



Exercise Ruaumoko - Report of the Economic Workgroup: Assessment of the Impacts of a Volcanic Eruption on the Auckland Economy



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1. Executive Summary

Much of the central Auckland metropolitan area sits above an active volcanic field. Forty-nine eruptions have occurred in the past with Rangitoto being the most recent, estimated as being 700 years old. As the Auckland region comprises one third of New Zealand's employees and is responsible for one third of gross domestic product, the impacts of such a natural disaster are likely to be catastrophic to the region's and nation's economies.

Preparedness for such an event is largely untested, and a large civil defence emergency management exercise – Exercise Ruauumoko - is to be undertaken in March 2008 to test New Zealand's all-of-nation arrangements for responding to a major disaster resulting from a volcanic eruption in Auckland.

An integral component of this exercise is to better understand the economic impacts and to explore techniques and processes which assist in minimising those impacts and ensuring an efficient and speedy recovery process. For the purposes of the project and to enable quantification of the impacts, it was assumed the volcano will erupt in the vicinity of Mt Eden.

The overall approach was aimed at engaging with a sample of Auckland's business community ("Business Group") to provide their views on the impacts of such an event on their businesses and sectors. The Business Group also outlined mitigating responses or interventions they and the wider community could undertake to minimise the impact, and to minimise the time it would take for the economy to recover from a volcanic disaster.

The information provided by the Business Group provided one of the inputs into an Economic Futures Model developed by Market Economics Ltd. This model analysed and quantified the economic impacts of the event on the Auckland and New Zealand economies. It then assessed how these impacts could be minimised by the application of the mitigating responses suggested by the Business Group.

The Market Economics model anticipates that the Auckland region would suffer a 47% reduction in gross domestic product (GDP), but this could be reduced to 40% by the application of business mitigation responses. The rest of the North Island, together with the South Island would benefit somewhat from the relocation of some displaced businesses to their regions, with an estimated 3% increase in GDP. Overall, this results in a 14% decline in GDP for New Zealand, and with industry response this could be reduced to 12%. Such a reduction would therefore be felt throughout the country.

The consequences will be more severe to New Zealand than those of the great depression in the early 1930s when negative economic growth rates peaked at -7% across the nation.

Employment is expected to reduce by 268,000 jobs being lost (48% of total) in the Auckland region, although this could be reduced to 221,000 (39%) by applying mitigation responses. This will result in a 14% fall (237,000 jobs) in employment counts over the whole country, or an 11% fall (190,000 jobs) with proactive business mitigation response.

Further reductions in the impacts are likely with a concerted campaign of preparedness, and with more comprehensive mitigation arrangements put into place.

The Business Group acknowledges the serious impacts and believes these can be reduced by the adoption of a more aggressive approach to risk management planning and processes by businesses themselves. Many acknowledge for example the absence of business continuity plans in a large proportion of Auckland businesses. All businesses, large and small have a role to play and individual resilience is a key component of such a programme.

It was also identified that the disruption to engineering lifelines would provide the single biggest constraint for the recovery of business, and that government intervention will be critical in coordinating and integrating the recovery effort.

2. Introduction

2.1 Background

In 2005 the government directed that two national-level disaster preparedness exercises be held to test the nation's arrangements for responding to major disasters. Exercise "Ruaumoko" is the name given to the second of these exercises and is based around a volcanic eruption occurring in Auckland. Its aim is to test New Zealand's all-of-nation arrangements for responding to a major disaster resulting from a volcanic eruption in Auckland. Preparation for this exercise has been comprehensive, with the main exercise phase in mid March 2008.

The impacts of such an event would clearly be catastrophic for Auckland and would impact upon a wide range of sectors. Hurricane Katrina in New Orleans and the Boxing Day Tsunamis in Asia have demonstrated how significant the economic consequences of large scale natural disasters can be.

To test arrangements for Ruaumoko, a number of sectors are included in the exercise, one of which is the Business sector or theme.

The Auckland economy is dominant within the national context, contributing \$44 billion to the national economy of \$130 billion in terms of Gross Domestic Product (GDP). Any major disaster in Auckland, such as a volcanic eruption, tsunami or tropical cyclone, has the potential to cripple the NZ economy.

This report addresses one of the three function areas within the business theme – that of assessment and management of the economic effects and in particular the effects upon business. It assesses and quantifies the economic impacts a volcanic eruption may have upon businesses and mitigating responses businesses may undertake to reduce the impact.

Because of the sheer quantum of businesses and business sectors in Auckland – there are 48 core sectors, many of which have limited sector representation mechanisms – it is not possible for this exercise to include them all. The approach has been one of working with a sample of 10 sectors as a "pilot" group. The Auckland CDEM Group may wish at some future time to extend this study to cover a more comprehensive range of businesses.

2.2 Objectives of Project

The aim of exercise Ruaumoko is to test New Zealand's all-of-nation arrangements for responding to a major disaster resulting from a volcanic eruption in Auckland. A component, and the subject of this report, is to manage the potential economic impacts of such an event.

The overall economic workstream objective is:

"To understand the impacts and develop a process which assists in ensuring rapid recovery and continuity of the NZ and Auckland economies in a volcanic emergency including:

- Determining and developing effective relationships for response
- Understanding the potential impacts
- Determining the appropriate sector response actions, including:
 - Communication of key messages

- Reporting processes
- Understanding the processes to reinstate the economy”

In carrying out work to achieve this objective, specific consideration is to be given to:

- Business continuity capability of the Auckland Business sector
- Effect on the national economy
- International economic confidence and relationships
- Tourism

3. Volcanoes in the Auckland Context

The Auckland isthmus is sited above an active volcanic field. Instead of erupting from one established cone the Auckland field tends to erupt at a different location within the field with each new event. During the 140,000 year lifespan of the field, there have been 49 volcanoes within a 20km radius of Auckland City¹. It is likely that the Auckland field has a lifetime of 1 million years, so it is estimated that there are many eruptions still to come. Although there is no fixed return period, eruptions occur every few hundred to few thousand years. There is about a 5% likelihood of another eruption within the next 50 years.

The most recent eruption was that of Rangitoto, the largest in the field, which erupted about 600 years ago. There is some evidence which suggests that there is a trend of increasing size of eruptions, but there is no scientific information on where the next eruption will occur, so predicting the timing, location and size of the next eruption is difficult.

Although it is not possible to predict its location, it is anticipated that there will be some warning signs. There are likely to be a series of earthquakes associated with moving magma in the days or maybe even weeks leading up to the volcano. These earthquakes will become stronger and more frequent as the magma rises, and thus there is the possibility of generally identifying the surface location, utilising the region's network of seismometers which monitor earthquakes, the closer the magma gets to the surface.

The warning period prior to the eruption is likely to be short (from a few days to a few weeks). In the last few days prior to the volcanic event, earthquakes to Mercalli Intensity 6-7 (i.e. causing slight to substantial damage), uplift and ground deformation are likely within 3-5 km of the vent. Once the volcanic event commences in earnest, complete devastation is likely within 1-3km of the vent resulting from eruptions, explosions, and lava flows.

