

Engineering lifelines and transport – should New Zealand be doing it better? Part two

Research Report 355B - August 2008

Engineering lifelines and transport – should New Zealand be doing it better? Part two

Phases 3 and 4: Gap analysis and solution development

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ISBN 978-0-478-33414-2
ISSN 1177-0600

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Gordon, M., and Matheson, S. 2008. Engineering lifelines and transport – should New Zealand be doing it better? Part two. Phases 3 and 4: Gap analysis and solution development. *NZ Transport Agency Research Report 355B*. 78pp.

Keywords: asset management, engineering lifelines, natural hazards, risk

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Additional note

The NZ Transport Agency (NZTA) was formally established on 1 August 2008, combining the functions and expertise of Land Transport NZ and Transit NZ.

The new organisation will provide an integrated approach to transport planning, funding and delivery.

This research report was prepared prior to the establishment of the NZTA and may refer to Land Transport NZ and Transit NZ.

Acknowledgements

The authors would like to thank the following people for their assistance with this project:

John Lamb and Dave Brunson

Peer reviewers

Abbreviations and acronyms

| | |
|----------------------------|---|
| AELG | Auckland Engineering Lifelines Group |
| AM | Asset management |
| AMP | Asset management plan |
| CDEM | Civil defence and emergency management |
| CELG | Canterbury Engineering Lifelines Group |
| EEM | Economic evaluation manual, Vol 1 (Land Transport NZ) |
| GIS | Geographic information system |
| GNZ | Institute of Geological and Nuclear Science, New Zealand |
| IIMM | International Infrastructure Management Manual |
| Land Transport NZ | Land Transport New Zealand (now NZ Transport Agency) |
| LTCCP | Long-term council community plan |
| LTP | Land transport programme |
| MCDEM or 'the Ministry' | Ministry of Civil Defence & Emergency Management |
| NELC | National Engineering Lifelines Committee |
| NIWA | National Institute of Water and Atmospheric Research, New Zealand |
| OAG | Office of the Auditor General |
| RAMM | Road assessment and maintenance management (system) |
| RCA | Road controlling authority |
| SH | State highway |
| Transit or Transit NZ | Transit New Zealand (now NZ Transport Agency) |
| VMS | Variable message signs |
| WELG | Wellington Engineering Lifelines Group |

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1. Introduction

1.1 Purpose

This project was initiated through the Transfund New Zealand 2003/2004 Research Programme. The focus was on engineering lifelines and, in particular, efforts to improve the resilience of roading networks throughout the country to natural hazards.

The primary objective of the project was to seek to reduce the impact of natural hazards on land transport infrastructure by investigating:

- whether the engineering lifelines approach had increased the resilience of New Zealand's land transport system
- how well the engineering lifelines approach was integrated into other natural hazard mitigation approaches and into asset management plans (AMPs)
- if the local regional approach to lifelines planning had provided the best overall result for the country
- international 'best practice' and identifying gaps between this and New Zealand practice
- the risks New Zealand land transport infrastructure was exposed to (likelihood and consequence)
- the barriers to improving New Zealand's performance in this area
- available tools and technology that could enhance lifelines practice
- future actions and implementation options.

The research was divided into four phases:

- Phase 1: Situation scan
- Phase 2: New Zealand risk exposure
- Phase 3: Gap analysis
- Phase 4: Solution development.

The report has been published in two parts: Part one contains Phase 1 and Phase 2; and Part two contains the merged Phases 3 and 4.

In the report, the term 'engineering lifelines activity' or other references to 'lifelines' refer to a collaborative inter-utility and cross-sector planning process to reduce the pre- and post-emergency impacts of low-probability disaster scale events.

1.2 Outline of Phases 3 and 4

This section of the report:

- reviews what road controlling authorities (RCAs) have actually been doing in terms of assessing and mitigating risk
- assesses the effectiveness of RCAs and their AMPs in dealing with natural hazards and mitigation measures
- reviews the appropriateness of Land Transport NZ's allocation methods in dealing with high-impact natural hazard events
- identifies the strengths and weaknesses of New Zealand practice and the likely barriers, and identifies the critical gaps in relation to the Ministry of Civil Defence & Emergency Management's (MCDEM or 'the Ministry') best practice guide (2006)
- integrates the conclusions from Phases 1 and 2
- identifies actions in relation to AMP content and the roles of asset managers in relation to lifelines utilities
- puts forward recommendations for improving practice in relation to risk management, lifelines and infrastructure resilience.

1.3 Engineering lifelines

Lifelines are essential 'utility' services that support the life of the community – such as water, wastewater, stormwater, power, gas, telecommunications and transportation networks.

This project focused on transportation networks and, in particular, roading networks. However, there is a high level of dependence by other lifeline utilities on roading networks, for example, water, sewerage, power and telecommunications services all use the road corridor and often also rely on structures such as road bridges. A failure of part of the road network may not only result in the consequential loss of another service, but also make access more difficult for repairing and restoring the service.

1.4 Hazards

The engineering lifelines process focuses on the effects of hazards from external sources. Traditionally in New Zealand, these are natural hazards such as earthquakes, volcanic eruptions, floods, wind, snow and landslides. However, exposure to technological and man-made hazards is also increasing globally and must be considered in the lifelines context.

1.5 Outcome of Phase 2: New Zealand risk exposure

Phase 2 of the project reviewed the natural hazard research undertaken in New Zealand and assessed the correlation between the level of risk from natural hazards with lifelines effort in different parts of the country.

A risk exposure index was developed that covered all natural hazards. Numerical ratings were assigned and combined to form an overall risk exposure rating for different regions. This was then compared with the level of lifelines activity, roading expenditure, population and the regional share of the economy for each area.

This comparison indicated that lifelines activity had been focused on areas with a wide range of risk. While the degree of lifelines management was at a high level in areas with greatest risk there were some at-risk areas where there had been limited lifelines activity. Possible reasons for this were explored with RCAs and recorded in this part of the report (see section 2 and Appendix A).

The second part of the Phase 2 work was to survey the coordinators of all the lifelines groups and projects throughout New Zealand. The survey indicated that where lifelines had been established, the natural hazards were well identified and the likely impacts on the roading network and the subsequent impact on other utilities were well understood. There was a view, however, that there had been very limited action either planned or undertaken to mitigate assets against the impact of a natural disaster.

The survey used for lifelines group coordinators was subsequently refined and further developed in order to obtain feedback from RCAs throughout the country.

Finally, concepts for assessing and comparing transport infrastructure resilience were identified and can be considered for further development in risk management and asset management planning.

2. Survey of RCA practice

2.1 Introduction

The questionnaire developed for the Phase 2 survey of the lifelines organisations was amended and extended to cover the activity of RCAs. This questionnaire was then circulated, by email and post, to the ‘Roading Asset Manager’ or equivalent at all 72 local authorities in New Zealand with a request that it be completed and returned.

Completed questionnaires were returned by 34 (46%) local authorities. The returns were from a wide range of councils large and small, rural and urban. The responses received are considered representative of local authorities throughout New Zealand.

The roading asset managers from a further six councils were interviewed in more depth to better understand the linkages between lifelines project/group activity and their own AMPs.

Lifelines practice was also discussed with Transit NZ. Responses from Transit NZ are considered separately in each of the subsequent sections, as Transit NZ covers the whole country and local authority roading groups are much smaller entities.

The questionnaire and a summary of the responses are provided in Appendix A. Discussion of the results is recorded in the following sections.

2.2 Lifelines activity and participation

This survey showed a very similar level of overall lifelines activity in individual regions to the earlier survey of lifelines groups and projects.

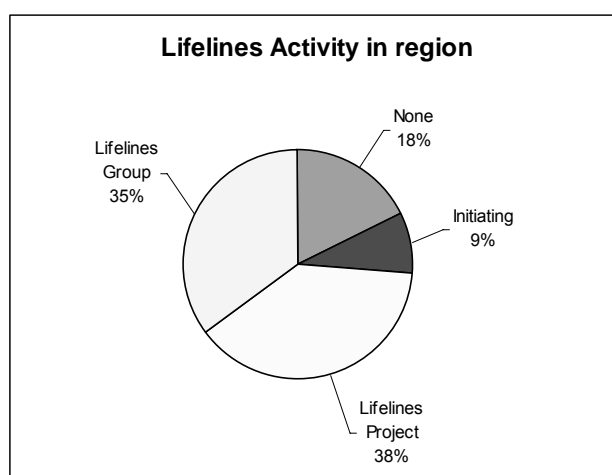


Figure 2.1 Lifelines activity by region.

However, 26% of the individual respondents to the RCA survey (ie the people involved in managing transportation assets) indicated that they themselves had only a minimal involvement with lifelines and 15% had no involvement. This was considered to be a high

proportion given the importance of the transport function following a hazard-based emergency event.

On the positive side, 26% were active in risk management or in developing plans and programmes to address hazard events. A further 33% said that they were actively involved with wider lifelines activity, such as attending or chairing lifelines meetings.

State highways cover all regions, so Transit NZ’s involvement varies depending on the area and the level of activity by lifelines groups and/or projects. For example, in the Canterbury/West Coast area, several local Transit NZ staff participate in lifelines activity and Transit NZ is a member of the Canterbury Engineering Lifelines Group.

2.3 Knowledge of hazards

2.3.1 Local authorities

The survey results indicated that natural hazards had been identified in nearly all of the areas from which responses were received. In 56% of these areas the probability and likelihood of occurrence of natural hazards had been assessed by experts.

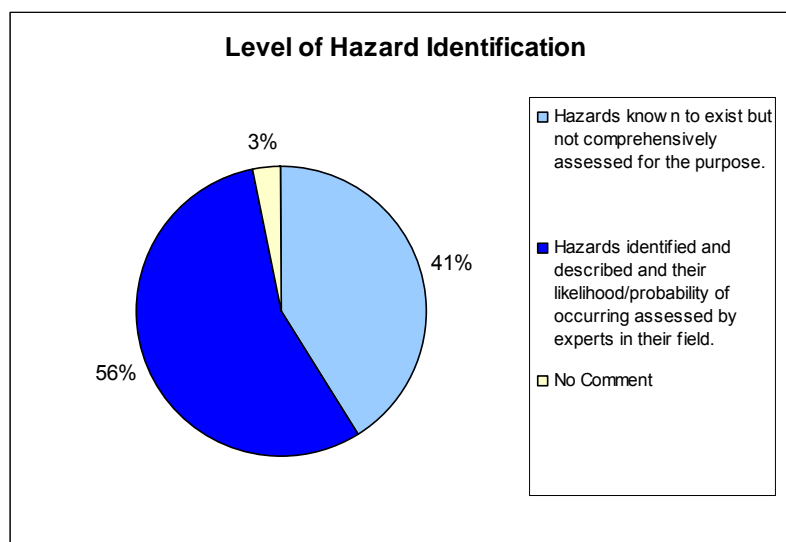


Figure 2.2 Identification of hazards.

However, the respondent’s personal knowledge about the impact of different natural hazards on the roading network varied for each hazard, as shown below.

The impacts of flooding, landslide and coastal events on the roading network were particularly well understood by over 60% of the local authority respondents, and for 35% flooding events had been systematically analysed asset by asset.

Personal knowledge of the impacts of an earthquake or volcanic event on the network was less with some 25–30% indicating they had only a limited knowledge.

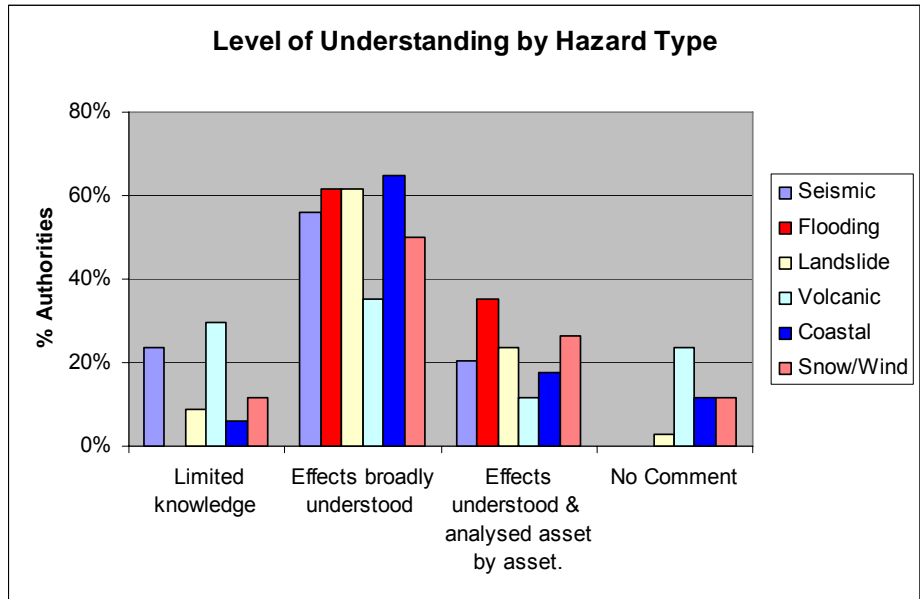


Figure 2.3 Understanding of the impact of hazards.

There was a reasonable understanding of the wider impacts of a roading network failure and the effects this would have on other utilities. There was a slightly lower level of understanding of how the failure of utility networks due to a natural hazard would impact on the roading network.

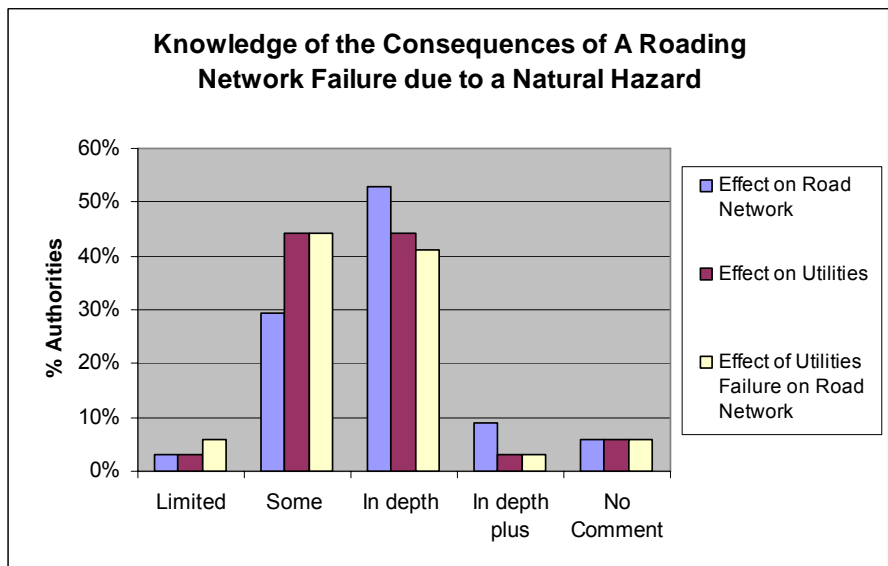


Figure 2.4 Understanding of the impact of hazards on the roading network.

There was in very few cases a documented understanding of the wider social and economic impacts from either a roading or utility network failure due to a natural hazard, this being shown as 'in depth plus' above.

The following are some of the issues raised by this analysis:

- There was a good understanding among local authorities of more frequent events such as flooding, but it appeared to be harder to relate to those infrequent, but potentially

very damaging events such as earthquakes and volcanic activity. The issue, therefore, is how to change this and prepare for these events and thus better manage the risk.

- The very low level of understanding of the 'social and economic impacts' indicated that these tended not to be considered, or if considered, might be beyond the roading asset manager's scope.

2.3.2 Transit New Zealand

Practice varies around the country. In a number of regions, the likelihood and consequences of a wide range of hazards have been assessed, but in others comprehensive risk assessment has not been undertaken. This typically relates to the work that lifelines groups and/or projects have undertaken – as this knowledge is applied to gain a better understanding of the effects on the state highway network.

Seismic, flood and landslide/ground instability hazards have had the most significant attention given to them – for these the hazards are well understood and the effects analysed on a systematic asset by asset basis. In particular, the seismic effects on bridges are being addressed through the seismic screening programme which has been underway for some years.

Where specific sites or bridges are known to be at a high level of risk from other hazards, such as volcanic activity or snow and ice, then the hazard and its effects are well understood and mitigation measures are in place. Examples of this are the effects of Mt Ruapehu lahars and snow and ice on the Desert Road and Milford highways.

