquiry into the Parnell Civil Defence Emergency: June 1973, Government Printer, Wellington.
- Crawford, G., 2005a. NOAA Weather Radio (NWR) - a coastal solution to tsunami alert notification. *Natural Hazards*, 35: 163-171.
- Crawford, G., 2005b. TsunamiReady communities: no overnight solution, *Natural Hazards Observer*, pp. 5-6.
- Darienzo, M., Aya, A.L., Crawford, G.L., Gibbs, D., Whitmore, P.M., Wilde, T. and Yanagi, B.S., 2005. Local tsunami warning in the pacific coastal United States. *Natural Hazards*, 35(1): 111-119.
- Doi, K., 2002. Earthquake early warning system in Japan., *Early Warning Systems for Natural Disaster Reduction*. Springer, Berlin, pp. 447-452.
- Drabek, T.E., 1994. Disaster Evacuation and the Tourist Industry, University of Colorado, Institute of Behavioral Science, Program on Environment and Behavior, Boulder.
- Drabek, T.E., 1996. Disaster Evacuation Behavior: Tourists and other Transients, University of Colorado, Institute of Behavioral Science, Program on Environment and Behavior, Boulder.
- Drabek, T.E., 2000. Disaster Evacuations: tourist-business managers rarely act as customers expect. *Cornell Hotel and Restaurant Administration Quarterly*, 41(1): 48-57.
- Dudley, W.C. and Lee, M., 1998. TSUNAMI! University of Hawaii Press, Honolulu, 362 pp.
- Gregg, C.E., Houghton, B.F., Paton, D., Hamnett, M.P. and Johnston, D.M., (submitted). Awareness of a Siren-Based Emergency Warning System: Implications for Tsunami Preparedness in Hawai'i. *Natural Hazards*.
- Gruntfest, E.C. and Huber, C., 1989. Status Report on Flood Warning Systems in the United States. *Environmental Management*, 13: 279-286.
- Handmer, J., 2002. Are Flood Warnings Futile? Risk communication in emergencies. *The Australasian Journal of Disaster and Trauma Studies*, 2002/2: online journal.
- Johnston, D., Becker, J., Gregg, C., Houghton, B., Paton, D., Leonard, G. and Garside, R., in press. Developing warning and disaster response capacity in the tourism sector in coastal Washington, USA. *Disaster Prevention and Management*.
- Johnston, D., Paton, D., Crawford, G.L., Ronan, K., Bürgelt, P. and Houghton, B., 2005. Measuring tsunami preparedness in Coastal Washington, United States. *Natural Hazards*, 35(1): 173-184.
- Johnston, D.M.; Scott, B.J.; Houghton, B.F.; Paton, D.; Dowrick, D.J.; Villamor, P.; Savage, J. 2002. Social and economic consequences of historic caldera unrest at the Taupo Volcano, New Zealand and the management of future episodes of unrest. *Bulletin of the New Zealand Society for Earthquake Engineering*, 35(4): 215-230
- Lachman, R., Tatsuoka, M. and Bonk, W.J., 1961. Human behavior during the tsunami of May 23, 1960. *Science*, 133(3462): 1405-1409.