In terms of the actual physical effects of an earthquake, the following table summarises the likely impacts and their location.

	0-3km	3-5km	5-7km	7+km
Pre-event	Earthquakes	Earthquakes		
	Uplift	Uplift		
	Ground deformation	Ground deformation		

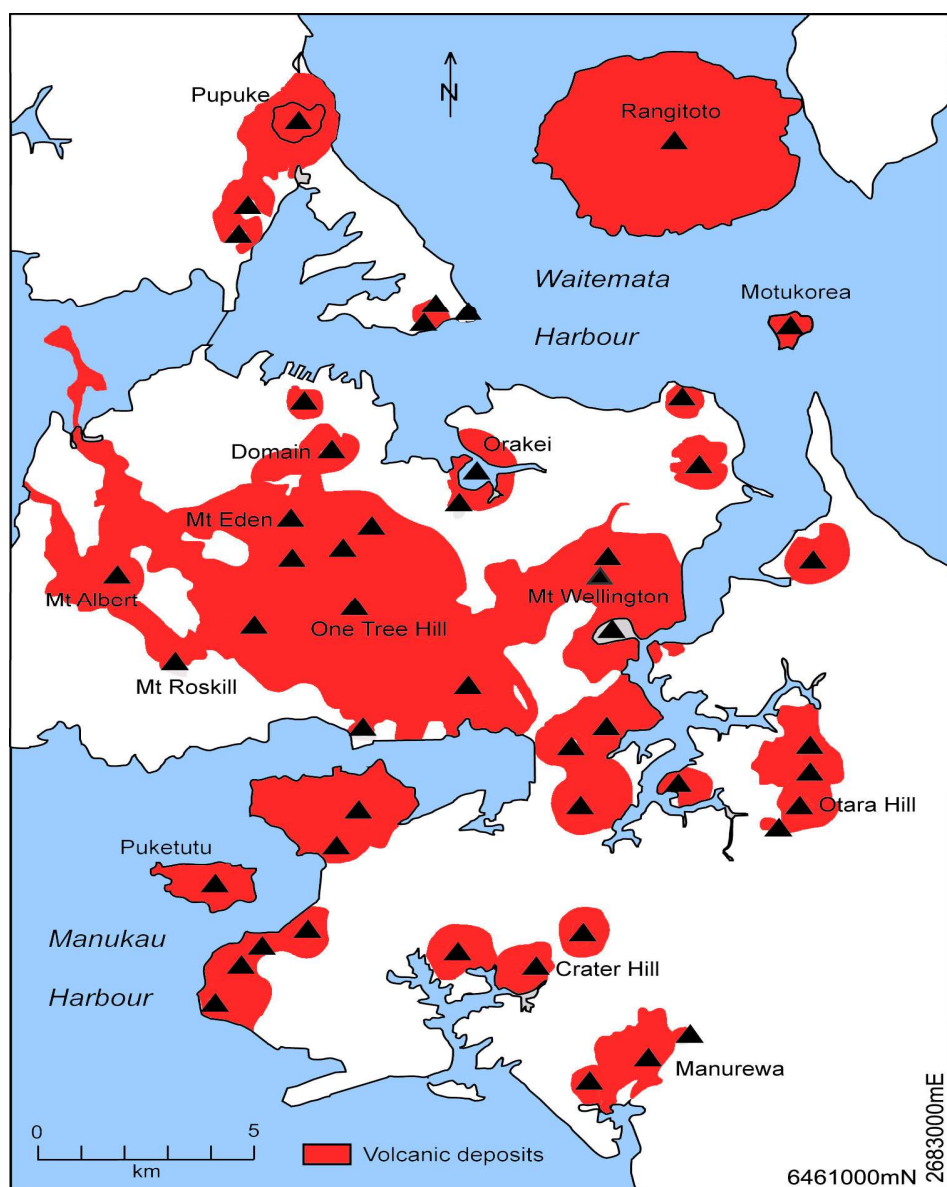
¹ Smith, I.E.M & Allen, S.R., *New Zealand's Volcanoes: Auckland*, Department of Geology, University of Auckland. <http://www.gns.cri.nz/what/earthact/volcanoes/nzvolcanoes/aucklandprint.htm>

Event	Ashfall	Ashfall	Ashfall	Ashfall
	Lava flows	Lava flows	Lava flows	Lava flows
	Fires	Fires	Fires	Fires
	Toxic gases	Toxic gases		
	Eruptions			
	Explosions			
	Base surge			

Table 1: Summary of Likely Impacts of a Volcanic Event in Auckland

The extent and location of the Auckland volcanic field is shown on Figure 1 below.

Figure 1: Location of the Auckland Volcanic Field and Spread of Volcanoes



Map Courtesy of Louise Cotterall University of Auckland

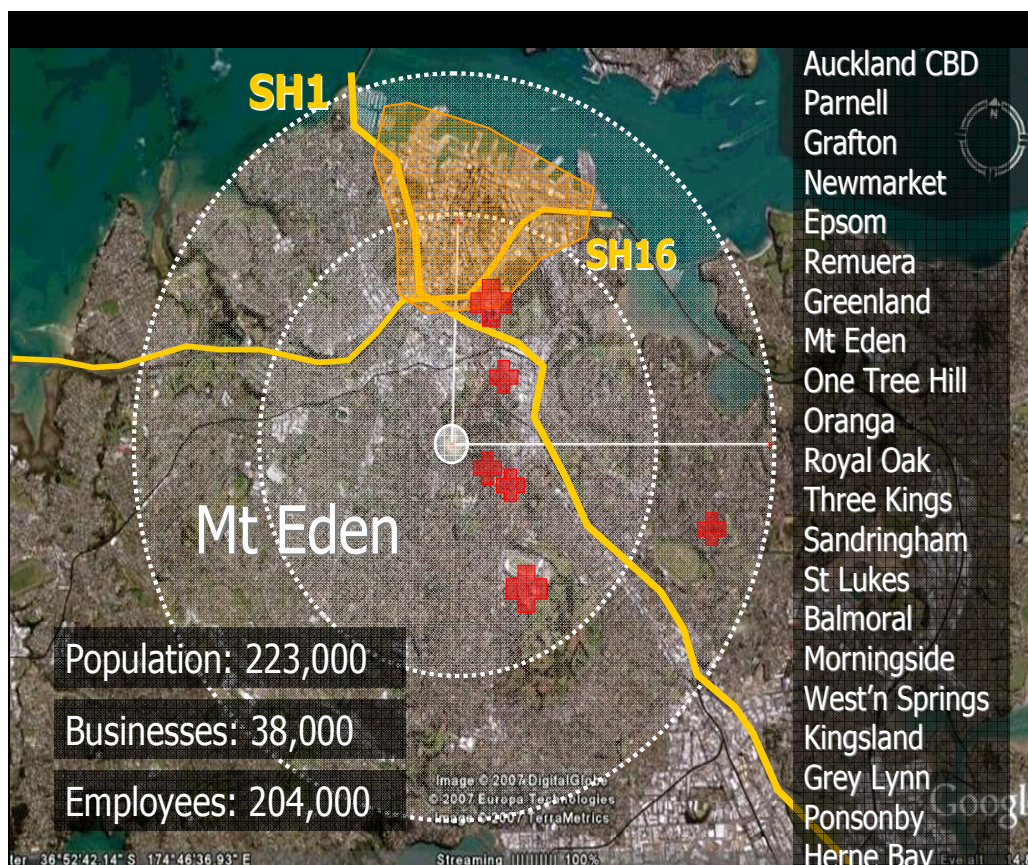
For the purposes of Exercise Ruaumoko it is assumed that there will be a 3km-radius 'devastation' zone around the volcano. It is also assumed there will be a 5km-radius evacuation zone in advance of any eruption, in line with the Auckland Volcanic Contingency Plan.