Transit NZ has an in-depth knowledge of the consequences of a road network failure, but has not systematically analysed the social and economic impacts of these failures, such as the result on the country's economy if there was a major long-term disruption to the network. Seville and Metcalfe (2006) developed a framework which could be used for assessing the socio-economic impacts of road closures.

Less is known of the effects on utilities using the state highway (SH) corridor, or the effects of a utility failure on the SH network, this knowledge being more 'subjective'. However, the effects are more comprehensively addressed when a site is known to be at risk as the approach is site by site and is risk based.

2.4 Mitigation and funding

The survey included a series of questions about the actions being taken to mitigate the impacts of a natural hazard on the roading network and the level of funding being directed towards those activities.

The first question concerned the overall level of activity in relation to forward programme development and, in particular, the inclusion of improvement works in the budget.

2.4.1 Local authorities

As can be seen below, only 21% had specifically included works in the forward budget. However, it needs to be noted that some of this work was restoration of assets that had already been damaged (eg Manawatu floods), as well as forward prevention works.

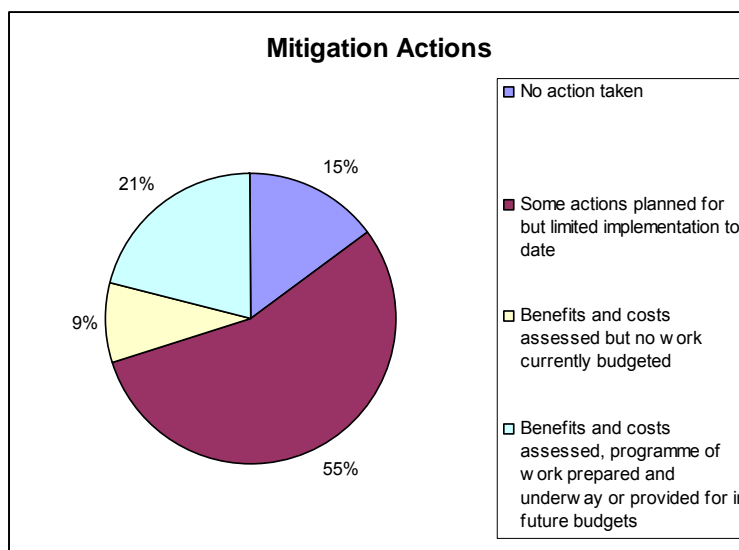


Figure 2.5 Mitigation action taken.

Of the 41% of responding authorities who reported that they had identified projects or prepared a programme, 60% had commenced repairs or construction work based on the programme, and nearly all of these reviewed their programme on an ongoing basis.

The work was largely on bridge and pavement assets, with some on drainage assets. Again, this included the restoration of damaged (eg flood) assets as well as strengthening in anticipation of potential future damage. Work activity included:

- ongoing programmes of permanent slip repair (retaining walls, gabions etc) and preventative drainage work
- completion of earthworks, pavement and seal construction
- upgrading of alternative routes on local roads to handle state highway traffic
- strengthening structures, in particular bridges
- rebuilding roads and pavements
- drainage improvements.

The responses indicated that the amount of expenditure targeted at improving the road network's resilience was low. Most local authorities spent less than \$50,000 per year and only four estimated expenditure would be more than \$500,000 per year over the next 10 years. A question to be considered is whether there are constraints arising from work category definitions.

Some respondents indicated a high level of current and proposed expenditure but on review much of this was found to be expenditure on repairs and renewals following recent flooding

events. It would be useful to be able to capture accurate data on expenditure targeted specifically at improving resilience, rather than simply repairing damage. Consideration of such a category in forward budgets would be useful.

A summary of the questionnaire responses is shown in the graph below.

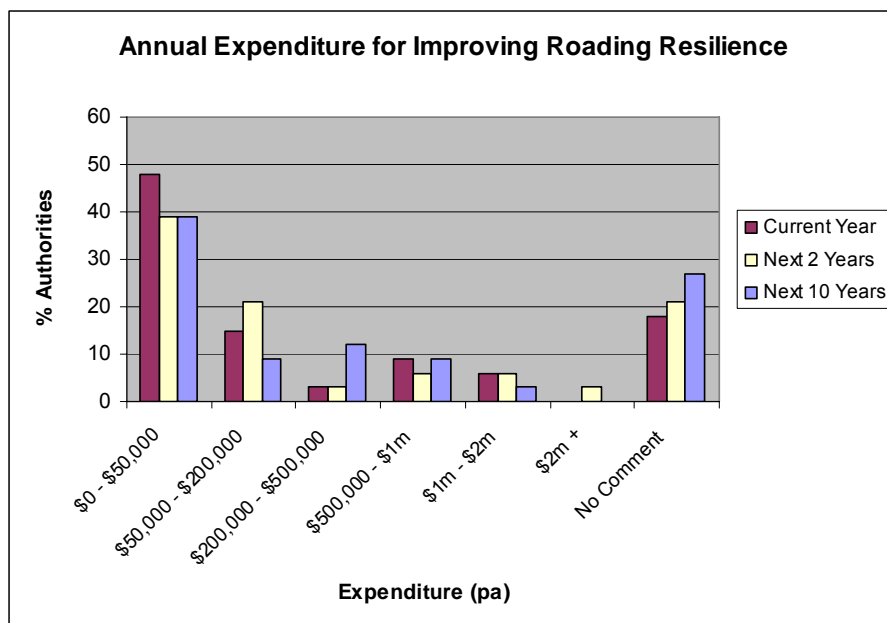


Figure 2.6 Annual expenditure on improving roading resilience.

Often natural hazard risk mitigation will be achieved through other roading projects without it being a specific objective. An example is the replacement of an old bridge, perhaps with poor foundations and exposed to scour or vulnerable to an earthquake. In such cases, it would be useful to have some means of assessing the relative increase in resilience that is achieved by replacing the bridge.

There was a wide range of answers to the question ‘What is your subjective opinion as to the % of your five-year capital programme, in addition to the specifically targeted expenditure referred to above, that will achieve noticeable hazard reduction?’. The range was 0% to 100% with an average of 4.5% excluding the 0% and 100% outliers. While this appeared low it was of a similar order to the amount of expenditure specifically targeted at improving resilience.

Some 18% of respondents indicated that they were aware of significant natural hazard sites (where the combined probability times consequence was significant and warranted some action) within their network that could not be mitigated due to a lack of funding. These sites included slips, liquefaction and flooding hazards. The interesting question here is that, in knowing about the hazard has a response been thought through or planned, and is the impact on the community understood and well communicated?

This lack of funding was not necessarily because of Land Transport NZ funding allocation procedures, as most considered that the project evaluation procedures provided adequate

guidance and catered adequately for projects involving natural hazard risk mitigation. A number of suggestions for improving the evaluation procedures were made and included:

- the need to be clear on 'uneconomic' natural hazard mitigation, ie related to traffic volumes
- the provision of templates/simplified procedures using risk management approach
- specific category (for natural hazard mitigation)
- mandating minimum standards outside the project BCR cut-off, or by clarifying 'HIGH' status for this type of work under one of the other funding criteria
- an agreement needed to be reached on risk assessment criteria. Projects had been declined because of disagreements over likelihood of occurrence.

2.4.2 Transit NZ

Transit NZ regularly assesses the benefits and costs of mitigation measures following on from hazard-based risk analyses, and has an active, rolling programme of hazard mitigation activities. Transit NZ also has a business recovery plan, which provides for Transit NZ's response to emergency events and the resources needed. Transit NZ (2004) also has an overarching *Risk management process manual (AC/Man/1)*.

Mitigation measures examples include:

- **Preventative maintenance work category** – intended to 'reduce the risk to the network of imminent failure and/or pending high maintenance/replacement costs'. Projects must be over \$10–\$15,000 in value and must pass a risk-based test in terms of maintenance economics, safety or route security. For the latter, the consequences of failure must pose such a high safety or route security risk that the work cannot be programmed as normal construction. All projects are scrutinised by a panel and the process assigns a relative priority value for position in the national programme. The risk-based route security test includes an assessment of the probability of occurrence in the forward 12-month period, the length of closure, the detour length and the traffic volume in calculating a 'security factor'.
- The annual programme value is \$5m, with projects being drawn from the priority list. It is reviewed annually and will in the near future be a forward three-year programme. Not all projects in the programme are lifelines or route security based.
- Current significant projects include \$1m on SH 1 at the Kilmog, north of Dunedin. This involves stabilisation of a major earth movement risk.
- **Seismic screening programme for bridges and structures** – this activity is controlled by the Transit NZ manual *Seismic screening of bridges* (1998). Since then, the programme has been applied to the national network and various seismic strengthening projects have been identified and carried out. Significant projects, based on low probability but potentially catastrophic events (such as the Thorndon overbridge, Wellington) have been carried out for lifelines purposes, despite low B/C ratios. Other projects have been identified and are underway – such as a liquefaction risk analysis for the Clarence River bridge, located on SH 1 – an important link between Christchurch and the North Island.

- Generally, Transit NZ developed a feel for what needs to be done, with a focus on structures and retaining/crib walls. Lower-risk events which can be managed are accepted. Efforts are ongoing.
- **Construction programme** – any capital project which is identified through normal management processes can be included and submitted to Land Transport NZ for funding. The contribution of the project to achieving the outcomes of the Land Transport Management Act 2003 influences priorities.
- **Monitoring** – where sites, such as the Desert Road and the White Slip near Kaikoura, are subject to natural hazards that cannot be physically mitigated, ongoing monitoring is undertaken so that the timing and extent of the hazard event can be predicted. These systems can include variable message signs (VMS) warning motorists of the presence of a hazard.

Other areas which are currently receiving attention include bridge scour, although there is still much work to be done in assessing and prioritising lifelines risks. Flooding and flood-related damage is a significant ongoing risk for the SH network, and there are many sites where affordability and competition for resources and funding constrains what action can be taken.

Many construction projects provide a degree of route security improvement, although that may not be the principle project objective, for example, the Gates of Haast project and Klondyke to Arthurs Pass upgrade, where safety and other factors are the primary concern.

Funding procedures are considered to be generally acceptable, with sound analysis to be presented for justification.

Communications are currently a key weakness. Transit NZ is investing in satellite phone technology, which will link it with CDEM, consultants and contractors in the event of a major telecommunications failure. However, there is a need to convey information to road users and the community. In major events, recovery of badly damaged SH routes will not be quick nor easy, and community expectations and needs must be managed. Telecom 0800 numbers will be overloaded, and a possible solution would be to 'brand' known radio stations/frequencies throughout the country to provide CDEM, highway status and other utility information.

While Transit NZ is a member of the National Engineering Lifelines Committee (NELC), the work that it does in this area and the knowledge that has built up is not necessarily being transmitted to other RCAs, who could learn and apply similar principles.

It also appears that there are risk mitigation works that Transit NZ could do but which local authorities are constrained from doing. For example, there are a number of Transit NZ processes that could be applied to local authority network management – such as the preventative maintenance procedure for prioritising route security risks. This would involve expansion of Work Category 241 Preventive Maintenance in the latest *Programme and funding manual* (Land Transport NZ 2007).

2.5 Asset management plan

There were several questions aimed at understanding how AMPs were dealing with risk management and in particular natural hazard events.

2.5.1 Local authorities

In response to the first question 'Does your roading AMP include a section on risk management with specific consideration of natural hazards and/or lifelines?' 50% answered no.

This was a larger number than expected given that the *International infrastructure management manual* (IIMM) (NAMS 2006) guidelines on preparing AMPs include a section on risk management. It is possible that plans may include a section on risk management but either it is not dealt with fully or they do not have any particular reference to natural hazards or lifelines. Maunsell's past experience in reviewing AMPs has been that many contain very limited information on risk analysis or lifelines projects.

However, following the survey many authorities have updated or prepared new asset/activity management plans leading into the first round of full long-term council community plans (LTCCPs), and it is likely that there has been some enhancement of risk management sections within these plans.

For those surveyed, the level of detail of the assessment of natural hazards in the AMP is shown in the chart below:

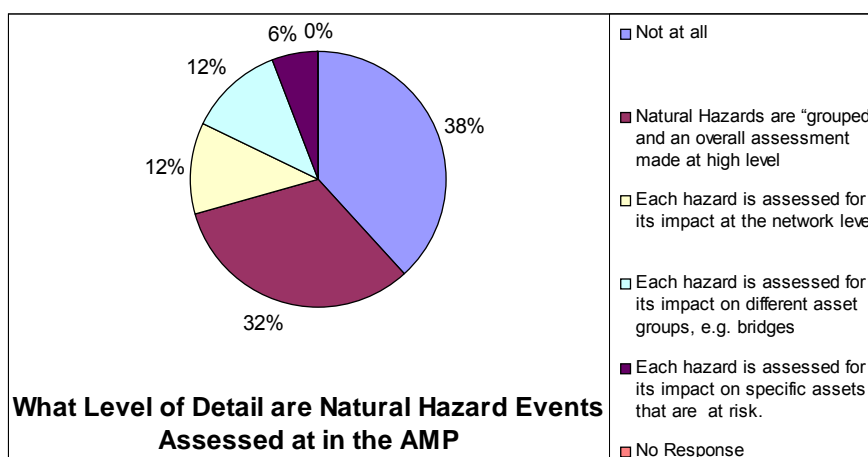


Figure 2.7 Assessment of natural hazards in AMPs.

While for most the assessment is at a high level, there are an encouraging number considering the impact of specific hazards on individual asset groups and/or specific assets.

A small number (15%) of authorities included in their roading AMP individual projects specifically targeted at minimising the risk to roading assets from natural disasters.

An important component of a lifelines project and civil defence planning, is the identification of key emergency transport routes for use following a significant natural hazard event. These routes are expected to be more resilient and a higher priority for repair and restoration after the event.

However, only six (18%) of the respondents indicated that emergency routes were identified in their AMPs. Five of the six were involved in lifeline projects or groups. This represents only a small proportion making use of information from the lifeline process in their AMP. An example is provided in Appendix C.

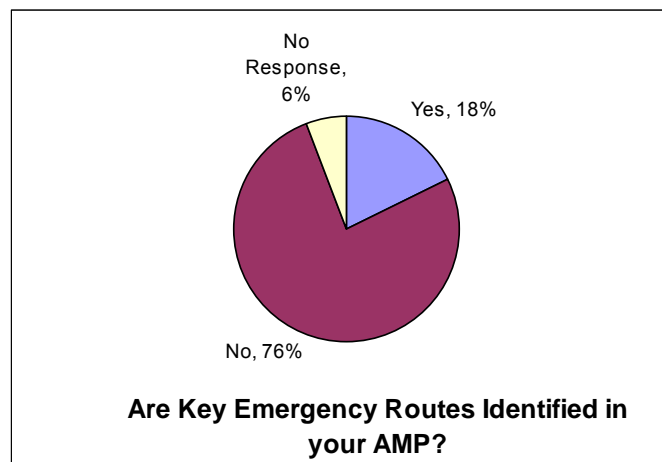


Figure 2.8 Identification of key emergency routes in AMPs.

Most of the local authorities indicated that the information in their AMP carried through to their LTCCP. A check of the web pages of a number of councils showed that most carried a summary of the AMP into the LTCCP document. This usually included level of service information and performance measures, a capital programme, key issues for the roading activity and linkages to the community outcomes. Some included a summary of the assets and their valuation.

There was, however, very little information on risk management in relation to lifelines, nor on the interdependencies that existed between infrastructure groups.

2.5.2 Transit NZ

Transit NZ has developed an overarching state highway AMP, a bridges and structures AMP, and an ITS AMP. There is also a *State highway asset management manual* (Transit NZ 2006), which guides the provision of asset management services and processes.

Risk management in relation to hazards and lifelines is explicitly incorporated in the AMP documents, in accordance with NZS 4360 framework and Transit NZ's (2004) *Risk management process manual*. The plans drive and support the need for hazard mitigation programmes and activities.

Natural hazards and their effects are detailed in the bridges and structures AMP – to the asset specific level. This is not the case for other assets, however, where hazards are simply grouped and assessments made at a high level.

The forward works programme (rather than the AMP) specifically identifies any projects which are ‘lifelines driven’, and based on route security considerations.

There are no separately defined emergency transport routes, as state highways are generally considered to form the basic backbone of the country’s strategic network – and will be the major routes required following a significant hazard event – at national, regional and territorial authority level.