- Lee, W.H.K., Epinoso-Aranda, J.M. 2002. Earthquake early warning systems: current status and perspectives. In: *Early Warning Systems for Natural Disaster Reduction*. Springer, Berlin, pp. 407-423.
- Leonard, G., Johnston, D. and Paton, D., 2005. Developing effective lahar warning systems for Ruapehu. *Planning Quarterly*, 158: 6-9.
- Leonard, G., Johnston, D., Paton, D. and Kelman, I., 2004. Mitigating the lahar risk at Whakapapa Ski Area, Mt Ruapehu: Public perceptions and the effectiveness of the new warning system, Institute of Geological and Nuclear Sciences science report, Lower Hutt.
- Mayhorn, C.B., 2005. Cognitive aging and the processing of hazard information and disaster warnings. *Natural Hazards Review*, 6: 165-170.
- MCDEM, 2003. Working together for prepared communities: National public education strategy 2003-2008, Ministry of Civil Defence and Emergency Management (MCDEM), Wellington.
- Mileti, D., Nathe, S., Gori, P., Greene, M. and Lemersal, E., 2004. Public hazards communication and education: the state of the art, *Natural Hazards Center Natural Hazards Informer issue 2*, Boulder.
- Mileti, D.S. and Sorensen, J.H., 1990. Communication of emergency public warnings, Oak Ridge National Laboratory, Oak Ridge.
- OEM&ODGAMI, O.E.M.a.O.D.o.G.a.M.I., 2001. Tsunami Warning Systems and Procedures guidance for local officials., Oregon Department of Geology and Mineral Industries (ODGAMI) Special Paper 35, Portland.
- Paton, D. and Johnston, D., 2001. Disaster and communities: vulnerability, resilience and preparedness. *Disaster Prevention and Management*, 10(270-277).
- Pfister, N., 2002. Community response to flood warnings: the case of an evacuation from Grafton, March 2001. *Australian Journal of Emergency Management*, 17(2): 19-29.
- PPW, 2002. Improving the effectiveness of the homeland security advisory system, Partnership for Public Warning report by The Workshop on Effective Hazard Warnings, Emmitsburg.
- Ronan, K. and Johnston, D., 2005. Promoting community resilience in disasters: the role for schools, youth, and families., Springer, New York.
- Sorensen, J.H., 2000. Hazard warning systems: review of 20 years of progress. *Natural Hazards Review*, 1: 119-125.
- Tierney, K., 2000. Trinet studies and planning activities in real-time earthquake early warning: Task 2: Lessons and guidance from the literature on warning response and warning systems, Report prepared for the California Institute of Technology, Pasadena, CA.
- Vogt, B.M., 1990. Evacuation of Institutionalized and Specialized Populations. ORNL/TM-10277, Oak Ridge National Laboratory, Oak Ridge.
- Voight, B., 1990. The 1985 Nevado del Ruiz volcano catastrophe: anatomy and retrospection. *Journal of Volcanology and Geothermal Research*, 42: 151-188.
- Webb, T. and (compiler). 2005. Review of New Zealand's preparedness tsunami hazard, comparison to risk and recommendations for treatment, GNS Science client report 2005/162, Lower Hutt.
- Yeo, S.W. 2003. Effects of disclosure of flood-liability on residential property values. *Australian Journal of Emergency Management* 18(1), 35-44.

## 7.2 Internet Resources

Several internet resources can be considered broad further reading when considering public notification of warnings. These were all drawn upon in the preparation of this review:

United Nations / International Strategy for Disaster Reduction Platform for the promotion of early warning <http://www.unisdr.org/ppew/>

Partnership for Public Warning <http://www.partnershipforpublicwarning.org/ppw/>

Federal Emergency Management Agency (FEMA) library <http://www.fema.gov/library/dizandemer.shtm>

First Mile Solutions <http://www.firstmilesolutions.com/>

Natural Hazards Centre <http://www.colorado.edu/hazards/>

NOAA Warning decision training branch <http://www.wdtb.noaa.gov/workshop/wdm/>

Resources on emergency notification and communication (Accessible Emergency Notification and Communication: State of the Science Conference) [http://tap.gallaudet.edu/Emergency-Resources.htm#Emergency\\_Notification\\_and\\_Communication](http://tap.gallaudet.edu/Emergency-Resources.htm#Emergency_Notification_and_Communication)

Subcommittee on Natural Disaster Reduction (SNDR) is a Subcommittee of the Committee on Environment and Natural Resources of the *National Science and Technology Council* <http://www.usgs.gov/sndr/>

UK Emergency Planning College <http://www.epcollege.gov.uk/index.htm>

UK National Steering Committee: Warning and Informing the Public: <http://www.nscwip.info/>

UK Resilience Exercise Planners Guide [HTTP://WWW.UKRESILIENCE.INFO/CONTINGENCIES/BUSINESS/EXERCISE PLANNERS GUIDE.HTM](http://www.ukresilience.info/contingencies/business/exercise_planners_guide.htm)

### 7.3 People and agencies contacted, and 'suppliers' reviewed

Auckland Regional Council (Jane Olsen, Acting Team Leader, Hazards Management)

ALERT <http://www.alertsystems.org/>

American Signal Corporation <http://www.americansignal.com/>

Cell-alert (cell broadcasting) <http://www.cell-alert.co.uk/>

Common Alerting Protocol <http://www.incident.com/cap/what-why-how.html>

Commtech Services, Taumarunui (Shane Mail, Manager) (fixed PA loud-speaker announcements – referred to by DoC Whakapapa).