The impacts however will be felt over a much wider area than a 5 km radius. The impacts on the business sector and the economy are discussed in detail in Section 5 below. For the feedback from the Business Group to be quantified and for the model to function effectively, a particular location for the volcano needed to be determined, so it was decided that a worst case scenario would be adopted: a volcanic event centred at Mt Eden (see Figure 2 below). This in no way reflects the location of the volcano in the wider Exercise Ruaumoko which will only be revealed as the exercise unfolds and when volcanic activity starts to "occur".

If an eruption was to occur in the vicinity of Mt Eden, the following consequences could be experienced:

- 200,000+ residents displaced
- 40,000 businesses disrupted – close or business continuity arrangements
- 200,000+ employees affected
- Hospitals and medical facilities shut down
- SH16 and SH1 roads closed and possible closure of other major arterial roads
- Widespread disruption of infrastructure: power, water, gas, telecommunications, etc

Figure 2: Mt Eden, Devastation and Evacuation Zones, Impacted Areas and Consequences



4. Methodology/Approach

4.1 Overall Approach

The overall approach was aimed at engaging with representatives of Auckland's business community (the "Business Group") to provide their views on the impacts of such an event on their businesses and sectors. The Group also outlined mitigating responses or interventions they and the wider community could undertake to minimise the impact, and to minimise the time it would take for the economy to recover from such a disaster.

The information provided by the Business Group provided one of the inputs into an Economic Futures Model developed by Market Economics Ltd. This model analysed and quantified the economic impacts of the event on the Auckland and New Zealand economies. It then assessed how these impacts could be minimised by the application of mitigating responses suggested by the Business Group. The workings of the model and results are key to the project and are discussed in following sections.

It was considered impractical to cover the whole Auckland business sector in the project, which would conservatively involve 48 sectors, and would be a massive undertaking. This type of project had never before been attempted in the Auckland region, and so it made sense to limit the size of it. This "pilot" project provided the opportunity to test the methodology and assess the results, helping to develop an understanding of the impacts and to develop a process to assist in ensuring rapid recovery following a volcanic event.

Because of the interconnectedness of the various sectors, it was envisaged that the results coming from this project would be able to be used by other sector groups leading up to the wider exercise.

4.2 Sectors involved

Participants representing the following businesses or sectors were involved in the project:

- Construction
- Small to Medium Enterprises (SMEs)
- Tourism
- Engineering Lifelines (e.g. telecommunications, water, electricity, gas, etc.)
- Manufacturing
- Banking
- Insurance
- Land Development
- Fast Moving Consumer Goods (FMCG)
- Auckland Employers and Manufacturers Association (EMA)
- Regional Economic Development (Auckland Plus)
- Government Agencies

4.3 Workshops and Questionnaires

A series of workshop were held with business representatives from October to December, 2007. In these workshops the following process was followed:

- Participants were presented with the background scenario for Ruauumoko including the consequences of a volcanic event in Auckland.
- Detailed feedback was sought about the geophysical and economic impacts on their businesses and sectors.
- Feedback was sought on planned or potential mitigating responses or interventions to minimise the impact, and to minimise the time for the region to recover from such an event.
- A questionnaire was circulated seeking detailed information by business/sector on business location, timing, and relocation options. This was supplemented by questions on business continuity planning (BCP).
- This feedback was fed into, and augmented the Economic Futures Model to quantify the effects on both the regional and national economies. The results were relayed back to the participants for discussion.

4.4 Economic Projection Model Methodology

Market Economics Limited developed the Economic Futures Model to identify the economic impacts, using geophysical information provided by Exercise Ruauumoko, and economic information obtained from Statistics New Zealand. The study was augmented with feedback and comments by industry representatives during Exercise Ruauumoko workshops, and through their responses to questionnaires. This allowed a comparison between a status quo 'Business-as-Usual' scenario, and two volcanic event scenarios, (1) without businesses taking steps to mitigate against the impacts of a volcanic event on their business, and (2) with businesses taking steps to mitigate against the impacts of a volcanic event.

4.4.1 Definition of Time Periods, Zones and Sectors

- **Time Periods**

This study analyses only the impacts generated during the first year of the volcanic event². For the purposes of this study, the year of the volcanic event was split into five distinct time periods: pre-event, event, immediate, short-term and medium-term. These time periods were based on Exercise Ruauumoko directives. The 'pre-event' period is defined as the 10 days immediately prior to the volcanic event, during which the 'warning signs' of a volcanic event are likely to be experienced. It is anticipated that during this period people will become anxious, and will be evacuated. It is assumed that no loss of life will ensue. Next, the 'event' period is defined as the 30 day period, during which volcanic activity takes place. It is anticipated that almost all economic activity within a 7km radius of the volcano will cease, as residents are evacuated, and businesses close. The 'immediate' period is defined as the 14 days immediately after cessation of volcanic activity. During this time period, it is

² The Reserve Bank of New Zealand is undertaking a study of the long-term monetary and fiscal impacts of a volcanic event.

anticipated that economic activity will be low in most sectors due to large-scale destruction, and fear of further volcanic activity. This period is followed by the 'short-term' period, which encompasses the next 128 days. Many businesses will be able to take actions to recommence operations during this period, whether at their usual place of business, or at another location. The final time period analysed in this study is the 'medium-term' period. This is defined as the next 183 days (i.e. the next 6 months), which completes the year. Most businesses are assumed to gradually re-establish themselves during this time.

- **Zones**

The intention of this study is to demonstrate the expected economic impacts of a volcanic event located in Auckland. To commence the study, a decision was made to locate the hypothetical volcanic event at Mt Eden. This location was chosen as it encompasses the Central Business District (CBD) of Auckland. Note that other locations may result in different outcomes.

Background information for the Exercise provided the basis for a qualitative assessment of the intensity of the likely effects of a volcanic event. Five zones were used to capture the spatial distribution of the direct economic impacts: 0-3km, 3-5km, 5-7km, the rest of the Auckland Region, and the rest of New Zealand.