2.6 Use of technology

One section of the research was to see what part new technology was playing in lifelines work and asset management planning. Local authorities’ responses to the question ‘what technology is used for lifelines purposes for the road network?’ were split evenly between planning to use, used and no comment (don’t know). Where it was being used it was for the following applications:

- available but not used for lifelines (1)
- GIS mapping, risk assets (4)
- mapping (3)
- lifelines assessments (1).

GIS was used primarily as a data management tool with links to road assessment and maintenance management (RAMM) and other roading asset management systems.

Transit NZ is also planning to make more extensive use of GIS applications (mapping and as a data management tool linking to RAMM etc) and more use of electronic, real-time monitoring systems.

There is further comment on technology issues in Section 5.

2.7 Relationships and preparedness

The success of organisations with lifelines responsibilities before and after a significant natural hazard event depends on good relationships between agencies and the preparedness of the community.

The response to three questions for local authorities on this topic is shown below:

What is your view of the relationship between RCAs and other lifelines agencies within the region?

| Multichoice option | % | No. |
|--|-------------|------------|
| Our RCA has no formal or a weak relationship with other utilities and emergency services agencies, in relation to lifelines planning | 0% | 0 |
| Some evidence of a relationship but this is occasional and more reactive than proactive | 6% | 2 |
| Strong documented relationship with regular communication, information sharing, and joint meetings/workshops/exercises | 58% | 19 |
| No comment | 36% | 12 |
| Total | 100% | 33 |

What is your view of the level of community awareness about the impact of natural hazards on the roading network?

| Multichoice option | % | No. |
|---|-------------|------------|
| Community has little or no knowledge of the impacts of hazard events on the roading network | 0% | 0 |
| Community has some awareness | 27% | 9 |
| Community has a high level of awareness | 61% | 20 |
| No comment | 12% | 4 |
| Total | 100% | 33 |

Overall, how would you rate your organisation's (as an RCA) ability to respond in a major natural hazard event? (Include hired in resources, contractors etc.)

| Multichoice option | | % | No. |
|---------------------------|---|-------------|------------|
| Inadequate | 1 | 0% | 0 |
| | 2 | 0% | 0 |
| | 3 | 9% | 3 |
| | 4 | 42% | 14 |
| Exceptional | 5 | 45% | 15 |
| No comment | | 3% | 1 |
| Total | | 100% | 33 |

The responses from local authorities suggested that agencies were working well, that the community had a good level of awareness of the impacts of hazards, and those who completed the questionnaire believed that their organisations would respond well to a major disaster.

However, Transit felt that its relationships with other agencies were more reactive, with some evidence, but there was room to develop this further.

Transit's view was that there needed to be a higher level of community awareness of the potential impacts of hazard events.

Transit manages a wide range of consultant and contractor relationships, and through these resources has an extensive response capability. This needs to be well coordinated and good communication systems are critical. Overall, Transit considered response capability as a '4' on the above scale, suggesting that there was still some room for improvement.

In this respect, Dantas et al (2006) examined the issues for the state highway network in *Information sharing during disaster: Can we do it better?*. The authors concluded that there were significant challenges in coordinating effective responses to large scale events due to the number and variety of organisations involved. This pointed to the need for robust yet simple frameworks for information sharing and communication. There were also seen to be opportunities to develop and utilise telecommunications and geospatial technology for sharing information.

Transit increasingly uses monitoring information and systems, such as avalanche prediction for the Milford highway which is based on MetService data.

2.8 Conclusions from the survey

Key conclusions/observations from the survey are as follows:

- Lifelines engineering has not been a key influencing factor for many local authorities. There should be a higher level of involvement by transportation asset management personnel in lifelines engineering – particularly given the importance of this function to other lifelines utilities.
- There is a view that natural hazard risks are generally well understood, even where there has been little or no lifelines activity. In general, hazards are well identified and the likelihood of occurrence has been assessed by experts.
- There is a better understanding of the effects of the more frequently occurring floods and storms than infrequent seismic and volcanic hazards.
- There is, however, a low level of understanding of the 'social and economic' impacts of hazard events, which suggests that these factors may be under-recognised by asset managers both within local authorities and Transit NZ.
- Amongst local authorities, there is a very low level of funding for specific works to mitigate or improve the transport network's resilience to natural hazards. Transit NZ has a useful operational framework for identifying and prioritising route security risks that could also be applied to local authority networks. This may, however, require some changes to Land Transport NZ's (2007) *Programme and funding manual*.

- The low level of funding directly allocated to risk mitigation by local authorities reinforces the conclusion above that engineering lifelines practices and inter-utility collaboration have not been significant business drivers.
- Roading AMPs contain only a nominal amount of information about risks and natural hazards and lifelines issues.
- Furthermore, while risk is becoming more important to asset managers, the application of lifelines principles in integrating a hazard-based risk management process across all lifeline utility sectors in a district is not apparent in most AMPs.
- There is very limited use of technology by local authorities in the areas of asset management and lifelines.
- There are no robust measures being used by RCAs for assessing the resilience of roading networks, nor for assessing the wider economic, social, environmental or cultural impacts of hazard events that disrupt roading networks.
- There is a view that communities are knowledgeable and well prepared for natural hazard events, but this is not necessarily shared by all, and the question must be asked whether this is overly optimistic.

3. Asset management plans and risk management

3.1 Asset management practice

Asset management practices have advanced significantly over the last decade. Improvements have been driven by both legislation and a desire to improve management practices.

New Zealand is relatively advanced in the area of road asset management and is one of very few countries operating a national RAMM system for its entire road network. Hence, in general, road AMPs have a reasonably sound technical base related to the condition of the assets.

Most RCAs have been using what has been described as ‘basic’ asset management and are now developing more ‘advanced’ asset management planning. Basic asset management has been based on current levels of service, while advanced asset management includes alternative service levels, optimisation strategies including predictive modelling, and risk management.

The Office of the Auditor General (OAG) has written criteria for achieving consistency in asset management planning. This tends to be focused on local authorities, rather than entities such as Transit NZ, although the principles are equally valid. The latest criteria have been published in the *International infrastructure management manual* (NAMS 2006), and are separately defined for ‘core’ and ‘advanced’ levels of asset management. Core criteria are considered the minimum level for compliance with the Local Government Act 2002 (LGA), while advanced criteria relate to the ‘management of activities based on a substantial asset base or where there are potentially high risks to the well-being of the community’. This latter point is significant in relation to the role of roads as engineering lifelines.

In terms of risk management, the advanced criteria require that management of assets includes recognition and application of the principles of integrated risk management, specifically:

- risk management should be consistent with the risk management standard AS/NZS 4360 (Standards NZ 2004) and good industry practice risk management for local government SNZ HB 4360 (Standards NZ 2000).
- asset risk management should be integrated with other corporate risk management processes
- asset risk management should encompass:
 - identification and risk management strategies for critical assets
 - engineering lifelines based risk assessments and mitigation plans, including reference to the organisation’s disaster recovery and business continuity plans
 - the link to maintenance and replacement strategies.

Of particular note is the requirement for engineering lifelines assessments, disaster recovery plans and business continuity plans.

The minimum 'core' compliance criteria require risk management to identify critical assets and associated risks, and risk management strategies.

Thus an AMP that meets OAG requirements for advanced asset management should include a section on risk management with specific consideration of natural hazards and/or lifelines. It should also include a link between lifelines issues and maintenance and renewal strategies and include the appropriate service level requirements for lifelines routes.

3.2 Benefits of integration

One of the benefits of integrating lifelines information into an AMP is that deficiencies, concerns and issues arising from a lifelines project, or the experiences of past hazard events, are then recorded in a formal way and are considered on an ongoing basis with reviews of the asset every three years. Ideally, for local authorities, this will be aligned with the three-yearly preparation of LTCCPs. The LTCCP should also have a summary section, integrating all infrastructure information in relation to the authority's lifelines services (roading, water, wastewater, etc).

A further benefit is that priority routes or corridors can be treated appropriately in terms of how they are maintained and renewed. Through an AMP, emergency service organisations can be provided with an understanding of the risks associated with key response and recovery routes, and the knowledge that at-risk components of lifelines routes can/will be improved within a given timeframe. They should also have an opportunity to comment formally when the AMP and LTCCP is reviewed.

From discussions with people who have been involved in lifelines projects and emergency management for many years, there has been a concern that too little information about natural hazards and their consequences for infrastructure is recorded in AMPs in a way that sustains knowledge for the future.

3.3 RCAs' progress

The questionnaire completed by RCAs indicated that only a small number of RCAs have taken steps to introduce more advanced asset management planning, and that fewer still have integrated lifelines planning into their AMPs in a way that complies with OAG criteria for asset management planning.

The AMPs of seven local authority RCAs were reviewed in more detail to better understand what information they were providing and how they were presenting it, with a view to developing a best practice contents template that could be used when they next updated their AMP.

In the majority of the AMPs reviewed it was a challenge to find links between asset management planning and lifelines related project work.

Even for the larger urban authorities, where there have been extensive lifelines projects, only a limited amount of lifelines information had come forward into the roading AMPs.

From discussions with staff in these authorities, it appears that lifelines project recommendations and information are typically being used in asset management processes, such as forward works programme development. It is just that the linkages are not well documented in the AMP.

Examples of good practice observed in these AMPs include:

- using AS/NZS 4360 for risk assessment
- providing a detailed risk register with risks rated
- providing strategic route information including at risk components on those routes
- describing a programme of work targeted at mitigating risk from natural hazards
- providing clear links to other documents including lifelines project reports.

Transit NZ reviews and updates its AMPs on a regular basis. The Forward Works Programme is moving towards a longer-term focus and greater integration with the AMPs. This will progressively enhance lifelines content.

Subsequent to the survey, many local authorities have used new templates for preparing activity management plans, these having been developed to fulfil the requirements of the LGA, in particular schedule 10. The intention in preparing these templates was that activity management plans would replace existing AMPs. This has also been the approach of many local authorities who have used the templates.

3.4 Developing best practice

One of the aims set out in the guidelines for using the AMP templates is to produce a plan that, amongst other things, addresses a council's lifelines (CDEM) responsibilities.

The templates include a set of specific appendices and Appendix Q covers 'Significant forecasting assumptions, uncertainties and risk management'. The template guidelines for the roading activity are, however, very light on the content required under risk management. Most of the detail about what should be considered in preparing the risk management component (Appendix Q) is provided in the template guidelines for the water supply activity.

One of the AMPs reviewed used the activity management plan template format. The format appears to work well, with all the information on risk management in the one section, and there may be advantages for a local authority in having the risk information for each activity presented in a similar way.

Suggestions for improving the template are included in Appendix B.

In order to meet OAG requirements as expressed in the IIMM (NAMS 2006) and best practice for asset management planning, the findings of this research project for roading/transportation plans are that:

- the risk management component of an asset (or activity) management plan should include a section on hazard-based risk preparedness with the following content, or clear reference to:
 - the requirements of the CDEM Act, the CDEM group and the CDEM group plan covering the area
 - hazard studies, lifelines projects, and lifelines group reports and activities – this could include copies of significant hazard plans with critical infrastructure identified in relation to these hazards
 - identification of key interdependencies with other lifeline utilities – this may be in terms of the impact of a roading/transportation asset failure on the utility, or vice versa
 - disaster resilience summaries prepared by the organisation for the activity
 - the organisation’s emergency response plan, disaster recovery plan and/or business continuity plan, with specific content relating to the roading/transport activity
 - a plan showing key emergency routes for transportation, as well as key emergency service facilities such as hospitals and fire stations
 - a risk register which incorporates all natural (and technological) hazard risks that are identified in the CDEM group plan and that are relevant to the activity
 - an assessment of the critical risks, including prioritisation based on the level of risk exposure to the community
 - a risk-based capital investment strategy, which identifies specific risk mitigation projects to be carried forward to the LTCCP and annual plan
 - maintenance and renewal strategies for critical assets.

This component should also describe or provide:

- reference as to where/how reliant the RCA is on Transit NZ’s roads in a disaster
- reference to local authority routes that may need to be used by through traffic in the event of state highways being closed
- a list of vulnerable assets on key routes (including state highways)
- a list of key routes/locations which are vulnerable to another service’s asset failures
- reference as to how the organisation is planning to deal with vulnerable parts of the network including Transit NZ’s and other service authorities
- any particular strategies for key routes
- any strategies for reducing risk from natural hazards and any process for improving the knowledge of natural hazards.

An example of a priority emergency routes map is given in Appendix C.

Improvement plans should include a process for developing proposals to assist with mitigating risk.

The risk section of the AMP should follow the process outlined in AS/NZS 4360 (Standards NZ 2004). It must provide the 'knowledge trail' and enable communication with stakeholders and decision-makers. Sufficient information must be provided, so they can be confident that all risks have been considered, plans are in place for managing risks, and funding is available to mitigate the level of risk that satisfies community expectations and willingness to pay.

The risk assessment can be a complex undertaking. A model was suggested by Seville and Metcalfe (2005) to provide a methodology for achieving this in a structured manner.

3.5 Conclusions

In summary, the key conclusions are:

- asset (and activity) management plans should be enhanced to meet best practice guidelines for risk management
- lifelines engineering assessments conducted in collaboration with other lifeline utilities should be explicitly referenced in the AMP, so that this information can be shared and accessed by staff and stakeholders
- the recommended template for risk management and engineering lifelines content in an AMP should be promoted as desired best practice.

4. Civil defence and emergency management

4.1 CDEM group planning

The Civil Defence and Emergency Management Act 2002 (CDEM Act) came into effect on 1 December 2002 and background information is provided in the Phases 1 and 2 report of this project.

4.1.1 Role of CDEM groups

Civil defence emergency management groups (CDEM groups) are a core component of the CDEM Act. A CDEM group is a consortium of the local authorities in a region working in partnership with emergency services, amongst other things, to:

- identify and understand hazards and risks
- prepare CDEM group plans and manage hazards and risks in accordance with the four 'R's (reduction, readiness, response and recovery).

The CDEM Act provides for groups to form across all regions.

Note that these groups are not the same as lifelines groups – the latter being a voluntary grouping of organisations formed to further cross-sectoral lifelines activity in an area. Lifelines groups can play a significant role in contributing information and advice to both lifeline utilities and CDEM groups to assist them meet their legislative requirements.

CDEM groups have been established throughout New Zealand since the start of this research project, and have completed their initial plans and are starting on the second version.

4.1.2 CDEM group plans

A number of CDEM group plans have been viewed on regional council websites. There is a range of detail in the plans with excellent hazard and lifelines information included in appendices to some of them. All of those viewed have included a hazards assessment using AS/NZS 4360 (Standards NZ 2004).

Some plans reviewed contain action points which are targeted at improving the understanding of hazards (both risk and consequences) and improving or commencing lifelines projects. For example, the Otago plan includes an action plan to investigate establishing a lifelines project for the whole region using support from the Dunedin Lifelines Group.

The CDEM groups provide a mechanism for promoting (supporting) lifelines work and its ongoing development.

4.1.3 Lifelines and CDEM planning

In 2003, the Ministry of Civil Defence & Emergency Planning produced a best practice guideline *Lifelines and CDEM planning*. It is aimed at individual lifeline utilities, lifelines groups and the emergency management community. Its purpose was to develop a consistent

approach regionally and nationally to the involvement of lifeline utilities in CDEM planning. With most CDEM groups having completed their plans it is probably appropriate that the success of this be reviewed.

The CDEM best practice guideline also outlines lifelines/CDEM group roles at different stages of CDEM planning (four 'R's). The key role for lifelines groups remains in the *reduction* phase with the assessment, or ongoing review of hazards and vulnerabilities, and identification of mitigation priorities. With the introduction of the CDEM Act there is also an increasing number of new lifelines projects which are related to the *response* phase.

In terms of *readiness* the ongoing role of lifelines groups is around assisting with response planning between the utilities and assisting with exercises.

This document is further discussed below.

4.1.4 Disaster resilience summaries

An initiative has been taken by the NELC, in association with the Ministry, to obtain disaster resilience summaries from lifelines utilities. These contain a range of information about the utility's assets, vulnerability to hazards, interdependencies, and readiness and response preparedness. They will be of value to the group controller and lifelines coordinators during and after a hazard event; however, it is not clear at this point how they could be used to robustly monitor the resilience of the infrastructure over time.

A model template has been developed and a number of utilities have completed a summary. The intention is that the summaries will be aggregated into an overall resilience summary for each region. However, it is understood that while there has been some progress in Canterbury, there has been less in other regions.

Much (if not all) of this information could be included in the AMP.