Department of Conservation, Whakapapa (Peter Blaxter, Programme Manager, Biodiversity & Public Safety)

Federal Warning Systems <http://www.federalwarningsystems.com/>

Hawke's Bay CDEM Group (Lisa Pearce, Emergency Management Coordinator)

Philipson Smith Ltd., Auckland (sirens), (via Barry Lowe, Western BoP CDEMO)

Ministry of Civil Defence and Emergency Management (David Coetzee, Emergency Management Planner (Intelligence))

MetService (Rod Stainer, Manager National Weather Services)

Neighbourhood Support New Zealand <http://www.ns.org.nz/>

Natural Hazards Centre, Boulder Colorado (Prof. Denis Mileti, warning message and notification expert, retired/emeritus)

New Zealand Fire Service (Bill Ellis, Chief Fire Officer, Waitakere)

New Zealand Police (Senior Sergeant Garth Stockley and senior officer(s), Inspector Brent

Holmes -- !still to make contact)  
Reverse911 (auto-diallers) <http://www.reverse911.com/>  
Royal New Zealand Coastguard  
<http://www.iserve.co.nz/users/jois4/nzcoastguard.org.nz/htdocs/>  
Rural Fire Service (Nobby Reeki, DoC) <http://nrfa.fire.org.nz/contacts/rfa/doc/auuckland.htm>  
Surf Lifesaving New Zealand (Dean Storey, operations and services)  
<http://www.slsnz.org.nz/>  
Tauranga and Western BoP CDEM Office (Barry Lowe, Manager)  
Telecom New Zealand (Brian Potter, Manager, New Zealand Business Risk)  
<http://www.telecom.co.nz>  
Vodafone New Zealand (Alisha Jewett, Leader, Business Continuity)  
<http://www.vodafone.co.nz>  
Warning systems UK <http://www.warningsystems.gb.co.uk/>  
Washington State, USA, Military Dept., Emergency Mgmt. Div. Mitigation Section (George Crawford, Earthquake Program Manager)

## **APPENDIX 1 — PART 8(60-62) OF THE NATIONAL CIVIL DEFENCE EMERGENCY MANAGEMENT PLAN ORDER 2005**

### *General warnings*

#### **60 Objective**

- (1) The objective is to issue warnings so that local authorities, agencies, and people can take action to reduce loss of life, injury, and damage.
- (2) Warnings about predictable events (for example, severe weather, volcanic eruption, tsunami) are to be given as quickly as practicable.
- (3) For unpredictable events like earthquakes, where warning is not possible, the objective is to inform emergency response by providing assessments of the likely impact on any affected areas.
- (4) The responsibility for issuing warnings rests with the agency that through its normal function is involved with the identification and analysis of the particular hazard or threat (see Appendix 1).
- (5) Relevant government agencies, CDEM Groups, local authorities, and lifeline utilities must maintain arrangements to respond to warnings.

#### **61 Scope**

- (1) Warning systems are to provide warnings about significant hazards with the potential to affect human populations, geographical areas, or social or economic activities.
- (2) This plan does not cover—
  - (a) localised, long-term, or slowly-evolving threats; or
  - (b) the local actions and procedures required to disseminate or respond to warnings.
- (3) The effectiveness of a warning depends on its delivery and receipt, recipients' understanding of what they should do under the particular threats, and readiness and response at all levels.

#### **62 National warning system**

- (1) The national warning system establishes a process for the receipt of general warnings and communication of civil-defence-emergency-management related information for warning purposes at all hours by MCDEM.
- (2) MCDEM maintains the national warning system to issue civil defence warnings received from responsible agencies.
- (3) The standard operating procedure under this system specifies the principles and methods for disseminating national warnings.
- (4) National warnings must be provided by MCDEM to CDEM Groups, local authorities, police, certain government departments, lifeline utilities, and certain broadcasters.
- (5) Different hazards require different types of warnings and procedures. The civil defence emergency management hazards for which national warnings may be issued are listed in Appendix 1.
- (6) CDEM Groups are responsible for—
  - (a) disseminating national warnings to local communities; and
  - (b) maintaining local warning systems.
- (7) If arrangements are made with the duty officer of MCDEM, the national warning system is available to issue warnings with respect to hazards for which warning arrangements are decided and maintained by other responsible agencies.