- **Sector Coverage**

The 6-digit ANZSIC (Australia New Zealand Standard Industrial Classification) level data was aggregated to 48 industry sectors, in order to feed it into the Economic Futures Model. This data was further aggregated to 21 industry sectors, for reporting purposes. This was undertaken by grouping industries with similar characteristics together, and eliminating those industries which were not present in the study area. See Appendix A for the concordance between the 48-level and 21-level industry classifications.

4.4.2 Data and Information Sources

- **Employment Data**

Market Economics Limited sourced employment data from Statistics New Zealand's Business Directory. Employment data is measured in employment counts, which is the total number of people employed, including both full-time and part-time employees.

- **Gross Value and Value Added Data**

Gross value and value added data was sourced from Market Economics Limited's proprietary Economic Futures Model.

- **Business Responses**

Business feedback and responses were documented in the form of the completed impacts and responses questionnaires, and minutes from Exercise Ruaumoko workshops.

- **Geophysical Impacts**

Background information describing the likely geophysical impacts of a volcanic event was integrated into the model. This background information was sourced from the Exercise Ruaumoko slides and presentations, and is summarized in table one (see section 3).

4.4.3 Methodological Sequence

The aim of this study was to calculate the impacts of a hypothetical volcanic event by zone and by time period. A Geographic Information System (GIS) was used to break down the zones (0-3km, 3-5km, 5-7km, Rest of Auckland, and Rest of New Zealand) by industry sector. Employment count data was then applied to calculate the gross output produced per employee, in each sector. In order to calculate the direct effects of a volcanic event, the gross output per employee was broken down, according to the Effects and Relocation Matrices. This enabled an estimation of the gross output per employee per time period (e.g. during the 'immediate' period), and gross output per employee per zone (e.g. in the Rest of Auckland).

Step 1: Scenario Development

This study analyses the economic impacts of two volcanic event scenarios, compared to the Business-As-Usual scenario (in which there is no volcanic event). The first volcanic event scenario, "Event Without Response", is one in which businesses are not prepared to cope with a volcanic event. They are assumed not to have taken precautionary or mitigating measures. This first scenario is based upon an initial Exercise Ruauumoko workshop held with a selected group of industry representatives (the Business Group)³, and the Exercise Ruauumoko background information.

The second volcanic event scenario, "Event With Response", is one in which businesses are assumed to have taken some mitigating actions, to reduce the impact of a volcanic event on their business activities. For example, businesses may regularly update their business continuity plan (BCP), maintain lists of their customers and suppliers, and lists of alternate suppliers. They may form alliances with competitors to help each other in times of need. Large businesses may also spread their operations around the country, enabling one branch to take on the work of another, in an emergency.

The "Event With Response" scenario is based upon two subsequent Exercise Ruauumoko workshops with industry the Business Group, and a detailed impact and response questionnaire that they completed. Both volcanic event scenarios also drew upon the geophysical and economic data. Appendix B provides a fuller description of the three Scenarios: Business-As-Usual, Event With Response and Event Without Response.

Step 2: Estimation of Direct Economic Impacts

Having developed the 'Event With Response' and 'Event Without Response' scenarios, matrices were constructed to quantify the anticipated economic impacts of a volcanic event on each industry sector. Two matrices were drawn for each scenario: the first matrix sought to quantify the effects of a volcanic event on gross output, and the second matrix sought to determine the zones to which displaced businesses may relocate to.

The Effects Matrix estimates the proportion of normal output produced by 21 aggregated industry sectors, within each time period, and within each zone, given a volcanic event takes place. The numbers within the matrix represent the proportion of normal output that is anticipated. For example, '0' represents 0%, '1' is 0-20%, and so on, up to '6' which represents 100%. As this study assumes that the 0-3km zone is completely destroyed and the 3-5km zone evacuated and therefore closed to business in the interim, any output produced by businesses originally from these zones must have been relocated. The 5-7km

³ This Business Group was continually used throughout the project.

zone is assumed to suffer a lesser degree of damage and destruction; therefore, some businesses will continue to operate from this zone, whilst others will relocate.

The Relocation Matrix estimates the zones (0-3km, 3-5km, 5-7km, Rest of Auckland, and Rest of New Zealand) to which displaced businesses will relocate. These are the businesses whose workplaces were damaged or destroyed by the volcanic event (i.e. all of those originally located in the 0-3km zone and some in the 3-5km zone). Two Relocation Matrices were constructed for each scenario: the first captures relocations within the pre-event to short-term period, and the second captures relocations within the medium-term period.

A series of appendices provides further detail on this step. Firstly, Appendix C describes the development of the Effects and Relocation matrices. Secondly, Appendix D summarises the development of the 'Event Without Response' matrices. Thirdly, Appendix E summarises industry representatives' responses from the questionnaire, which were used to create the 'Event With Response' scenario.

Step 3: Economic Futures Model and its Results

In this Step the flow-on economic impacts associated with the direct economic losses identified in Step 2 were assessed. These so-called 'multiplier impacts' capture supply chain impacts both upstream and downstream of a business along with any changes in consumer spending brought about by the event. These impacts were estimated using Market Economics Ltd's proprietary Economic Futures Model (EFM) of the Auckland Region economy. The Auckland Region EFM is a multi-regional input-output table capable of capturing not only the impacts of the volcanic event on the directly impacted area, but also impacts in the rest of Auckland, rest of North Island and South Island economies. Specifically, the EFM uses input-output mathematics to quickly evaluate the multiplier flow on impacts associated with the event.

The Economic Futures Model calculates the expected impacts of a volcanic event in Auckland on gross output, Gross Domestic Product (GDP), and employment. Gross output and GDP impacts are measured in constant 2004 dollars, while employment impacts are measured in full-time equivalent employment (FTEs). The model calculates the direct and indirect impacts realised in each region and time period, and for each scenario: Business-As-Usual, Event Without Response and Event With Response. It produces a range of graphs and tables depicting the economic impacts of the BAU scenario compared with the economic impacts of the volcanic event scenario, with and without industry response.

5. Results

The results are derived from the information provided by the Business Group in the workshops and the questionnaire, and from the modelling undertaken by Market Economics Limited. This section deals firstly with a discussion on the impacts of a volcanic eruption located in the vicinity of Mt Eden. It also includes a discussion on the mitigating responses suggested by participants of the Business Group, to reduce the impacts on the economy, and to reduce the time taken for the economy to recover. This is followed by a presentation of the results of the economic modelling exercise described above.

5.1 Impacts and Mitigating Responses

5.1.1 Overview

In general, the economic impacts are likely to be very severe, and lead to widespread disruption of the regional and national economies. This would impact upon other sectors such as the increased requirement for social services. The Business Group believes the business sector is integral to recovery from a major volcanic event and should be afforded a high priority in any government recovery support programmes and initiatives.

Businesses understand the need for individual resilience in emergency situations, and many are well prepared for small scale emergency events such as an electricity outage. However, there is general agreement amongst the Business Group that no amount of preparation could completely protect an individual company from the widespread devastation caused by a significant volcanic eruption in the Auckland region. Preparedness measures can minimise the damage to businesses and assist in the process of reinstating business and the economy. These measures may be undertaken by the businesses themselves, as well as other agencies, particularly government agencies, which will have an important role in coordinating and integrating economic recovery efforts.