4.2 CDEM expectations

4.2.1 'Working together: Lifeline utilities and emergency management'

This document (MCDEM 2002) provides background detail to the requirements of the CDEM Act 2002, stating the vision of the Act: Resilient New Zealand – strong communities, understanding and managing their hazards.

It emphasises the importance of the following key messages:

- *Senior management buy-in is obtained – especially agreement to work across the sector within the bounds of competition (not such an issue for RCAs).*
- Risk management and continuity planning are promoted as core business – responsibility cannot be transferred to customers or consultants.
- Cross-utility communications and relationships are established to support the organisation's survival.

The specific requirements of the Act are spelt out, whereby it is expected that all lifeline utilities will:

- function to the fullest possible extent during and after an emergency
- have plans for such functioning (continuity) that can be made available to the Director of the Ministry of Civil Defence & Emergency Management
- participate in CDEM planning at national and regional levels where requested
- provide technical advice on CDEM issues where reasonably required.

Specific expectations given under these headings include:

- strong relationships
- sound risk management
- identification of the likely physical impact of particular hazards on systems
- emergency response and recovery arrangements for response coordination
- external risks considered, such as failure of interdependent utilities
- plans for continuance of operation are in place and routinely exercised
- participation in workshops involving utility representatives and CDEM staff, to identify gaps in the four 'R's
- utilities addressing gaps, such as through mutual aid agreements or retrofitting assets
- reviewing the consequences of hazards and clarifying responsibilities, roles and coordination.

4.2.2 'Lifelines and CDEM planning'

This document (MCDEM 2003) calls for utility cooperation across sectors to address critical interdependencies, and internal sector cooperation at a national level. For example, this would see the transportation sector working together to address shared risks.

It discusses the role of lifelines groups and provides a framework for planning interaction between the CDEM community, lifelines utilities/sectors and lifelines groups. For lifelines utilities/sectors, this includes actions such as:

- identifying key contacts
- assessing and comparing hazard risk information
- preparing a 'disaster resilience summary'
- outlining risk management policies and processes
- identifying key operational risks and public safety messages
- key elements of readiness and response evaluated, including interdependencies and restoration priorities
- updating AMPs and capital works programmes
- participating in multi-agency exercises
- taking part in ongoing monitoring programmes and in external risk, asset and emergency management utility forums.

It also identifies the ongoing roles and functions of CDEM groups, lifeline utilities and lifelines groups in relation to reduction, readiness, response and recovery. For individual utilities, this essentially involves ongoing involvement in relation to the points listed above and in particular:

- undertaking actions considered necessary to reduce risk and improve response and recovery
- participation in reviews of hazards and lifelines
- providing an update of mitigation activity at the annual meeting of the lifelines group
- participation in response and recovery with a CDEM group.

This pre-supposes that a lifeline utility will have a clear understanding of the risks it faces and is able to prioritise the actions it needs to take. This should all be adequately documented and integrated in AMPS.

Key conclusions and observations include:

- The CDEM Act identifies important functions for CDEM groups and lifeline utilities. CDEM, lifelines and asset management functions should be well linked, systematically addressed by RCAs and documented in AMPS.
- There remains a significant amount of work to be completed if CDEM expectations are to be recognised in contemporary AMPS.
- As an example of disaster resilience summaries has not yet been developed in a comprehensive manner across the country, there is an opportunity for this information to be documented in AMPS.

5. Use of technology

The research considered the role new technology is playing in lifelines and asset management planning.

The survey results indicate that, at the local authority level, there is limited use of technology related to lifelines and the management of natural hazards.

The actual or potential use of technology is described below in three areas, monitoring (which includes the presentation of real time information), data mapping and modelling.

5.1 Monitoring

Technology is increasingly being used to provide real-time information to help with the prediction of or provide warnings about natural hazard events. This includes the collection of a range of meteorological data, monitoring of water levels and the measurement of landslide movement. It also includes monitoring of earth movements and volcanic activity to assist with prediction in these areas.

High-profile examples include the monitoring of the crater lake at Mt Ruapehu to provide warning of lahars and the monitoring at Franz Joseph Glacier to provide warning of extreme flood flows. Internationally, tsunami monitoring and warnings are provided by the Pacific Tsunami Warning Centre in Hawaii.

Transit NZ is increasing its use of technology for monitoring potential hazards. Examples include the prediction of snow on SH 1 in the central North Island and assessing avalanche risk on the highway to Milford Sound. Transit has also been upgrading technology to provide real time information on weather and road information on a nation-wide basis for motorists.

While there is an increasing availability of real-time data available for monitoring hazard events, caution is advised for civil defence or emergency management personnel relying on real-time electronic data, due to the risk of a loss of power or communication lines during a hazard event.

5.2 Data mapping

The RCA survey indicated that there was limited use of technology for lifelines purposes.

Many RCAs are using geographic information systems (GIS) to record data about their assets, or groups of assets, but only a few have included lifelines data or information about risks from natural hazards in the data sets. This was confirmed in the interview process.

Research for the Canterbury CDEM group (Maunsell 2006) included GIS mapping of hazards data with an electronic overlay of lifelines data, such as key transportation routes and the

location of petroleum storage facilities in relation to the hazard type. An example is shown below.

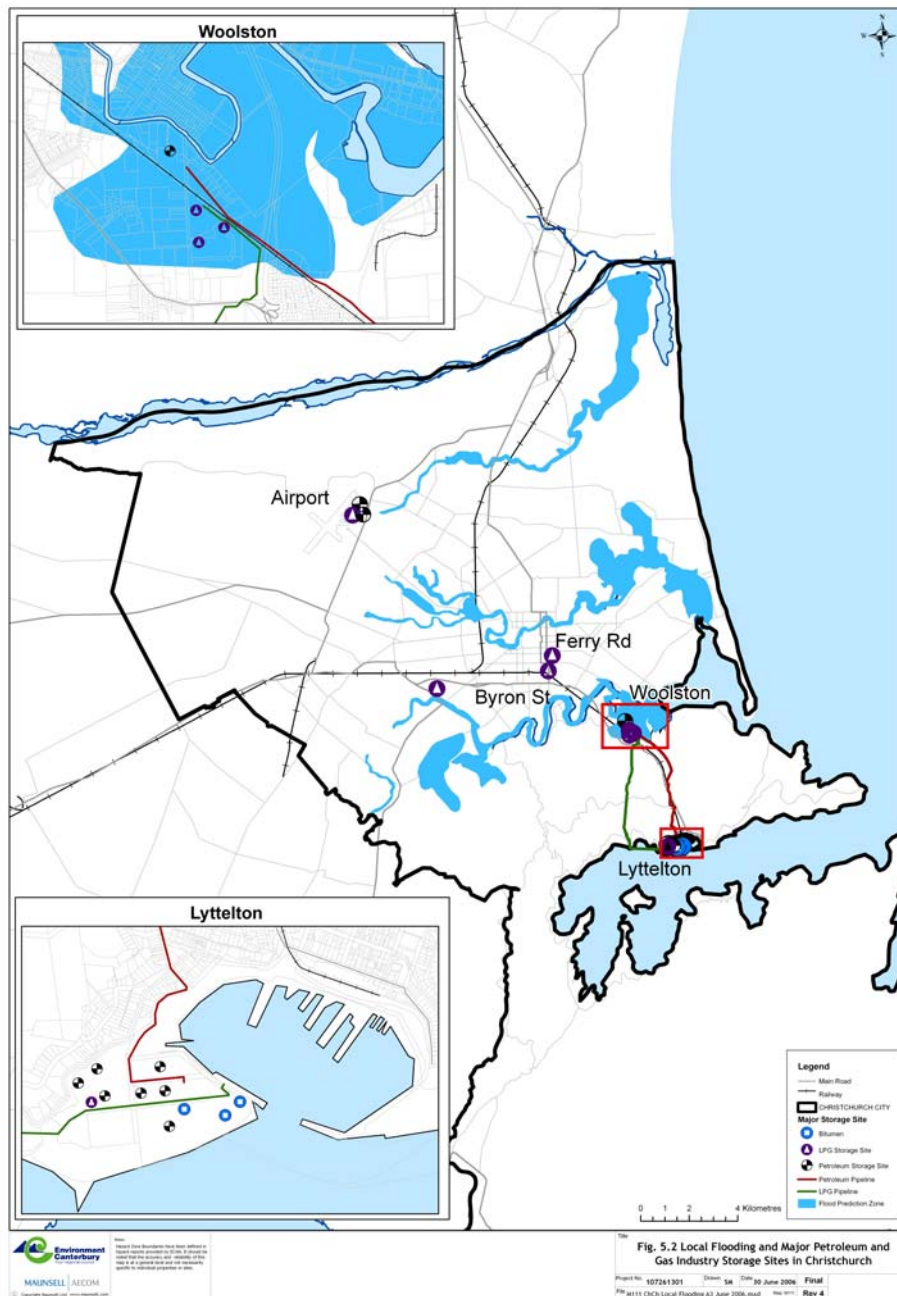


Figure 5.1 GIS map example.

5.3 Modelling

Phase 1 of the research suggested that GIS systems had a high potential to model the impacts and costs of hazards.

As an example, the Auckland City Council commissioned a project to develop a GIS-based model illustrating the vulnerability of the council's roading and stormwater assets to a range of natural disasters, and the likely maximum probable financial loss from each event.

The model was based on the HAZUS-MH model developed by the Federal Emergency Management Agency (USA). It uses (GIS) software to map and display hazard data, the results of damage, and economic loss estimates for buildings and infrastructure. It also allows users to estimate the impacts of hazard events such as hurricane winds, floods and earthquakes on social parameters such as population distribution.

In effect the model merged the hazard data, asset data and financial data that was available for Auckland City.

Infrastructure assets included roads, bridges and the stormwater network.

Figure 5.2 shows an example of asset data map output.

Hazard event scenarios included volcanic eruption, earthquake, tsunami and flooding. Examples of the output from the model are shown in the following diagrams. The first two show volcanic (1000-year, ash-fall contours) and earthquake (magnitude 6, response acceleration contours) event scenarios. Assumptions are made as to the source of the event, for example, the earthquake event is assumed to be at 10 km depth with an epicentre 20 km east of central Auckland.

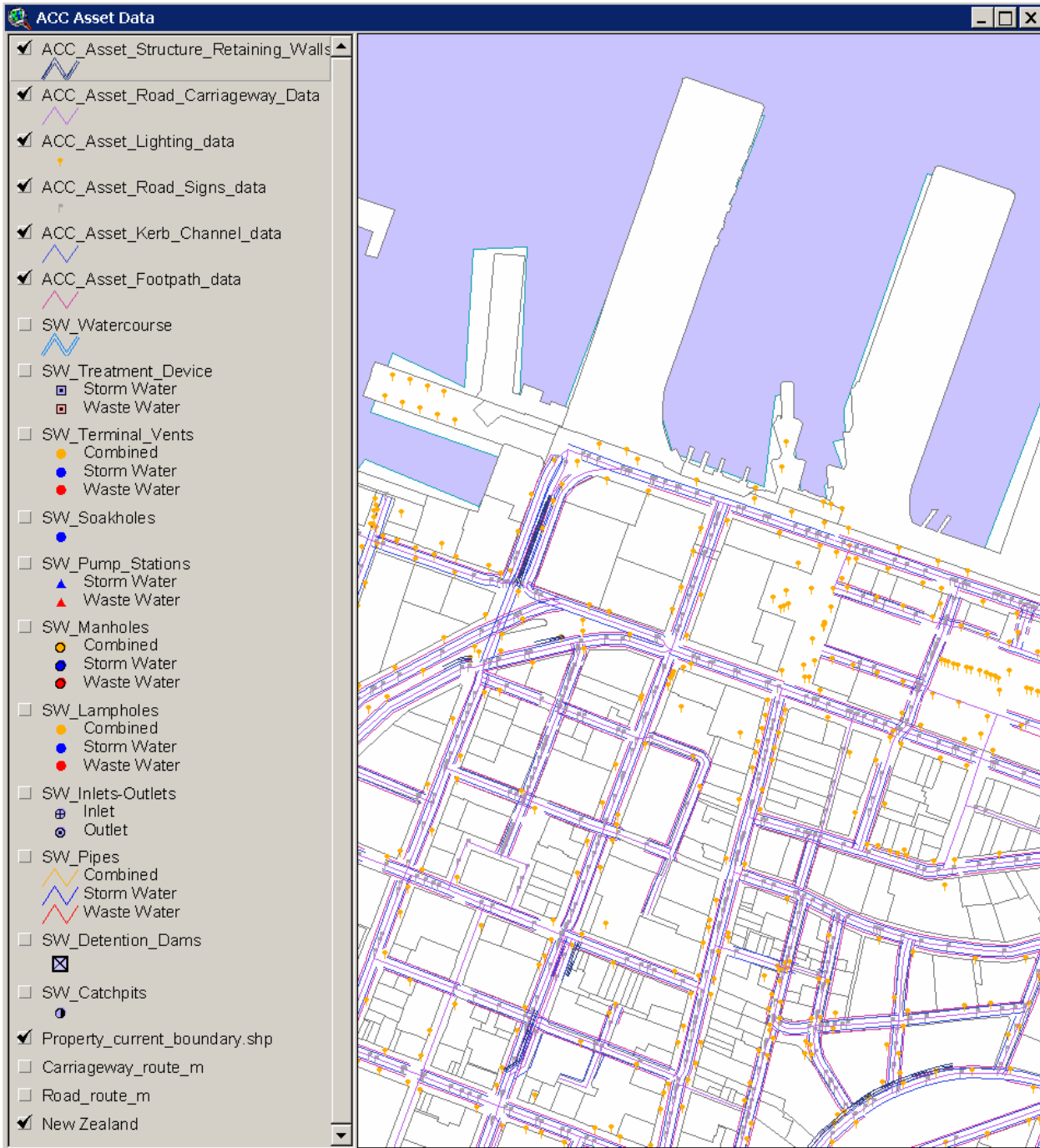


Figure 5.2 Asset data.

5. Use of technology

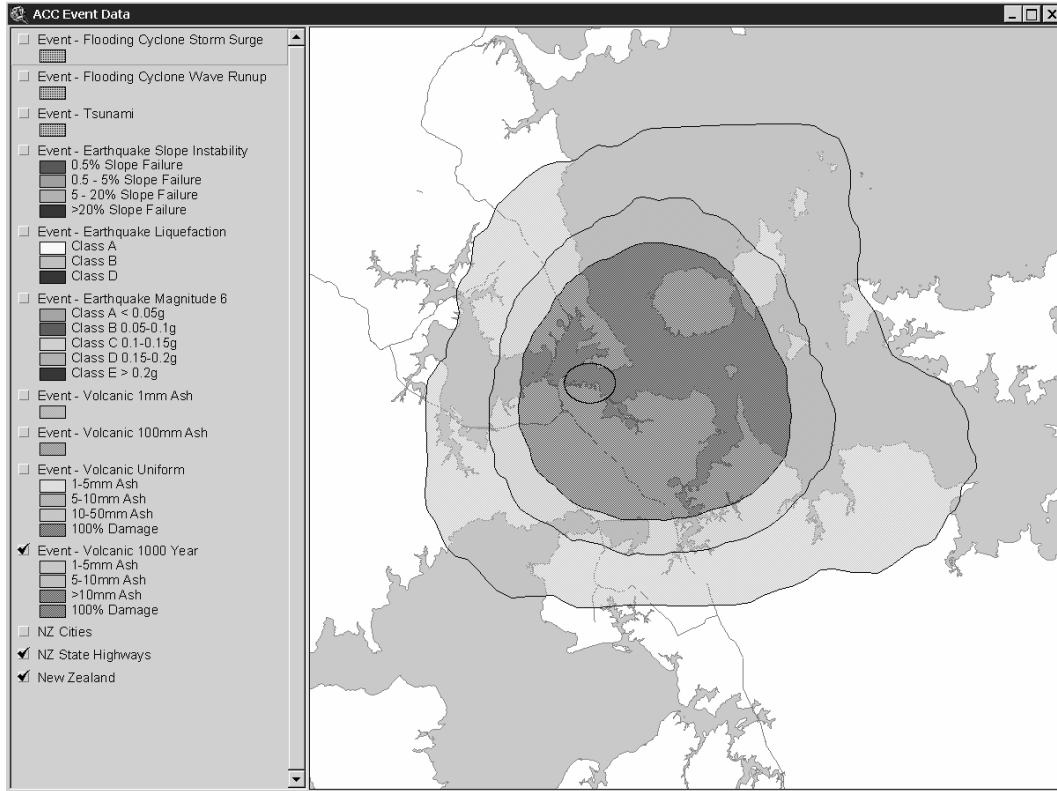


Figure 5.3 Volcanic event.