Within the devastation zone businesses are expected to suffer severe physical damage to their premises, and depending upon the type and size of business, may not be able to continue operating. Larger organisations, such as banks, may be able to transfer services to other branches, as their data is backed up in centralised locations. However, this is dependent upon key lifelines such as Telecom being able to provide increased services to alternative locations at short notice. Smaller businesses (for example hairdressers, retailers, etc.) are usually reliant on local customers and are likely to have to close completely, as their business is not easily transferable.

Loss of business within the evacuation zone (3-5km) is likely to be temporary, although some forced closures may occur. The key issues in this case are how quickly they can be returned to their premises, the degree of stability in their customer support base (given a potential change in spending priorities), and whether the business is able to survive for an extended time without operating, given that many fixed costs such as labour, interest, and rent will still be incurred. Again, it was the view of the Business Group that larger businesses would be more able to survive this scenario, as they tend to have greater resources and often the ability to move operations elsewhere, such as to works depots.

The exercise scenario assumes a 3 km radius devastation zone, and a 3-5 km radius evacuation zone, from the volcanic event. Because of the interconnected nature of the business community, both within the affected region and on a national scale, the impacts of a volcanic event are likely to be felt by all businesses throughout New Zealand, to some extent.

For example, changes to supply chain connections would impact upon manufacturers, wholesalers and retailers, as well as household consumers. Consumers' spending patterns are likely to change following a volcanic event as they reprioritise their spending.

There is also a general view that business confidence could fall following a volcanic event. This could be exacerbated by a lack of firm leadership, and slow response to restore engineering lifelines. Services, especially banking and insurance providers must also respond in a timely manner to avert loss of confidence.

Some businesses are likely to perform strongly after such an event, particularly those associated with the rebuilding programme, such as construction, finance and insurance sectors. However, the finance industry may be adversely affected if loans are defaulted.

There were a number of themes which developed out of the workshops and questionnaires. The impacts and mitigating responses are summarised in the following sections under these themes as a means of organising this information.

5.1.2 Infrastructure - Engineering Lifelines

The reduced or unavailability of engineering lifelines across the region is considered by the Business Group to have the greatest impact on their ongoing operation. Any volcanic eruption at a key location, such as Mt Eden, is going to severely impact upon the ability of the region's businesses to operate. This includes transport (the motorway network, arterial roads and local roads, port and airport), telcos (telecommunications, radio and television network infrastructure), electricity, water (sewerage and water supply), and fuel supplies.

All of these are vital to the functioning of the business community. A key concern is the lack of flexibility in some lifelines – if one part of the network is disabled, the whole network is disabled.

An example of this is Auckland's motorway system. This provides for strategic routes into and through the metropolitan area, but is reliant on the Southern Motorway which would be particularly susceptible if a volcanic eruption occurred in the vicinity of Mt Eden. Although work is underway on constructing the western bypass motorway, this is approximately 10 years away from completion. The whole region is dependent upon the southern motorway, which is critical for the delivery of products and raw materials. This vulnerability is a key reason why the western motorway network should be completed.

Similar vulnerability has been revealed in the past with the electricity crisis, and with the water and sewerage trunk lines. These would be most severely affected with a Mt Eden eruption scenario, this being a very strategic location through which much of the region's key network infrastructure passes. Similar vulnerability exists with fixed infrastructure such as the port and airport, so contingencies such as availability of Hamilton airport, should be considered.

The Business Group is aware that Auckland Engineering Lifelines Group provides a platform for disaster management of lifelines. From the Group's perspective an important part of the planning for exercise Ruaumoko is to ensure that consideration is given to identifying alternative networks, and to prioritising the use of these in a volcanic event. Although there is no motorway alternative, there are existing arterial roads, the use of which could be set aside for emergency purposes and for access to and from businesses. Similar considerations could be made to providing alternatives for ports, fuel supplies, and electricity.

The need for backup should be taken into account when prioritising expenditure on such infrastructure. Small business representatives for example, emphasised the important role eftpos now plays in all transactions. They highlighted the chaos which can occur to the continued operation of retailing when this system breaks down at present, and believe they will not survive for long without this facility. Because of the breakdown in this network, businesses well outside the devastation and evacuation zones will also be impacted.

An issue for reinstatement of infrastructure is the speed with which it is reinstated to its prior capacity. The Business Group believes that reinstatement of key lifelines is vital for their survival and should be accorded high priority in any recovery initiatives. Feedback from some of the lifelines agencies reveals that they are very well organised in terms of business continuity and disaster management planning, with active and regular exercising, and with most of the key agencies being members of the Auckland Engineering Lifelines Group. There are some exceptions to this, and efforts should be made to ensure there is full representation on the AELG.

In addition there are some agencies that are not included in the AELG movement but whom the Business Group believed should be considered for inclusion – this includes the banking industry which will be critical in providing credit for the renewal of lifelines.

5.1.3 Finance

The availability of credit will determine whether or not many businesses will be able to continue operating. Many larger businesses, such as in the banking or insurance sectors, have ample credit in place to be able to pay staff, suppliers etc.

However, in the case of SMEs, it is apparent that this may not be the case. SMEs comprise 80 - 90% of the region's businesses. Many of them do not have large reserves of cash to support them in times of hardship. Reflecting the economy, a majority of the SMEs are in the service industry – for example, motor vehicles, tourism, personal care, retailing businesses – so loss of customers will lead to an inability to pay wages, and to pay suppliers and rent and other expenses. This will have a ripple effect throughout society and the economy.

Many of the Business Group referred to the need for access to finance, and the government's role in this. For example, the Reserve Bank may need to prop up the New Zealand Dollar to prevent a major fall, as a declining purchasing power could lead to significant cost increases in imported goods (especially fuel and reconstruction materials). There may also be a major movement of capital out of the country. The Reserve Bank also has a key role in protecting the integrity of the finance industry, and may need to introduce credit policies at a national level. It may need to intervene, to prevent a fall in New Zealand's credit rating, as this could make it difficult for businesses to obtain access to finance.

Some businesses/sectors may default on loans etc soon after the event. An emergency benefit is vital and a process for providing emergency finance needs to be set up in advance so that businesses can readily get up to speed with what support is available and can commence the process almost immediately.

If there is any fall in the NZ dollar, this will affect imports - especially those needed for the economy to be kick started. The business sector is heavily reliant on imports, including for food – half of all food (including ingredients) is imported.

The Business Group also considers there is an issue of the general public not having access to money. Thus with reduced circulation of money, there will be a consequential downstream reduction in business throughout the region.

In respect of the banking industry, apart from ensuring the sector itself is in good shape, there will be a huge demand for access to funding for rebuilding or to provide temporary funding for businesses to be able to continue operating. Banks and other funding agencies

should ensure they have available to them lines of credit to fill this vacuum should a major disaster like a volcanic eruption occur.

Cash is likely to become king as business either cannot manually transact payments, or are unprepared to accept payment mechanisms such as manual processing of eftpos which will entail a degree of credit being granted to the customer until such time as the bank can manually process the transaction.

If the CBD is closed – part of it is within the devastation zone and all within the evacuation zone – this will have major impacts. The banking industry can survive without some of its branches, but without head offices in the CBD the situation may become much more severe.

Note that banking is driven by behaviour in other sectors, so it is likely there will be a surge in activity as warnings are made. A surge may lead to overload of facilities and potentially a breakdown in some services.

The construction industry advised that it would need financial relief from conditions of contract for existing jobs, in order to transfer staff, plant and machinery resources to undertake construction in the rescue, recovery and rebuilding phases. Further compensation may need to be provided to the owners of these existing contracts, as their work will not be completed on time. This financial relief may need to be facilitated with support by the government.

5.1.4 Insurance

It is important that businesses are fully covered by insurance, although the insurance sector believes this is not the case. It is equally important that the insurance sector is prepared for the huge number of claims which will occur given the exercise scenario. A major complaint from claimants from disasters both within and outside NZ has been that it has taken far too long for claims to be processed, and in turn the speed with which the recovery of the economy is slowed considerably. The insurance industry should be geared up to process claims as fast as practicable.

Generally, the three major players in the insurance sector all regularly update and exercise their Business Continuity Plans (BCPs). However sector representatives believe under-insurance is common.

Businesses can reduce the financial consequences of a volcanic event by keeping insurance policies up to date (e.g. stock, property, health, and business interruption insurance).

A related issue is that insurance costs (premiums) are likely to increase after a major event such as the Exercise Ruaumoko scenario.

5.1.5 On-going Availability of Staff/Skills

The on-going availability of staff to enable businesses to continue operating is of concern for the Business Group. It is anticipated that there is the potential that some staff will be lost completely from the work force (assuming some decide to leave Auckland altogether, decide to not re-enter the workforce after temporary closures, or may perish in the devastation zone), some will be evacuated to other parts of the region or country, albeit temporarily, and some staff will become unavailable due to these staff assuming other responsibilities. This could include caring for children if schools are closed/temporarily shut down, caring for other

members of the family, moving or repairing their own homes. Many are also likely to suffer trauma, and find they are unable to work. Trauma counselling for staff and some business owners would need to be available. The appropriate government agencies need to be prepared to facilitate this type of service.

A related issue raised by the Business Group was that of availability of the appropriate skills in the rebuilding phase. This has the potential to slow down the recovery phase, as companies strive to rebuild their businesses. The skills needed are likely to be different from those of normal operations and in some sectors, eg construction, many additional staff are likely to be needed.

A key role of government agencies will be to facilitate and co-ordinate the movement of appropriate skills from elsewhere in the country, or maybe even from overseas when specialist skills not available within NZ are needed. This may necessitate a change for example in immigration rules to encourage the right immigrants. There is likely to be a need for emergency training programmes to provide the skills needed for the re-building phase.

5.1.6 Public Information Management

The Business Group believes that management of information relating to a volcanic emergency is critical in minimising the impacts and in maintaining and rebuilding businesses and the economy. It is important that the provision of information must be accurate, deliberate, planned and sustained, and should be geared towards ensuring that the community, customers, suppliers, investors and financiers have confidence that the Auckland and New Zealand economies can recover.

If this does not occur, there is concern that perception may take over to the detriment of the business community. For example 35% of all tourists to New Zealand pass through Auckland. Although tourist facilities such as hotels may be diminished in Auckland, there will be a need to actively counter the perception of the danger to tourism in New Zealand. The world media may portray the problem being worse than it actually is. Past experience (eg the Ruapehu eruption) with such events tends to paint a picture that much greater areas of the country are physically affected than the reality. This has the potential for example to affect the wider tourism industry in NZ, and cause a downturn in visitor numbers.

Other impacts may include the loss of markets as there is a perception that New Zealand companies will not longer be able to supply goods, or suppliers may perceive that New Zealand companies are no longer able to finance imports. Of particular concern could be the impact on financial markets, and the perception of the robustness of the nation's economy after such an event. Credit may no longer be freely available to businesses for the re-building phase as risk is perceived to be higher, and the New Zealand currency may be significantly undermined.

Although businesses can manage some of the lower level information flows for example to their suppliers and customers, it is the larger regional scale information flows that are of concern to the Business Group. Management of this information flow is the role of local and regional government agencies. It is critical to managing and minimising the impact on the economy, and must be based upon excellent intelligence systems for gathering accurate information, and on business needs assessment processes.

This information will also be critical for government and other agencies determining how they prioritise their recovery planning and practice.

5.1.7 Tourism

Tourism was to be given special consideration in the project. Tourism was represented in the workshops by Tourism Auckland, although other agencies represented have relationships with the tourism sector.

Seventy per cent of New Zealand's tourists use Auckland International Airport as an entry point and one third visit Auckland. Most of the hotels are located within the CBD, so with the Mt Eden scenario the region's tourist hotels would be decimated as accommodation providers are not able to easily move their operations if they are located within the devastation or evacuation zones. Important sources of income for the industry and the region such as conventions would need to be relocated. Often these are booked five years in advance.

Much of the tourist industry are SMEs, and as such will suffer the range of impacts as other SMEs will – for example few have business continuity plans, access to credit may disappear, and their financial viability will be at risk unless visitor numbers return reasonably quickly and their business can soon be up and running again. Often the industry is under-insured. The industry is particularly vulnerable to the loss of key infrastructure, in particular the airport. The Business Group believed consideration should be given to the development of mitigating responses for these issues to reduce the impact upon the industry.

The tourist industry in particular will suffer from perception of the emergency overseas, and this is likely to lead to an immediate downturn in visitor numbers which may be difficult to build up again. A robust public information action plan, referred to in the previous section, is critical to the ongoing viability and long term recovery of the tourism industry from a major disaster in the Auckland region. Other incentives, such as the development of a BCP pack (see section 4.1.8), and arrangements for other airports such as Hamilton to take increased flights, are important.

Although the sector tends to “follow on” from others, there is a view that the high capability for earning foreign exchange for New Zealand should afford the sector some priority in the re-building phase.

5.1.8 Interdependencies (relationships)

There is a great degree of interconnectedness between businesses, especially in a small country, like New Zealand, and the synergies which could potentially be lost in the event of a volcanic disaster were noted. All businesses are dependent upon other organisations. For example, the construction industry is dependent upon the supply of steel, from NZ Steel at Glenbrook.

Although a business may be in a position to operate, dependency upon other sectors may prevent it from doing so. For example, if key sections of the transport network are not useable, staff may not be able to get to work, customers may be unable to reach the business, and suppliers may be unable to deliver goods. A shortage of fuel supplies may prevent the operation of machinery or vehicles. If some businesses are closed, (either temporarily or permanently), they may not be able to pay their staff, and consequently the amount of money in the economy may be reduced. This is especially likely to affect those businesses selling ‘non-essential’ goods.

The Business Group also recognised the relationships to other sectors, such as the provision of social services. For example, a failure in the provision of health and government services may impact the ongoing viability of the business sector.