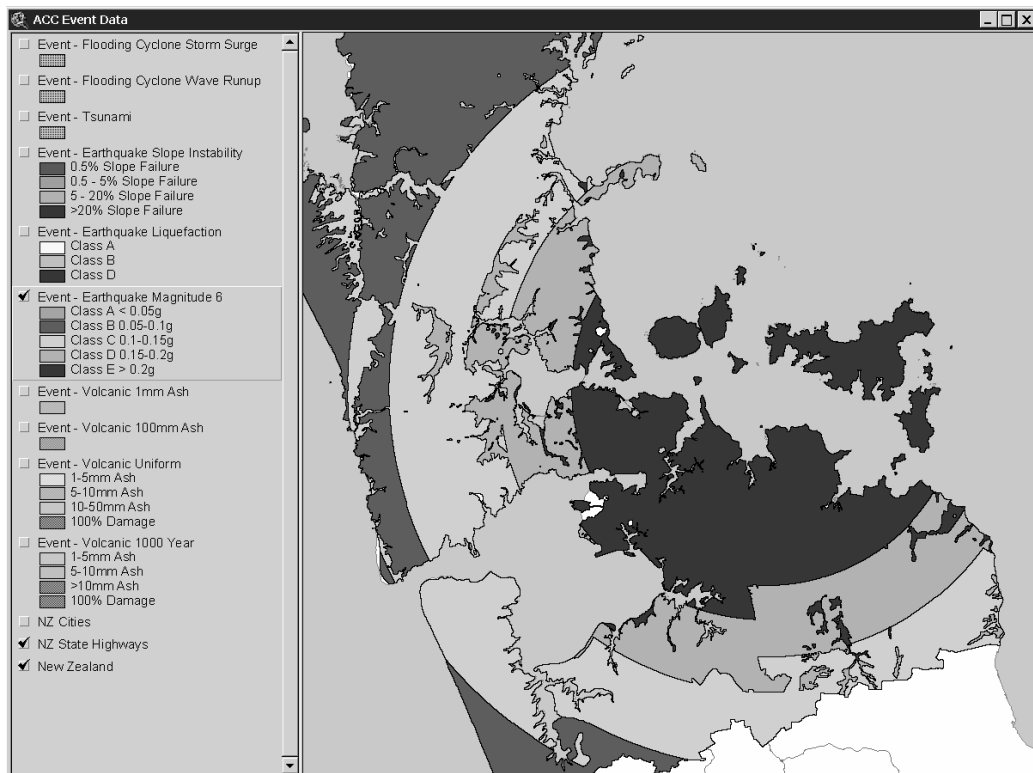


Figure 5.4 Earthquake scenario.

The key outcome from this modelling project was estimates of the probable maximum loss from each natural hazard scenario.



Figure 5.5 HAZUS – MH software program.

A similar tool is currently being developed in New Zealand by NIWA and GNS, called RiskScope. It is being piloted in Christchurch, Westport and Napier. Like HAZUS-MH, it uses damage ratios (fragility), community spatial data and hazard data to assess the financial impact on communities – in particular, injuries/fatalities and property damage. It could also be used for infrastructural assets.

Other uses of modelling technology include technical analysis that enables the prediction of the ultimate failure point of structures in a given natural hazard event such as an earthquake.

Such knowledge enables asset managers to assess whether bridges can be restored relatively easily, or be impassable for days or weeks following a particular event, and what the restoration requirements could be.

Some of this work has been undertaken by a small number of councils in New Zealand, such as the analyses by Christchurch City Council in relation to its bridge seismic mitigation programme, as shown below.

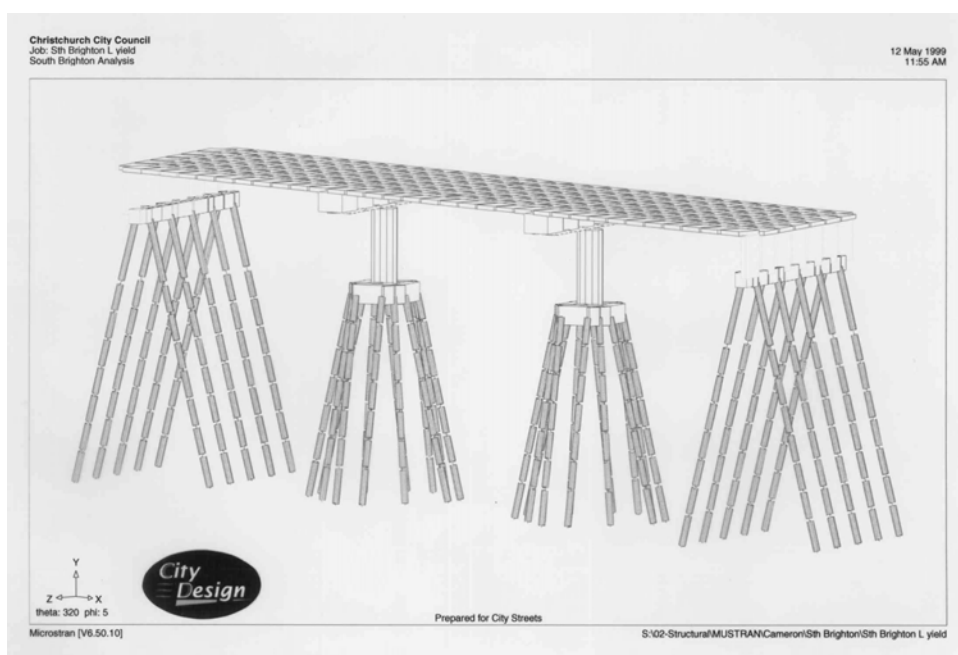


Figure 5.6 Christchurch City Council bridge seismic mitigation programme.

5.4 Conclusions

Key conclusions and observations include:

- By identifying the vulnerability of infrastructure assets and the consequential risks to communities, asset managers can optimise priorities for new assets, replacement, rehabilitation and maintenance works.
- GIS technology in particular can provide benefits in terms of presenting to decision-makers, and also in visualising and analysing the spatially related effects of hazards on infrastructure.
- Using a tool such as HAZUS-MH or RiskScape enables financial and social implications to be assessed, such as the maximum probable loss due to natural hazard scenarios. This supports decision-making in terms of the level of insurance or financial resources that may be needed to recover from the impacts of a particular natural hazard event.



Figure 5.7 Seismic strengthening of a bridge deck to abutment connection.

6. Monitoring of progress

6.1 Introduction

This section addresses the question of how do we know if New Zealand is making progress in improving the resilience of the transport network to natural hazards?

Monitoring in relation to the following is discussed:

- CDEM groups
- lifelines groups
- strategies, LTCCPs and AMPs
- resilience measures.

There are no formal monitoring or auditing processes of CDEM groups by MCDEM, in terms of their achievement of targets proposed in their plans

The lifelines and CDEM planning best practice guideline (MCDEM 2003) suggests annual monitoring of lifelines progress in terms of activity focused on reduction and five to six-yearly reviews of hazards. This would appear to be appropriate for monitoring mitigation progress but represents a significant change in reviewing hazards compared with what appears to be happening at present. Of course, review may simply mean asking if there has been any additional research that changes the previous assessment.

6.2 Lifelines groups

A summary of the current lifelines groups in New Zealand and the status of project work within the groups is provided in Part one of this report which covers Phases 1 and 2 of the project.

Since Phase 1 was undertaken projects that have been completed include:

- Invercargill lifelines report *Working together to reduce risk*
- Wairarapa lifelines report *Risk to lifelines from major hazards*
- *Alpine fault earthquake scenario* for West Coast region
- Manawatu-Wanganui lifelines report *Risks and responsibilities*.

The lifelines groups that completed projects some time ago have continued to meet with varying levels of activity. For most groups recent focus has been on providing information for inclusion in CDEM plans and assisting CDEM groups with plan preparation.

The NELC maintains an overview of lifelines activity as well as encouraging and assisting with information exchange between groups. It has no formal auditing or review process. A significant amount of information exchange occurs at the annual forum. Organisations, with

a national interest, such as Transit NZ and Telecom are members whose contributions are valued.

Because they are voluntary, lifelines groups are essentially self monitoring in terms of what they set out to achieve. New targets or projects may be discussed with and supported by the National Committee but progress is dependent on the dedicated individuals who keep things moving.

There does not appear to be any formal or mandatory process for lifelines groups to revisit/review the initial lifelines projects and report on progress in improving resilience to hazard events.

Lifelines groups expect that the work identified in lifelines studies and projects is identified and programmed in AMPs, and from there implemented and reported. Success is, however, dependent on local interest and enthusiasm for lifelines work.

6.3 Strategies, LTCCPs and AMPs

Many organisations monitor the status of their asset management practices, including AMPs, on a regular basis as part of the improvement process when the plan is updated. This includes relating the status of asset management planning to the criteria established by the Office of the Auditor General.

The LGA came into effect in December 2002, introducing a number of significant changes for local authorities.

Major changes were the increased emphasis on long-term planning, integration with asset management, and the requirement to identify community outcomes and prepare an LTCCP. The content of an LTCCP with respect to assets is covered by Schedule 10 of the Act, with clear requirements to identify assets, the negative effects relating to the assets or their use, impacts of changes to levels of service or demand, future capacity needs, how maintenance and renewals will be undertaken and the associated costs. The LTCCP must also clearly state how the assets will contribute to the achievement of community outcomes and how that will be measured.

This should include reference to lifelines and infrastructure resilience.

Audit NZ took a proactive approach in auditing LTCCPs during 2005–2006, as required by the Act, and this has included the content of associated activity (or asset) management plans. The aim has been to assist local authorities to meet the requirements of the Act and include auditable goals and targets. Significant cost has been incurred by local authorities during this process and substantial work undertaken on these plans. Despite this, there has been less ‘pure lifelines’ work undertaken in recent years and many plans do not adequately address lifelines risks.

However, as the LGA is not specific about how infrastructure should cope with hazard events, this aspect has not been a focus of audit efforts. Also, while the CDEM Act includes requirements for lifeline utilities (including RCAs), the emphasis on external monitoring or the audit of specific performance in terms of increasing resilience appears to be absent.

Transit NZ reviews and updates its AMPs on a regular basis, and this includes risk and lifelines content. The *National state highway strategy* (Transit NZ 2007) provides a longer-term context, although this does not specifically address these issues. The strategy provides a linkage to legislation, the *New Zealand transport strategy* (MoT 2002) and network management plans and activities, but little is said about how the resilience of the network – its ability to withstand natural or man-made shocks – is being monitored or enhanced.

6.4 Resilience measures

Without a robust method of measuring resilience over time, it is not possible to assess objectively how much progress has been made in improving the resilience of the transport network to natural hazards events.

Where they exist, lifelines groups have made considerable advances in identifying weaknesses and interdependencies between the different lifelines organisations. These organisations have actioned projects but there has been limited reassessment of the overall improvement in resilience since the projects were completed. It would be appropriate now for one of the more established groups to undertake a review of their lifelines project, with the aim of assessing the improvements made in the resilience of all lifelines networks.

The CDEM groups at this stage appear to have been focusing on the preparation of CDEM plans and thus have had a limited focus on reduction.

RCAs, who are tasked with undertaking improvements in the transport area, are proceeding slowly and with very limited reporting on what is proposed and what has been achieved.

Clearly however, resilience has increased because of the following factors:

- Lifelines groups and projects exist throughout most of the country, and specific measures to strengthen the network or improve response capability have been identified and put in place
- Reduction work has been undertaken by a number of councils and Transit NZ in recent years, in particular, seismic screening, strengthening of key bridges, and improving protection in relation to landslides and rock-fall events.

As described in Part one of this report which covers Phase 1 and Phase 2 of the project, the following are some parameters that could be used to assess resilience:

- The **resistance** of the asset to a hazard event. This could be assessed by how much of the network might be damaged and/or unusable after a hazard event and introduces the concept of ‘damage assessment ratios’.

- The **network layout** and whether there are alternative routes. If there are alternatives, then the road network's function may be able to continue, albeit it on a restricted basis.
- The **volume** of traffic in relation to the level of service offered by the road. The greater the impact of a hazard event on traffic, the lower the level of resilience.
- The **time** it would take to restore the road network and allow traffic back.

It would be worthwhile developing measures of resilience that could then be used to prioritise further investment reduction measures, and against which a national view could regularly be reported on.

In its simplest form, resilience could be measured by the financial exposure of assets to hazard events, such as modelled for Auckland City Council. A more targeted measure could be developed using factors in combination, such as those described above. Of importance at the community level is the impact of hazard events, and the consequential infrastructural asset failure, on society, the economy and the environment – these clearly being related to 'community outcomes'.

6.5 Conclusions

Key conclusions and observations include:

- There are no mandatory monitoring processes in place for CDEM and lifelines projects and actions. While the NELC regularly reviews progress of the various groups and projects around the country, monitoring at the local level is ad hoc, inconsistent and depends on the enthusiasm of local staff.
- There is less emphasis on lifelines in LTCCP and AMP processes than on other more routine matters, despite the significant disruption to community well-being that a hazard event could bring.
- Further work should be promoted in defining resilience measures, against which the effectiveness of different investments in strengthening, risk reduction or readiness could be assessed.

7. Funding signals

7.1 Survey feedback

As mentioned in section 2, the majority of local authority respondents indicated that they believed Land Transport NZ procedures for hazard mitigation works were adequate. Very few provided comments on the survey question about improvements to processes for funding these works. It is possible, given the low level of expenditure, that few have applied for funding for specific hazard mitigation-related projects.

Six (26%) of the local authorities surveyed indicated that they knew of significant natural hazard site exposures within their network (where the combination of probability and consequence was *significant* and warranted some action) that would not be proceeded with due to a lack of funding.

Discussions with local authorities highlighted that the key funding issue was finding the local share for a project rather than funding from Land Transport NZ. They also indicated that in some instances the subsidy from Land Transport NZ to restore assets could be greater following a hazard event, so there was limited incentive in being proactive with hazard mitigation. This attitude may change over time given the introduction of the CDEM Act, but it is likely that finding the local share for hazard mitigation works will remain a major hurdle for most authorities.

Comments from the survey included (words in italics added for clarity):

'Need to be clear on *processes for evaluating* 'uneconomic' natural hazard mitigation'

'Provide templates or a simplified procedure using a risk management approach'

'*Provide a specific category for hazard mitigation*'

'By mandating minimum standards outside the project BCR cut-off OR by clarifying 'HIGH' status for this type of work under one of the other funding criteria'

'An agreement needs to be reached on risk assessment criteria. In my experience projects have been declined by Land Transport NZ because of disagreements over the likelihood of an event/outcome.'

The survey has shown that there is a very small amount of funding targeted specifically at proactive hazard mitigation of the transport network, as opposed to reactive expenditure on restoration following events.

In summary these comments indicate that the processes for funding natural hazard mitigation works could be clarified, with more guidance provided by Land Transport NZ. While there is some uncertainty as to whether these comments relate to past or present funding processes, it would still be useful to define the status of hazard mitigation works.

Their potential to increase resilience, reduce risk exposure and improve protection to communities could be more explicitly addressed.

7.2 Land Transport Management Act 2003

The Land Transport Management Act 2003 has five main objectives:

- to assist economic development
- to assist safety and personal security
- to improve access and mobility
- to protect and promote public health
- to ensure environmental sustainability.

Funding of hazard mitigation works would appear to meet at least two of these objectives so inclusion of these works should be readily justified provided they have regional support.

This may require the establishment of a different category or different BCR cut-off point for hazard mitigation works, or perhaps a higher ranking given the objectives of the Act.

7.3 Project evaluation procedures

Current Land Transport NZ procedures in the *Economic evaluation manual Vol 1 (EEM)* (2007) (formerly the *Project evaluation manual*) provide for the costs and benefits associated with the loss of a route following a natural hazard event, including diversion requirements and associated travel time costs. An example of this was the recently constructed Avon River Bridge in Christchurch, now a state highway, where higher seismic design standards (and costs) were justified on the basis that all adjacent bridges were at risk in an earthquake. This associated lifelines component was a factor in the project being approved.