Productivity may also be reduced, as staff choose to stay home to care for sick or injured members of the family, or to look after children because schools are closed.

In short, the Auckland business sector is likely to need assistance to withstand and recover from a major disaster. Most of the Business Group agreed that co-operation rather than competition is important in the recovery phase. For example, suppliers could support their customers by ensuring continued supply of goods, and by offering leniency on credit terms during the recovery period.

The service sector can greatly assist other businesses in providing services such as emergency childcare and care of disabled and elderly people, to enable parents to return to work and help restore business operations. Overall, the most important factor in restarting businesses after a volcanic event is the timely restoration of critical infrastructure.

It was suggested because of the sheer number of small businesses, a loss of many SMEs could reduce profitability and viability of other businesses, both large and small. Suppliers may need to change their supply chain processes, alter the volume or frequency of their orders, or increase availability of selected products, etc., in order to meet demand. Customers may request a copy of their supplier's BCP, to ensure that they have made plans to cope with a disaster. The suppliers are themselves reliant upon the ongoing operation of port facilities and critical road networks for the distribution of goods.

The Business Group believes it is essential that these interdependencies are recognised and provided for by emergency services, engineering lifelines, and government agencies when coordinating the emergency effort. A key role of these agencies will be to facilitate a cooperative and supportive approach to recovery of the business sector.

It was also recognised that business sector societies (e.g. associations, guilds, cooperatives, etc.) could facilitate support within their sector. Following a disaster, experienced practitioners always rank good relationships as the key to facilitating good outcomes, to prioritising allocation of resources, and to gaining support for recovery programmes. The Business Group recognises that the business sector as a whole needs to work on developing and maintaining such relationships, both within sectors and among sectors.

Some members of the Group were concerned about the relationship that businesses have with government agencies. It was acknowledged that some SMEs in particular tend to think that "the government will take care of things" in an emergency, and this is unrealistic. It is probably appropriate, however, for government agencies to work with sector "umbrella" organisations, such as the Employers and Manufacturers Association or Tourism Auckland, who can in turn communicate within their industry, to ensure integration of recovery efforts occur.

5.1.9 Business Continuity Planning (BCPs)

One of the most important steps that a business can take to minimise the impact upon it in a disaster is to develop a business continuity plan (BCP), and ensure that it is regularly tested and updated.

BCPs and/or disaster management plans (which deal with the consequences of a major disaster) were identified by the Business Group members as being critical to any business in minimising the impact of a volcanic eruption. Many larger companies and organisations, especially those with a risk management role (e.g. insurance companies, banks, etc.), or with large resource bases tend to maintain BCPs. Most of these businesses have the ability to relocate their businesses relatively easily. Many also have back-up databases in separate locations.

The SMEs involved in the Business Group indicated that BCPs are not prevalent in their sector, as they are considered onerous and time-consuming. The SMEs also said this is partly because they consider that it would be difficult and costly to design an effective BCP. As 90% of Auckland's companies are SMEs, it was identified that considerable benefit could be gained by developing and distributing a standard BCP template to SMEs around the country. Small businesses could then follow the format and apply it to their own business. This could be extended to include disaster management planning and recovery. Basic elements of BCPs should include:

- Critical functions, and timeframes in which they must be restored.
- Key staff members who are required to perform the critical functions, and where they should present themselves for work.
- Business systems and IT required to undertake these critical functions. (NB. A separate Disaster Recovery Plan may be documented, specifying service level agreements with suppliers of systems, reasonable downtime, timeframes for restoration of services, etc.)
- Manual workaround solutions to be activated, in the absence of systems and IT.
- Other business requirements (e.g. telephones, faxes, printers, etc.)

Other disaster management planning may also include:

- A list of contact telephone numbers for staff.
- A list of contact numbers for customers and suppliers.
- A list of alternative suppliers
- A disaster recovery site or alternative temporary location for the businesses.
- Emergency access to credit.
- Up to date insurance policies (e.g. income protection, stock, property, health, etc.)
- Records of stock.
- Stockpiling of emergency supplies. This generally does not extend to inventory, as modern supply chain practice requires low inventory levels and fast responses (i.e. efficient supply chains).

The Business Group considered that the Ministry of Economic Development (or another government agency) may be best placed to develop a BCP template. Such an initiative would need to be accompanied by a marketing campaign outlining the programme and its benefits.

5.1.10 Leadership

A theme which kept recurring throughout the workshops was that of the need for good leadership. It became apparent after discussion amongst the Business Group that many issues would arise which could only be resolved through leaders providing direction and displaying judgement and sound decision-making. The effectiveness of disaster recovery work in New Zealand and overseas usually is heavily dependent on the effectiveness of leadership.

This includes prioritisation for access to infrastructure and resources – for example it is anticipated that essential services such as hospitals will get access to resources first, and essential industries such as construction will also be afforded priority. Many businesses will be considered “low priority”, but in the long term they are essential in the functioning of the economy, locally, regionally, and nationally. Some thought needs to go into how to prioritise resource allocation, but not at the overall long term expense, or short term recovery of, the economy.

The business sector itself will need strong leadership, firstly to coordinate and communicate any recovery operations, but also to represent and advocate for the sector in the wider recovery effort.

Government (local and central) leadership will be needed if companies are contracted to provide services but are not able to due to the impacts of the volcanic eruption on their business or because higher priority sectors need access to the resource.

It will be important to determine priorities and allocate resources for supplies and services. For example many organisations may have service level agreements with the same contractors, but in an emergency the use of such resources needs to be prioritised according to need and not based upon which company requested assistance first or had the ability to pay most for the service. For example in the construction industry where penalties for non-performance of contracts is common, leadership was identified as being needed to assist in overcoming this issue.

Leadership will be needed at all levels affecting business. This will be at the individual business and sector levels, across all the business sectors, within engineering lifelines, and at all levels of government. The Business Group suggests that considerable resource be allocated in the exercise to developing a detailed understanding of the leadership issues and how they are developed and/or improved to minimise the impact on the region's economy.

5.1.11 Government

The government has an important role in the prioritisation of resource allocation in rebuilding business – sectors/businesses are likely to be able to do some of this within their sectors themselves, but it is considered that government support and direction, possibly through the Civil Defence Emergency Management Act provisions, will be needed. Also, prioritisation will have to be balanced against the needs of other sectors, for example there is only 2-3 weeks of food in supermarkets/warehouses in Auckland, so clearly this sector will need to be afforded high priority.

The government may be able to offer a form of tax relief or financial support to businesses during the recovery period, to enable the diversion of funds towards reconstruction of plants, buildings, etc. The Business Group also suggested that the government should be able to facilitate provision of temporary accommodation for businesses, and their staff and families during the recovery period. Further financial assistance from the government was also recommended to enable suppliers to cover the additional costs incurred in continuing to supply their products to the impact zones (e.g. where relocation of staff was required), and to assist with business continuance costs (e.g. wages for staff unable to work due to the volcanic event).