At present, however, there is no clearly defined procedure in the EEM for factoring in 'emergency management' benefits for key lifelines routes, in providing continuous access to critical lifeline utility sites and priority sites (eg hospitals). The manual provides for national strategic factors (such as route security) to be included, but these tend to relate to routes which are either high-use or where there are limited alternatives. The example given provides a probabilistic analysis of the effects of a slip. Related to this, the section in the EEM on risk management addresses project-related risks, rather than hazards and lifelines risks.

Because the EEM is not explicit about lifelines-related social and economic benefits, it is not clear that they can be included in project evaluation analysis. Provided a good case can be made, there is scope for lifelines projects to be supported.

More explicit coverage of these issues in the EEM would be worthwhile. Furthermore, it would also be helpful to have a clear process for assessing the effects of natural hazard events on lower volume roads. This would include the positive impact that a more resilient network would have on tourism, freight and other essential services.

7.4 Regional land transport strategies

Under the Land Transport Management Act 2003, a regional land transport strategy should address transport lifelines issues and provide a process for prioritising projects at the regional level. Projects that are important for the region from a lifelines perspective should be included, at the request of the CDEM group if necessary, and evaluated as part of this process. These projects could then be funded from Land Transport NZ's regional allocation, although if they are on local roads there would still be the issue of local funding share.

7.5 Conclusions

Key conclusions and observations include:

- The funding signals provided by Land Transport NZ could probably best be described as neutral. Clearly Land Transport NZ has been receptive to including benefits for hazard mitigation works in the project evaluation process, but has not been proactive in showing how these benefits can be included. It would be helpful if a much more positive signal could be provided, especially on key lifelines routes once these have been clearly identified in AMPs and the mitigation projects supported regionally.

8. Strengths, weaknesses, gaps and barriers in current practice

8.1 Introduction

The information collected from the survey, interviews and reviews of AMPs has been summarised, and an assessment of the strengths, weaknesses, gaps and barriers in current practice is provided below.

This includes consideration of two documents prepared by the MCDEM:

- *Working together: Lifeline utilities and emergency management. Director's guidelines for lifeline utilities* [DGL 3/02], December 2002
- *Lifelines and CDEM planning: Civil defence emergency management best practice guide* [BPG1/03], July 2003.

RCAs are lifeline utilities under the Act.

8.2 Strengths

The survey of RCAs found particular strengths in current practice, as follows:

- Generally there was a good understanding of potential natural hazards by asset management practitioners.
- Impacts of natural hazards and external risks were well understood in broad terms, particularly flood and storm hazards.
- Risk management processes were well understood.
- There appeared to be generally good communication channels between different lifeline utilities, although this could be improved and widened.

8.3 Weaknesses

However, a number of weaknesses were apparent. There was a:

- relatively low number of road asset managers (the people who filled in the questionnaire) who were involved in lifelines groups or CDEM (links were often at a higher level)
- lower level of understanding of the impacts of the less frequent hazard events (eg seismic, volcanic)
- lower level of understanding of the effects of hazard events on specific assets, and critical assets were not defined
- difficulty relating to specific programmes or activities.
- low level of understanding of the impact a road asset failure would have on other lifeline utilities
- very low level of quantified knowledge of the consequences of asset failure on communities (eg social, economic impacts)

- lack of risk, hazard information and lifelines integration in AMPs
- failure to meet the expectations of the Auditor General as defined in the IIMM (NAMS 2006)
- low level of funding and limited progress on implementing mitigation works
- limited amount of monitoring of progress in improving resilience.

8.4 Gaps

From the strengths and weaknesses, and given the CDEM context described in section 4.2, the following gaps need to be addressed:

- The lack of background information about risks, natural hazards and transportation lifelines in the majority of the AMPs should be reviewed. There needs to be a lot more information provided, or at least much clearer cross-referencing to other documents containing the information.
- While lifelines information has been considered in preparing many AMPs this is not obvious when reviewing the plans. Linkages or communication channels are not apparent.
- The small amount of funding targeted specifically at hazard mitigation of the transport network should be reviewed.
- There is a need for a better risk management template in the template guidelines for activity management plans. An appendix covering CDEM/lifelines information for each activity would be of benefit. This would help a local authority using the templates to provide similar information about all of its engineering lifelines, and for some regions it may be helpful in collating information on a regional basis. One challenge to be addressed is that the template omits the electricity, gas and telecommunication utilities and interdependency issues.
- There should be a clear understanding of the ongoing role of lifelines groups in relation to CDEM groups.
- There is limited achievement in relation to CDEM expectations, as described in the guideline documents, in particular:
 - disaster resilience summaries are not typically prepared
 - there is limited involvement in cross-sectoral response exercises
 - there is limited monitoring or reporting of lifelines/mitigation information
 - the extent of compliance with the CDEM Act.
- The LGA and CDEM Act are both drivers in improving information about and preparedness for hazards. The AMP should define the role of the roading utility and provide clear linkages with the CDEM plan.
- Optimised decision making and risk management processes are not being used widely in asset management planning.
- Technology, even basic GIS presentation tools, is not being used widely in hazard and lifelines management. (It is not being used much in AMPs either.)

8.5 Barriers

The reasons for the weaknesses and gaps described above are likely to include the following:

- The high workload of asset managers, with a focus on everyday decision-making, can diminish any real sense of urgency in relation to lifelines planning.
- The level of resources and inputs needed to satisfy external requirements and expectations, for example in relation to the LGA, is also impacted by the relative scarcity of technical resources available in the sector.
- Associated with this is the fact that involvement in cross-sectoral lifelines activity seems to be 'discretionary' or 'voluntary', despite the requirements of the CDEM Act in relation to lifelines utility responsibilities. In contrast, the LGA has had a much more significant impact on the behaviour of councils, but there is little emphasis given to lifelines and risk management concepts in the legislation.
- There is a sense of optimism that events will be managed when they occur and that the community knows what to expect – despite the fact that the major, infrequent disaster scenarios considered in lifelines work may be overwhelming and lead to unexpected cascade failures across a broad spectrum of lifelines utilities. Nearly half of the respondents said that their ability to respond was 'exceptional'. Even the more frequent events, such as snowfall, continue to result in seemingly unexpected but predictable cascade failures across lifelines utilities to which a reactive rather than proactive approach seems to have been taken.
- There is a perception that funding is not readily available to deal with forward mitigation of hazard events, based on a risk management approach. In fact, there is a perception that emergency work receives a higher level of subsidy after the event and this can be a disincentive to undertaking forward reduction measures. Funding is a constraint at both national (Land Transport NZ) and local share levels.
- Priority is being given to infrastructure development to reduce more immediate and pressing priorities, such as congestion relief.

9. Research conclusions

9.1 Research objectives

The primary objective of the project was to seek to reduce the impact of natural hazards on land transport infrastructure by investigating:

- whether the engineering lifelines approach had increased the resilience of New Zealand's land transport system
- how well the engineering lifelines approach was integrated into other natural hazard mitigation approaches and into AMPs
- if the local regional approach to lifelines planning had provided the best overall result for the country
- international best practice and identifying gaps between this and New Zealand practice
- the risks New Zealand land transport infrastructure was exposed to (likelihood and consequence)
- the barriers to improving New Zealand's performance in this area
- available tools and technology that could enhance lifelines practice
- future actions and implementation options.

A summary of the preliminary research is presented next, followed by the conclusions from Phases 1 and 2 and finally an overall assessment of the findings in relation to these objectives.

9.2 Phases 1 and 2 summary

The first phase of this research project (see Part one of this report) assessed international and national practice in lifelines engineering, and found that practice was very much evolving and largely absent in many developed countries.

while hazards such as earthquakes, floods, and tsunami have been a feature of life throughout history and in modern times it is equally true that responses have focused on targeted and specific rather than collaborative actions. For example, bridges may be strengthened based on the amount of traffic they carry rather than the importance of the other lifeline services they may carry. Earthquake engineering for buildings has focused on better design to prevent or control structural failures, but perhaps with little attention to the damage impacts to services associated with the buildings. For example, the disruption resulting from damage to gas pipelines and connections can be just as (or more) catastrophic as the effect on the structure, as occurred with the fires triggered after the Kobe earthquake (Part one, p 27).

One of the strengths in New Zealand has been recognition of the importance of 'interdependencies':

New Zealand's approach to lifelines is fundamentally based on inter-agency understanding and collaboration – by 'overlaying' the services of each agency against the hazard event and understanding the interdependencies, the true magnitude of disruption to the community can be determined. In contrast, a highways agency concerned only about the failure of its own assets, such as bridges, would have little knowledge or awareness of the effects of consequential failure of other utilities' critical infrastructure passing over the bridge (such as a major telecommunications cable or a large water-main serving a community). New Zealand regards this shared communication and collaboration approach as the lifelines culture (Part 1, p 27).

Part one also provides an overview of the status of lifelines activity in New Zealand, with the following observations:

- There is lifelines activity throughout most of the country, although the level varies considerably.
- The focus of New Zealand's work has been, and continues to be, on reduction through mitigation works and planning. In terms of the other three 'R's, some effort has been directed to readiness with little collaborative attention being given to response and recovery – although at an individual organisation level the four 'R's receive greater attention.
- Perhaps the key difference with overseas work is New Zealand's combined approach to multi-hazards and multiple organisations; this seems to be unique in the world – certainly at a national level.
- Many groups/projects are looking to their future role in supporting CDEM groups in each region.
- While information is provided through projects and groups to the NELC, there is in many cases no clear picture of how road networks have been 'treated', nor whether the wider social/economic consequences have been considered by RCAs.
- A 'cutting to the chase' process is needed in lifelines so that early progress can be made in identifying key asset vulnerabilities and potential mitigation treatments.
- There seems to be a general lack of integration of lifelines in roading AMPs – with this being cited by some as a potential major barrier.
- A need is seen for AMPs to define those routes that will be needed as priority routes in restoring the services of other lifelines utilities. These routes can then be given priority in terms of improvement/protection. This also requires clear understanding of the needs of the utilities.
- Under the LGA, LTCCPs must be prepared by TLAs to describe their activities and to outline the role of infrastructure assets in meeting community outcomes. They will draw input from more detailed AMP/activity management plans and therefore have a role to play in the lifelines context, establishing and communicating levels of risk exposure, how risk will be managed, and also to manage risk expectations in the community.
- In reviewing the role of LTCCPs and AMPs, there is a need to look at how extensively the AS/NZS 4360 risk management standard (Standards NZ 2004) is being applied.

- The effectiveness of the interface between local authorities and Transit NZ in an emergency may also need to be explored.

Phase 2 of the project explored the level of activity in more detail with lifelines groups and projects, and discussed lifeline coordinators' views of their region's preparedness with an emphasis on the roading network.

The relative probability and consequences of a range of natural hazards were assessed on a regional basis and relative numerical ratings used to form an overall risk exposure rating. This was compared with the level of lifelines activity, roading expenditure and the regional share of the economy, and indicated that lifelines activity had been focused across areas with a wide range of exposure – from low to high.

Concepts for assessing and comparing transport infrastructure resilience were also identified.

The following conclusions were drawn from the survey of lifelines coordinators:

- In the regions where lifelines groups have been established with a project either completed or underway, natural hazards have been well identified and the likely impact on the roading network is well understood.
- The impact a roading network failure would have on other utilities is also well understood.
- Some lifelines coordinators indicated that there had been limited action, either planned or taken, to mitigate against the impact of a natural disaster.
- Apart from two regions, the perception was that very little funding has been specifically targeted at improving the roading network resilience to natural disasters.
- While 50% indicated that RCAs kept lifelines coordinators informed of mitigation work, it seems that there is limited communication with RCAs and/or not a good understanding of what different groups are doing. While most lifelines groups were very involved in the regional CDEM groups, there was a level of uncertainty about the ongoing relationship between lifelines groups and the groups established under the CDEM Act.

9.3 Phases 3 and 4 conclusions

These phases of the research project set out to establish what RCAs had actually been doing in the lifelines and hazard mitigation area and the effectiveness of that work. This section brings together the findings from this phase of the project.

9.3.1 RCA survey results

A questionnaire was sent to RCAs in New Zealand and 46% were returned. Meetings were then held with six local authorities and Transit NZ.

The following key conclusions and observations can be drawn from the responses to the questionnaire:

- Lifelines engineering has not been a key influencing factor for many local authorities, and a higher level of involvement by transportation asset management personnel is desirable.
- Natural hazard risks are generally well understood by the respondents, even where there has been little or no lifelines activity. In general, hazards are well identified and the likelihood of occurrence has been assessed by experts.
- There is a better understanding of the effects of the more frequently occurring floods and storms than infrequent seismic and volcanic hazards.
- There is a low level of understanding of the social and economic impacts of hazard events, which suggests that these factors may be under-recognised by asset managers.
- There is generally a very low level of funding for specific works to mitigate or improve the transport network resilience to natural hazards.
- Transit NZ has a useful screening and prioritisation process for projects which have route security benefits.
- The low level of funding directly allocated to risk mitigation by local authorities reinforces the conclusion that engineering lifelines practices and inter-utility collaboration have not been significant business drivers.
- While risk is becoming more important to asset managers, the application of lifelines principles in integrating a hazard-based risk management process across all lifeline utility sectors in a district is not apparent in most AMPs.
- There is very limited use of technology by local authorities in the areas of asset management and lifelines. Transit NZ has a number of hazard monitoring and information systems.
- There are no robust measures being used for assessing the resilience of roading networks, nor for assessing the economic, social, environmental or cultural impacts of hazard events.
- There is a view that communities are knowledgeable and well prepared for natural hazard events.

9.3.2 Asset management plans

A study of a number of roading AMPs highlighted a lack of information about risks and natural hazards in these plans. Very few plans contained any information or maps showing lifelines or key emergency routes and only one provided specific details of projects targeting hazard mitigation. Where funding was provided for mitigation work the AMPs seldom contained much detail or provided links to other background documents.

Despite the confidence shown in the responses, the impression that this research leaves is that there is a sense of complacency about the very real impacts of a major natural (or technological) event, in terms of major loss of or damage to infrastructure. Overseas experience, such as in Kobe, shows that the loss of key transportation infrastructure can wreak havoc on the regional economy and result in significant temporary and permanent social dislocation, and that these impacts were not understood before the event.

In order to meet legislative requirements, expectations of the Office of the Auditor General and best practice asset management planning, and to provide appropriate information for decision-makers and the community, the risk management component of an AMP/activity management plan should include a section on event (natural hazard) based risk preparedness which includes clear reference to:

- the requirements of the CDEM Act, the CDEM group and the CDEM group plan covering the area
- hazard studies, lifelines projects and lifelines group reports and activities – this could include copies of significant hazards plans with critical infrastructure identified in relation to these hazards
- identification of key interdependencies with other lifeline utilities – this may be in terms of the impact of a roading/transportation asset failure on the utility, or vice versa
- the organisation's emergency response plan, disaster recovery plan and/or business continuity plan, with specific content relating to the roading/transport activity
- a plan showing key emergency routes for transportation, as well as key emergency service facilities such as hospitals and fire stations
- a risk register that incorporates all identified natural (and technological) hazard risks identified in the CDEM group plan and that are relevant to the activity
- an assessment of the critical risks, including prioritisation based on the level of risk exposure to the community
- a risk-based capital investment strategy, which identifies specific risk mitigation projects to be carried forward to the LTCCP and annual plan
- maintenance and renewal strategies for critical assets.

Essentially, this information should provide the disaster resilience summary prepared by the organisation for the activity.

Other actions by asset managers are also required to ensure that:

- there is appropriate provision in maintenance contract specifications – emergency response capability 24x7
- organisational response facilities are in place and exercises conducted regularly, involving cross-sectoral utilities, contractors and emergency management stakeholders
- engineering lifelines needs are communicated to and understood by top management, council and boards, in order to secure their commitment.

In summary:

- Asset (and activity) management plans should be enhanced to meet best practice guidelines for risk management.
- Lifelines engineering assessments conducted in collaboration with other lifeline utilities should be explicitly referenced in the AMP, so that this information can be shared and accessed by staff and stakeholders.
- The recommended template for risk management and engineering lifelines content in an AMP should be promoted as desired best practice.

9.3.3 CDEM

- The CDEM Act identifies important functions for CDEM groups and lifeline utilities. CDEM, lifelines and asset management functions should be well linked, systematically addressed by RCAs and documented in AMPs.
- There remains a significant amount of work to be completed if CDEM expectations are to be recognised in contemporary AMPs.
- As an example, disaster resilience summaries have not yet been developed in a comprehensive manner across the country – there is an opportunity for this information to be documented in AMPs.

9.3.4 Technology

- By identifying the vulnerability of infrastructure assets and the consequential risks to communities, asset managers can optimise priorities for new assets, replacement, rehabilitation and maintenance works.
- GIS technology in particular can provide benefits in terms of presenting to decision-makers, and also in visualising and analysing the spatially related effects of hazards on infrastructure.
- Using a tool such as HAZUS-MH or RiskScape enables financial and social implications to be assessed, such as the maximum probable loss due to natural hazard scenarios. This supports decision-making in terms of the level of insurance or financial resources that may be needed to recover from the impacts of a particular natural hazard event.

9.3.5 Monitoring of progress

- There are no mandatory monitoring processes in place for CDEM and lifelines projects and actions. While the NELC regularly monitors progress of the various groups and

projects around the country, monitoring at the local level is ad hoc, inconsistent and depends on the enthusiasm of local staff.

- There is less emphasis on lifelines in LTCCP and AMP processes than on other more routine matters, despite the significant disruption to community well-being that a hazard event could bring.
- Further work should be promoted in defining resilience measures, against which the effectiveness of different investments in strengthening, risk reduction or readiness could be assessed.

9.3.6 Funding signals

Funding levels for natural hazard mitigation works appear to be very low in relation to the total expenditure on the roading network and the historical costs of emergency works. Few local authorities are spending more than nominal amounts on forward mitigation works. There appear to be a number of reasons for this, including:

- lack of funding (usually local share)
- hazard mitigation works are seen as a lower priority than capacity improvement or safety works
- hazard mitigation projects have not been identified or scoped, because it is not clear what should actually be done or is justified
- funding from Land Transport NZ for emergency repair work is available at a higher subsidy level than mitigation work.

The Land Transport Management Act 2003, through a regional land transport strategy and the regional funding allocation, provides a mechanism for funding mitigation works that are considered important on a regional basis. However, while there is pressure on funding for new transport infrastructure it may be difficult to obtain funding for mitigation works, especially where the traffic volumes are low. One positive aspect of this is that the new infrastructure should be designed to a standard to provide secure routes following a hazard event.

The survey and interview process has highlighted that there has been limited progress in undertaking mitigation works and improving the overall resilience of the transport network to a natural hazard event. This has confirmed the view of the lifeline coordinators surveyed in Phase 2 of the study.

Funding signals could probably best be described as neutral. Clearly Land Transport NZ has been receptive to including benefits for hazard mitigation works in the project evaluation process, but has not been proactive in showing how these benefits could be included. It would be helpful if a much more positive signal could be provided, especially on key lifelines routes once these have been clearly identified in AMPs and the mitigation projects supported regionally.

9.3.7 Related research

Other studies and reports have discussed related issues. Seville and Metcalfe (2005) discuss several examples and conclude that the work being done could together be leveraged and some firm methodologies developed.

This study supports that view, but has focused more on the role of AMPs and the concept of resilience.

9.4 Summary of findings in relation to research objectives

| Research objectives | Project findings |
|--|--|
| Has the engineering lifelines approach increased the resilience of New Zealand's land transport system? | <p>It is clear that both the 'discipline' and the work carried out to date have had some positive impacts on the resilience of the land transport system, although it is not possible to assess this quantitatively. Infrastructure vulnerabilities are better understood throughout the country, and a number of programmes have been identified or are being implemented to strengthen infrastructure. However, there is more that could be achieved and the approach has much to offer. It is important that practitioners at the local level become more involved and see lifelines studies through to the implementation phase.</p> <p>A positive aspect is the integration of locally based activity with the NELC, and this must continue – as it provides opportunity for local action within a nationally accepted framework.</p> |
| How well is the engineering lifelines approach integrated into other natural hazard mitigation approaches and into AMPs? | <p>Integration of the engineering lifelines approach with hazard identification, management and mitigation is generally effective at the national and lifeline group/project levels. However, practice varies considerably at the AMP level and in most cases there is very little information about how hazards may affect the infrastructure.</p> |
| Has the local regional approach to lifelines planning provided the best overall result for the country? | <p>The regional approach has allowed individual areas to progress lifelines planning to suit their circumstances, within a generic national framework and with support from other regions.</p> <p>Furthermore, national utilities with a national view are able to participate and contribute through the national coordination and information sharing approach of the NELC.</p> <p>Regions facing a higher relative risk exposure appear to be making ongoing progress. However, even in these areas it is of concern that lifelines practicalities are not robustly recognised in local authority asset management planning.</p> |
| What is international best practice and what gaps are there between this and New Zealand practice? | <p>New Zealand has a particular strength in terms of our multiple hazard planning and collaboration processes, and the willingness of many agencies to participate in lifelines. However, there are barriers to achieving effectiveness and full national integration.</p> <p>Best practice elsewhere sees more extensive use of technology and damage/loss prediction scenarios. However, New Zealand is making progress in these areas, such as through the work of NIWA and GNS. This technology needs to be understood and applied by local practitioners..</p> |

| | |
|---|---|
| <p>What risks is New Zealand land transport infrastructure exposed to (likelihood and consequence)?</p> | <p>There is a diverse range of natural hazard events that have the potential to severely disrupt the land transportation sector, and these have been highlighted in the research. The effects vary depending on location, and some regions face quite different risks to others.</p> <p>While seismic, volcanic and tsunami events are rare, their effects on infrastructure and communities will be significant. It is likely that these effects and their interdependencies are not as widely understood by asset managers as the more frequent flooding, landslide and meteorological events which while also significant locally are generally well understood.</p> |
| <p>What are the barriers to improving New Zealand's performance in this area?</p> | <p>Barriers include workload and short-term demands for investment, a sense that lifelines planning is optional, an overly optimistic approach by asset managers to response capability and 'managing on the day', and funding constraints in terms of strengthening infrastructure. These include competing with other more immediate priorities, difficulty in justifying work, and weak funding signals and incentives.</p> |
| <p>What available tools and technology could enhance lifelines practice?</p> | <p>Technology can be used in relation to:</p> <ul style="list-style-type: none"> • spatial data management, mapping and analysis • hazard monitoring • modelling and scenario development and prediction. <p>Some are being or have been developed within New Zealand, and examples include Transit NZ's screening and prioritisation process, and RiskScape (NIWA/GNS).</p> |
| <p>Future actions and implementation options.</p> | <p>Recommendations have been made in this report with a particular focus on:</p> <ul style="list-style-type: none"> • better understanding resilience and how it can be maximised through better infrastructure management • improving AMPs and risk management processes so lifelines planning is integrated with other investment decision-making processes • maintaining and building knowledge around natural hazards and how these will affect infrastructural networks • identifying tools that can be used to assess and manage lifelines risks. |

10. Recommendations

The following recommendations are based on the conclusions reached in this research project:

1. The results of the project should be circulated to all RCAs in New Zealand, and AMPs and activity management plans be further developed in relation to risk and the effects of hazards on infrastructure.
2. The improvements suggested in this report in relation to asset and activity management plans should be considered by the NAMS Group for incorporation in future infrastructure management manuals and guidelines.
3. Land Transport NZ should develop and publicise examples of assessments for project justification of natural hazard mitigation (reduction) measures in the *Economic evaluation manual Vol 1 (2007)* (formerly the *Project evaluation manual*).
4. The concepts of resilience measures and monitoring should be further developed by Land Transport NZ in association with key stakeholders such as the NELC and used for national performance reporting purposes.
5. An initial measure of resilience, such as the financial exposure of infrastructure to particular hazard events, should be developed by Land Transport NZ, and the use of the RiskScape model be explored with NIWA and GNS.
6. The NELC should develop a framework to enable lifelines groups to review the effectiveness of completed lifelines projects and studies, in terms of enhanced resilience.

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Appendix A - Survey results

Part 1: RCA questionnaire

Name

Position

Organisation

Date

Historically the majority of work on assessing natural hazards and considering engineering lifelines has been done at a regional level. This questionnaire aims to gain an understanding of how the individual road controlling authorities are/have been involved, their level of understanding and the state of RCAs' actions in using information on hazards in preparing asset management plans and programmes of work.

Lifelines participation

1. What is the level of lifelines activity in your region?

| | |
|---|---|
| | ✓ |
| None at all | |
| Initiating – A small core of people working to set up a lifelines project but no formal agreed plan | |
| Project – A project team established with input from majority of utilities and a nominated project manager | |
| Group –Initial lifelines project completed and group continues to monitor progress on improving resilience and undertake further research | |
| Don't know | |

2. What is your organisation's involvement as a road controlling authority with lifelines?

3. What is your personal involvement?

Hazards

4. How well identified are the natural hazards that may occur in your area?

| | |
|--|---|
| | ✓ |
| Hazards not yet formally identified. | |
| Hazards known to exist but not comprehensively assessed for the purpose. | |
| Hazards identified and described and their likelihood/probability of occurring assessed by experts in their field. | |

5. What is **your level** of understanding of the impact of a natural hazard on the roading network in your area? (Tick for each hazard)

| | Seismic | Flooding | Landslide | Volcanic | Coastal | Wind snow |
|--|---------|----------|-----------|----------|---------|-----------|
| Limited knowledge of the effects of a natural hazard on the roading network. | | | | | | |
| Effects broadly understood but not analysed systematically. | | | | | | |
| Effects understood and systematically analysed asset by asset. | | | | | | |

Event consequences

6. What is **your** understanding of the wider consequences of a roading network failure due to a natural hazard?

| Effect on roading network | Effect of roading network failure on utilities | Effect of utilities failure on roading network | |
|--|--|--|--|
| Very limited knowledge | Very limited knowledge | Very limited knowledge | |
| Some knowledge | Subjective understanding | Subjective understanding | |
| In-depth knowledge | In-depth knowledge | In-depth knowledge | |
| In-depth, plus documented understanding of wider social and economic impacts | In-depth, plus documented understanding of wider social and economic impacts | In-depth, plus documented understanding of wider social and economic impacts | |

Mitigation and funding

7. What action has been taken to mitigate the impact of a natural hazard on the roading network in your area?

| | |
|---|---|
| | ✓ |
| No action taken | |
| Some actions planned for but limited implementation to date | |
| Benefits and costs have been assessed but no work currently budgeted for. | |
| Benefits and costs have been assessed, a programme of work prepared and is either underway or provided for in future budgets. | |

If a programme is in place...

8. When was the plan/programme developed?

9. How far advanced is it?
10. How/when is the programme reviewed?
11. What assets are affected?
12. What sort of work has been undertaken?
13. What remains to be done?
14. What is the approximate amount of expenditure (pa) that has been specifically targeted at improving the roading network's resilience to a natural hazard in your authority? (eg identified projects)

| Amount | Last year | Current year | Next 2 years | Next 10 years |
|-----------------------|-----------|--------------|--------------|---------------|
| \$0 □ \$50,000 | | | | |
| \$50,000 □ \$200,000 | | | | |
| \$200,000 □ \$500,000 | | | | |
| \$500,000 □ \$1m | | | | |
| \$1m □ \$2m | | | | |
| \$2m + | | | | |

15. Often natural hazard risk mitigation will be achieved through other roading projects, without it being a specific objective. An example would be the replacement of an old bridge, perhaps with poor foundations and exposed to scour or vulnerable to an earthquake.

What is your **subjective opinion** as to the proportion of your forward five-year capital expenditure programme (total renewals and improvements), in **addition to** the expenditure above, that will achieve noticeable natural hazard risk reduction?
16. Are you aware of any significant natural hazard site exposures (where the combined probability X consequence is **significant** and warrants some action) within your network that cannot or will not be proceeded with due to a lack of funding? If yes – please describe briefly.
17. Do you consider that current Transfund NZ project evaluation procedures provide appropriate guidance and cater adequately for projects involving natural hazard risk mitigation?

Yes / No

18. If not, how could they be improved?

19. Do you as RCA keep the lifelines group informed of any mitigation work you are planning?

Yes / No
Comment.....

Asset management plan

20. Does your roading AMP include a section on risk management with specific consideration of natural hazards and/or lifelines?

Yes / No
Comment

21. Are you using your asset management plans or other key planning documents to justify, prioritise and programme hazard mitigation work?

Yes / No
Comment

22. If yes, does this follow the framework outlined in NZS4360?

Yes / No
Comment

23. What level of detail are natural hazard events assessed at in the AMP?

| | |
|--|---|
| | ✓ |
| Not at all | |
| Natural hazards are ‘grouped’ and an overall assessment made at high level | |
| Each hazard is assessed for its impact at the network level | |
| Each hazard is assessed for its impact on different asset groups, e.g. bridges, signs etc | |
| Each hazard is assessed for its impact on specific assets that are identified to be at risk, eg specific bridges | |

24. Does your AMP include separate projects specifically targeted at minimizing the risk to the roading asset from natural hazards?

Yes / No
Comment

25. Are they clearly identified in the AMP?

Yes / No
Comment

26. Are key emergency transport routes identified in the AMP? If yes please provide a copy.

Yes / No
Comment...

27. Does the information/outputs in the Asset Management plan carry through to your Councils LTCCP?

Yes / No
Comment

28. Does your LTCCP include any specific targets related to minimizing the risk from natural hazards? Please specify.

Other

29. What is your view of the relationship between Road Controlling Authorities and other lifelines agencies within the region?

| | |
|--|---|
| | ✓ |
| Our RCA has no formal or a weak relationship with other utilities and emergency services agencies, in relation to lifelines planning | |
| Some evidence of a relationship but this is occasional and more reactive than proactive | |
| Strong documented relationship with regular communication, information sharing, and joint meetings / workshops / exercises | |

30. What is your view of the level of community awareness about the impact of natural hazards on the roading network?

| | |
|---|---|
| | ✓ |
| Community has little or no knowledge of the impacts of hazard events on the roading network | |
| Community has some awareness | |
| Community has a high level of awareness | |

31. What technology is used for lifelines purposes for the road network? (eg monitoring hazards or GIS for mapping of at risk assets)

| | |
|--|---|
| | ✓ |
| Not used | |
| Planning to use | |
| Used for the following applications..... | |

32. If GIS is being used is it as an

| | |
|--|---|
| | ✓ |
| Electronic map | |
| As data management tool with links to RAMM/other roading AM system | |

33. Overall, how would you rate your organisation's (as an RCA) ability to respond in a major natural hazard event? (Include hired in resources, contractors etc.)

| | | | | | |
|------------|---|---|---|---|-------------|
| Inadequate | | | | | Exceptional |
| 1 | 2 | 3 | 4 | 5 | |

34. Do you have any useful case studies/project examples that could be used to widen knowledge in this area?

Part 2: RCA questionnaire results

Lifelines participation

1. What is the level of lifelines activity in your region?

| Multichoice option | % | No. |
|--|------|-----|
| None at all | 18% | 6 |
| Initiating – A small core of people working to set up a lifelines project but no formal agreed plan | 9% | 3 |
| Project – A project team established with input from majority of utilities and a nominated project manager | 38% | 13 |
| Group – Initial lifelines project completed and group continues to monitor progress on improving resilience and undertake further research | 35% | 12 |
| Don't know | 0% | 0 |
| Total | 100% | 34 |

2. What is your organisation's involvement as a road controlling authority with lifelines?

| Summarised comments | % | No. |
|---|------|-----|
| No involvement or no comment | 9% | 3 |
| Minimal involvement | 15% | 5 |
| Attends/contributes to meetings | 35% | 12 |
| Produced data/assessments/documentation | 29% | 10 |
| Handled by Civil Defence | 12% | 4 |
| Total | 100% | 34 |

3. What is your personal involvement?

| Summarised comments | % | No. |
|---|------|-----|
| No involvement or no comment | 18% | 6 |
| Minimal involvement | 29% | 10 |
| Member of lifelines group | 9% | 3 |
| Attends meetings | 6% | 2 |
| Active role in meetings | 18% | 6 |
| Project manages/identifies risks/prepares plans | 20% | 7 |
| Total | 100% | 34 |

Hazards

4. How well identified are the natural hazards that may occur in your area?

| Multichoice option | % | No. |
|--|------|-----|
| Hazards not yet formally identified. | 0% | 0 |
| Hazards known to exist but not comprehensively assessed for the purpose. | 41% | 14 |
| Hazards identified and described and their likelihood/probability of occurring assessed by experts in their field. | 56% | 19 |
| No comment | 3% | 1 |
| Total | 100% | 34 |

5. What is **your level** of understanding of the impact of a natural hazard on the roading network in your area? (Tick for each hazard)

| Multichoice option | Seismic | | Flooding | | Landslide | | Volcanic | | Coastal | | Wind Snow | |
|--|---------|-----|----------|-----|-----------|-----|----------|-----|---------|-----|-----------|-----|
| | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. |
| Limited knowledge of the effects of a natural hazard on the roading network. | 24% | 8 | 0% | 0 | 9% | 3 | 29% | 10 | 6% | 2 | 12% | 4 |
| Effects broadly understood but not analysed systematically. | 56% | 19 | 62% | 21 | 64% | 21 | 35% | 12 | 65% | 22 | 50% | 17 |
| Effects understood and systematically analysed asset by asset. | 21% | 7 | 35% | 12 | 24% | 8 | 12% | 4 | 18% | 6 | 26% | 9 |
| No comment | 0% | 0 | 3% | 1 | 3% | 1 | 24% | 8 | 12% | 4 | 12% | 4 |
| Total | 100% | 34 | 100% | 34 | 100% | 33 | 100% | 34 | 100% | 34 | 100% | 34 |

Event consequences

6. What is **your** understanding of the wider consequences of a roading network failure due to a natural hazard?

| Multichoice option | Effect on roading network | | Effect of roading network failure on utilities | | Effect of utilities failure on roading network | |
|--|---------------------------|-----|--|-----|--|-----|
| | % | No. | % | No. | % | No. |
| Very limited knowledge | 3% | 1 | 3% | 1 | 6% | 2 |
| Some knowledge | 29% | 10 | 44% | 15 | 44% | 15 |
| In depth knowledge | 53% | 18 | 44% | 15 | 41% | 14 |
| In depth, plus documented understanding of wider social and economic impacts | 9% | 3 | 3% | 1 | 3% | 1 |
| No comment | 6% | 2 | 6% | 2 | 6% | 2 |
| Total | 100% | 34 | 100% | 34 | 100% | 34 |

Mitigation and funding

7. What action has been taken to mitigate the impact of a natural hazard on the roading network in your area?

| Multichoice option | % | No. |
|---|-------------|-----------|
| No action taken | 18% | 6 |
| Some actions planned for but limited implementation to date | 53% | 18 |
| Benefits and costs have been assessed but no work currently budgeted for. | 9% | 3 |
| Benefits and costs have been assessed, a programme of work prepared and is either underway or provided for in future budgets. | 21% | 7 |
| Total | 100% | 34 |

If a programme is in place...

8. When was the plan/programme developed?

| Summarised comments | % | No. |
|---------------------|-------------|-----------|
| 1997 | 3% | 1 |
| 1998 | 0% | 0 |
| 1999 | 3% | 1 |
| 2000 | 3% | 1 |
| 2001 | 6% | 2 |
| 2002/03 | 3% | 1 |
| 2003/04 | 6% | 2 |
| 2004/05 | 6% | 2 |
| Subtotal | 30% | 10 |
| Other (Comment) | 15% | 5 |
| N/A - No comment | 55% | 19 |
| Total | 100% | 34 |

9. How far is it advanced?

| Summarised comments | % | No. |
|--------------------------------|-----------|-------------|
| Planning/works Identified | 6 | 18% |
| Construction/repairs commenced | 8 | 24% |
| Subtotal | 14 | 42% |
| N/A - No comment | 19 | 58% |
| Total | 33 | 100% |

10. How/when is the programme reviewed?

| Summarised comments | % | No. |
|-------------------------------|-------------|-----------|
| Annually | 24% | 8 |
| 3-yearly | 3% | 1 |
| Ongoing/regularly/as required | 12% | 4 |
| Subtotal | 39% | 13 |
| N/A - No comment | 61% | 20 |
| Total | 100% | 33 |

11. What assets are affected?

| Summarised comments | % | No. |
|---------------------|-------------|-----------|
| Roads | 23% | 10 |
| Bridges | 26% | 11 |
| Drainage | 5% | 2 |
| Electric | 2% | 1 |
| All | 2% | 1 |
| Subtotal | 58% | 25 |
| N/A - No comment | 42% | 18 |
| Total | 100% | 43 |

12. What sort of work has been undertaken?

| Summarised comments | % | No. |
|---------------------------|------------|-----------|
| Identification/evaluation | 9% | 4 |
| Slip repair/drainage | 7% | 3 |
| Route deviation | 2% | 1 |
| Bridge strengthening | 12% | 5 |
| Road upgrades | 7% | 3 |
| All | 0% | 0 |
| Subtotal | 37% | 16 |
| N/A - No comment | 47% | 20 |
| Total | 84% | 36 |

13. What remains to be done?

| Summarised comments | % | No. |
|------------------------------------|-------------|-----------|
| Further identification/effects BCR | 21% | 7 |
| Implementation | 3% | 1 |
| Continue construction programme | 18% | 6 |
| Subtotal | 30% | 14 |
| N/A – No comment | 58% | 19 |
| Total | 100% | 33 |

Construction programme includes:

- ongoing programme permanent slip repair (retaining walls, gabions etc) and preventative drainage work
- completion of earthworks and then pavement and seal construction
- upgrading of alternative routs on local roads to handle state highway traffic
- strengthen structures
- rebuilding roads and pavements
- drainage improvements.

14. What is the approximate amount of expenditure (pa) that has been specifically targeted at improving the roading network’s resilience to a natural hazard in your authority? (eg identified projects)

| Multichoice option amount | Last year | | Current year | | Next 2 years | | Next 10 years | |
|---------------------------|-------------|-----------|--------------|-----------|--------------|-----------|---------------|-----------|
| | % | No. | % | No. | % | No. | % | No. |
| \$0 – \$50,000 | 59% | 20 | 50% | 17 | 41% | 14 | 41% | 14 |
| \$50,000 – \$200,000 | 12% | 4 | 15% | 5 | 21% | 7 | 9% | 3 |
| \$200,000 – \$500,000 | 3% | 1 | 3% | 1 | 3% | 1 | 12% | 4 |
| \$500,000 – \$1m | 0% | 0 | 3% | 1 | 6% | 2 | 9% | 3 |
| \$1m – \$2m | 6% | 2 | 9% | 3 | 6% | 2 | 3% | 1 |
| \$2m + | 0% | 0 | 3% | 1 | 3% | 1 | 0% | 0 |
| Subtotal | 79% | 27 | 82% | 28 | 79% | 27 | 74% | 25 |
| No comments | 21% | 7 | 18% | 6 | 21% | 7 | 26% | 9 |
| Total | 100% | 34 | 100% | 34 | 100% | 34 | 100% | 34 |

15. Often natural hazard risk mitigation will be achieved through other roading projects, without it being a specific objective. An example would be the replacement of an old bridge, perhaps with poor foundations and exposed to scour or vulnerable to an earthquake.

What is your subjective opinion as to the proportion of your forward 5-year capital expenditure programme (total renewals and improvements), in addition to the expenditure above, that will achieve noticeable natural hazard risk reduction?

| Summarised comments | % | No. |
|---------------------|-------------|-----------|
| 0% | 18% | 6 |
| 0-5% | 26% | 9 |
| 10-20% | 21% | 7 |
| 20-30% | 3% | 1 |
| 70-100% | 6% | 2 |
| Subtotal | 74% | 25 |
| N/A – No comment | 26% | 9 |
| Total | 100% | 34 |

16. Are you aware of any significant natural hazard site exposures (where the combined probability X consequence is **significant** and warrants some action) within your network that cannot or will not be proceeded with due to a lack of funding? If yes – please describe briefly.

| Summarised comments | % | No. |
|---------------------|-------------|-----------|
| Yes | 18% | 6 |
| No | 70% | 24 |
| Unknown | 12% | 4 |
| Total | 100% | 34 |

Comments include:

- slips (2)
- liquefaction (1)
- road flooding (1)
- no description (2).

17. Do you consider that current Transfund project evaluation procedures provide appropriate guidance and cater adequately for projects involving natural hazard risk mitigation?

Yes / No

| Summarised comments | % | No. |
|---------------------|-------------|-----------|
| Yes | 41% | 14 |
| No | 26% | 9 |
| Unknown | 33% | 11 |
| Total | 100% | 34 |

18. If not, how could they be improved?

Comments include:

- Need to be clear on 'uneconomic' natural hazard mitigation, ie related to traffic volumes (1)
- Provide templates/simplified procedures using risk management approach (1)
- Specific category (1)
- By mandating minimum standards outside the project BCR cut-off OR by clarifying 'HIGH' status for this type of work under one of the other funding criteria (1)
- An agreement needs to be reached on risk assessment criteria. In my experience projects have been declined by TF because disagreements over likelihood (1)
- No comment (4)

19. Do you as an RCA keep the lifelines group informed of any mitigation work you are planning?

Yes / No

Comment.....

| Multichoice option | % | No. |
|--------------------|------|-----|
| Yes | 41% | 14 |
| No | 38% | 13 |
| No response | 21% | 7 |
| Total | 100% | 34 |

Comments:.....

Asset management plan

20. Does your roading AMP include a section on risk management with specific consideration of natural hazards and/or lifelines?

Yes / No

Comment

| Multichoice option | % | No. |
|--------------------|------|-----|
| Yes | 40% | 17 |
| No | 50% | 17 |
| No response | 0% | 0 |
| Total | 100% | 34 |

21. Are you using your AMPs or other key planning documents to justify, prioritise and programme hazard mitigation work?

Yes / No

Comment

| Multichoice option | % | No. |
|--------------------|-------------|-----------|
| Yes | 47% | 16 |
| No | 50% | 17 |
| No response | 3% | 1 |
| Total | 100% | 34 |

22. If yes, does this follow the framework outlined in NZS4360?

Yes / No

Comment

| Multichoice option | % | No. |
|--------------------|------------|-----------|
| Yes | 26% | 9 |
| No | 12% | 4 |
| No response | 9% | 3 |
| Total | 47% | 16 |

23. What level of detail are natural hazard events assessed at in the AMP?

| Multichoice option | % | No. |
|--|-------------|-----------|
| Not at all | 38% | 13 |
| Natural hazards are 'grouped' and an overall assessment made at high level | 32% | 11 |
| Each hazard is assessed for its impact at the network level | 12% | 4 |
| Each hazard is assessed for its impact on different asset groups, eg bridges, signs etc | 12% | 4 |
| Each hazard is assessed for its impact on specific assets that are identified to be at risk, eg specific bridges | 6% | 2 |
| No response | | |
| Total | 100% | 34 |

24. Does your AMP include separate projects specifically targeted at minimising the risk to the roading asset from natural hazards?

Yes / No

Comment

| Multichoice option | % | No. |
|--------------------|-------------|-----------|
| Yes | 15% | 5 |
| No | 85% | 29 |
| No response | 0% | 0 |
| Total | 100% | 34 |

25. Are they clearly identified in the AMP?

Yes / No

Comment

| Multichoice option | % | No. |
|--------------------|-------------|-----------|
| Yes | 15% | 5 |
| No | 6% | 2 |
| No response | 79% | 27 |
| Total | 100% | 34 |

26. Are key emergency transport routes identified in the AMP? If yes please provide a copy.

Yes / No

Comment...

| Multichoice option | % | No. |
|--------------------|-------------|-----------|
| Yes | 18% | 6 |
| No | 76% | 26 |
| No response | 6% | 2 |
| Total | 100% | 34 |

27. Does the information/outputs in the asset management plan carry through to your council's LTCCP?

Yes / No

Comment

| Multichoice option | % | No. |
|--------------------|-------------|-----------|
| Yes | 76% | 26 |
| No | 21% | 7 |
| No response | 3% | 1 |
| Total | 100% | 34 |

28. Does your LTCCP include any specific targets related to minimizing the risk from natural hazards? Please specify.

| Multichoice option | % | No. |
|--------------------|-------------|-----------|
| Yes | 26% | 9 |
| No | 68% | 23 |
| No response | 6% | 2 |
| Total | 100% | 34 |

Other

29. What is your view of the relationship between road controlling authorities and other lifelines agencies within the region?

| Multichoice option | % | No. |
|--|-------------|------------|
| Our RCA has no formal or a weak relationship with other utilities and emergency services agencies, in relation to lifelines planning | 0% | 0 |
| Some evidence of a relationship but this is occasional and more reactive than proactive | 6% | 2 |
| Strong documented relationship with regular communication, information sharing, and joint meetings / workshops / exercises | 56% | 19 |
| No comment | 38% | 13 |
| Total | 100% | 34 |

30. What is your view of the level of community awareness about the impact of natural hazards on the roading network?

| Multichoice option | % | No. |
|---|-------------|------------|
| Community has little or no knowledge of the impacts of hazard events on the roading network | 0% | 0 |
| Community has some awareness | 29% | 10 |
| Community has a high level of awareness | 59% | 20 |
| No comment | 12% | 4 |
| Total | 100% | 34 |

31. What technology is used for lifelines purposes for the road network? (eg monitoring hazards or GIS for mapping of at risk assets)?

| Multichoice option | % | No. |
|--|-------------|------------|
| Not used | 0% | 0 |
| Planning to use | 29% | 10 |
| Used for the following applications..... | 32% | 11 |
| No comment | 38% | 13 |
| Total | 100% | 34 |

Used for the following applications:

- available but not used for lifelines (1)
- GIS-mapping, risk assets (4)
- mapping (3)
- in relation to roading unless consider CCTV monitors. Some water level monitors on Waimakariri bridges (1)
- lifelines assessments (1).

32. If GIS is being used is it as:

| Multichoice option | % | No. |
|--|------|-----|
| Electronic map | 47% | 16 |
| As data management tool with links to RAMM/other roading AM system | 29% | 10 |
| No comment | 24% | 8 |
| Total | 100% | 34 |

33. Overall, how would you rate your organisation's (as an RCA) ability to respond in a major natural hazard event? (Include hired in resources, contractors etc.)

| Multichoice option | | % | No. |
|--------------------|---|------|------|
| Inadequate | 1 | 0% | 0 |
| | 2 | 9% | 3 |
| | 3 | 41% | 14 |
| | 4 | 47% | 16 |
| Exceptional | 5 | 3% | 1 |
| No comment | | 0% | 0% |
| Total | | 100% | 100% |

34. Do you have any useful case studies/project examples that could be used to widen knowledge in this area?

- See *Risks and realities* – produced by Center of Advanced Engineering for Chch Engineering Lifelines Group – covers Lyttelton, Port of Lyttelton Inner Harbour Rd.
- Recent flood events have been successfully managed. Our local road network has few elements that are considered to be lifelines.
- No, but in August 2004 flood event we utilised 20 contractors and all roads were passable within 24 hours.
- No. We have informally assessed the hazard risk to our roading network and appreciate that there is some risk in the event of a catastrophic event, but consider this risk/severity to be low, hence our low level of addressing this.
- The February flood event is a real live case.
- STDC responded well to recent Waitotara floods (Feb 2004). Repairs to roads \$3.5m.
- Floods of 2004.
- Major flooding events.
- Cyclone Bola.
- Our response to the February 2004 storm.
- Franz Josef Hazard identification studies. Work on state highway hazards – WDC totally dependent on SH resilience for recovery

Appendix B: Contents template for asset/activity management plans

The following list of headings and sub-headings is recommended as good practice for an activity or asset management plan. In relation to the activity management plan templates now in common use, a separate appendix (risk is currently included in an appendix with assumptions) is recommended. Finally, a summary should be carried forward to the LTCCP.

Introduction and strategic context

- Risk context – organisational, and include CDEM Act requirements, CDE group plan and relationships, lifelines group/project status and outputs
- Risk identification process – include reference to natural and technological hazards, including hazards information/studies, and the concept of critical assets
- Analysis – include reference to AS/NZS 4360 procedure and terms

Risk register

- Risk type and hazard events
- Description of each
- Impact on critical assets (at least)
- Interdependencies with other utilities (both ways)
- Impact on community
- Rating and priority
- Controls, in place and planned (4 'R's)
- Actions or improvements proposed

Contingency plans

- Emergency response plan
- Business continuity plan
- Disaster recovery plan

These may not necessarily be included here, but should where they are held, any current issues, and who is responsible, should be described

Outputs

- Summary table of critical risks and mitigation/control measures (4 'R's)
- Plan showing priority/strategic routes for recovery, key facilities and deficiencies. Identify whether transit or local roads
- Risk investment strategy (capital)
- Maintenance and renewal implications.

Appendix C: Emergency routes example