Besides financial support, the government could also promote economic recovery by projecting positive recovery images to the foreign media. This would help maintain foreign investment in New Zealand's economy, and encourage tourists to return to New Zealand.

Other suggestions included developing a business restart package, with a five year loan structure to enable businesses to relocate their operations to a new site, and to commence marketing and advertising. It was suggested that the Business School at the University of Auckland may be able to provide specialist assistance with the development of innovative ideas, and other assistance to enable business owners to work in, rather than on their businesses during the recovery phase.

The government may need to oversee an independent assessment of the cost of cleaning up and rebuilding, to mitigate against the risk of fraudulent activity. Priorities for reconstruction would also need to be determined, and the costs and benefits of reconstructing large buildings (e.g. schools and hospitals) which could exhaust supplies will need to be considered and balanced against reconstruction of commercial buildings.

5.1.12 Fast Moving Consumer Goods (FMCG)

FMCG are generally those goods purchased through supermarkets which are needed to keep people and communities going on a daily basis. FMCG are an important consideration when assessing economic impacts as on-going availability of food is critical to the successful recovery of all sectors, such as welfare, after a major emergency. Consideration of this sector also provides a useful insight into the interdependencies which exist amongst the various sectors.

A key issue which will create impacts in a volcanic emergency is that there are no large levels of inventory stock at either wholesale or retail levels. The sector operates on a “just in time” basis, with much of the food, such as fruit and vegetables being fresh. The major impact therefore revolves around continuing supply, there being around 3 – 4 weeks food in the “system”, with only 4 to 7 days directly available in stores. With a Ruauumoko type event there is a very real possibility that food supplies will run short. There is likely to be a huge run on food as people stock up when they consider there may be shortages.

With the two major players in the market – Foodstuffs and Progressive – having 90% of the market, any threat to their distribution centres in South Auckland may reduce their ability to maintain the supply food even for the current 3 – 4 weeks.

There are many complex and critical interdependencies with other sectors which will be critical in providing FMCG. These include infrastructure such as road transport continuing to be available, fuel supplies and electricity being available, customers’ ability to pay for goods and services, the ability to pay suppliers, distribution centres being unaffected by any disaster, and security being available to protect dwindling supplies. All other sectors are reliant on FMCG, and some, such as hospitals and other institutions, are reliant on daily delivery of large quantities of FMCG. There are also issues around supplying food to critical sectors, such as to hospitals and other institutions.

In terms of mitigation responses, the sector itself is well organised with good and regularly exercised BCPs. The critical nature of the sector is recognised and with early warning, which is likely in a volcanic eruption, the sector can organise itself and implement provisions in BCPs, such as ensuring alternative locations are available for distribution, and managing panic buying. There is also a large mitigation role to play for civil defence emergency management organisations. This includes providing good communications to the public on food availability, distribution and location, encouraging building larger scale inventories through individual households providing for their own needs for a longer period than most can do at present. CDEM groups also need to be in the position to prioritise access to dwindling supplies of food. Providing emergency access to finance to purchase food is also

critical given the likely huge job losses in Auckland which will be created by a volcanic eruption.

5.2 Modelling of Impacts and Responses

The graphs and tables in this section demonstrate the overall effect of a volcanic event in Auckland, by time period and by region. In summary, they infer that a volcanic event could have dramatic economic effects on the Auckland region, and also on New Zealand (as a whole). The effects are likely to be more severe on the economy than any event in the past century with losses in GDP and employment exceeding those which occurred during the Great Depression of the 1930's. The flow-on effects to other sectors would in turn create widespread disruption and possible social upheaval.

These effects could be considerably reduced by responses taken by industries. For example, a volcanic event could result in a 48% decline in employment in the Auckland region without response, yet if businesses respond proactively (e.g. take mitigating steps, employ business continuity plans, etc.), employment could fall to a lesser extent (by 39%). The results also show the importance of acknowledging the indirect impacts, as these make an important contribution to the totals.

Part One – Gross Domestic Product (Value Added)

Gross Domestic Product (or value added) is the gross output (i.e. sales) less intermediate consumption (to suppliers). The tables and figures posted below illustrate the anticipated effect that a volcanic event on Auckland may have on Gross Domestic Product (GDP). They are broken down by time period and by zone. Each table compares GDP expected under the business as usual (BAU) scenario (i.e. without a volcanic event) with GDP resulting from the volcanic event scenario, based on industries responding ('event with response') and not responding ('event without response').

Figures 3 and 4, and Table 2 illustrate the effect on GDP by region and zone, including both direct and indirect impacts. The 0-3km zone is assumed to be almost entirely destroyed, by lava and volcanic debris, etc, and the 3-5km zone is also expected to suffer significant damage. The businesses which had existed in this area would choose to either relocate elsewhere in Auckland, New Zealand or beyond, or to close down. For this reason, and also due to the lesser extent of damage, the 5-7km zone is expected to suffer a 46% reduction in GDP (given no industry response). With business response, the reduction of GDP would be considerably less, at 30%.

The rest of Auckland is anticipated to re-house a number of displaced businesses. However, given the economic importance of the businesses located in the 0-7km zones, it is anticipated that the total Auckland region would suffer a 40% reduction in GDP (by application of business mitigation response, or 47% without). The rest of the North Island, together with the South Island would benefit somewhat from the relocation of some displaced businesses to their regions, with an estimated 3% increase in GDP. Overall, this results in a 12% decline in GDP for New Zealand, given industry response (or 14% decline, without response). Such a reduction would be therefore felt throughout the country, especially as much of the GDP in the year following a volcanic event would comprise reconstruction and recovery expenses, to the detriment of economic development.

The following Tables 3 and 4 split the direct impacts (i.e. those relating to businesses located in the area of volcanic activity) from the indirect impacts (i.e. those relating to businesses which may be suppliers or customers of these businesses (or further down the

chain). The direct impacts (Table 3) do not necessarily correlate with the total combined (direct and indirect) impacts (Table 2) described above. Whilst modelling showed that GDP in the 5-7km zone is likely to reduce by 30% overall (given industry response), the direct impacts actually showed a 5% increase; this exemplifies the importance of incorporating indirect impacts into models. Similarly, analysis of the direct impacts showed a 21% increase in GDP in the Rest of Auckland zone, compared to a total (including direct and indirect impacts) reduction in GDP of 6%. The model also showed that the direct impacts of a volcanic event would likely result in a 21% reduction in the total Auckland region, compared to a total reduction of 40% (including direct and indirect impacts, and assuming a business mitigation response); and generally underestimates the detrimental effect of a volcanic event on the rest of the North Island, South Island, and New Zealand as a whole.

Modelling of the total (direct and indirect) impact on GDP in the total Auckland region revealed very large negative impacts across all time periods. The model suggests a 46% reduction in GDP during the pre-event period (the ten days leading up to the volcanic event), assuming business mitigation response, or a 51% reduction (without industry response) (see Figure 5 and Table 5). Assuming industry responses, this is followed by a 51% reduction in GDP during the volcanic event (30 days), 49% reduction in the immediate period (the first 14 days after the volcanic event), 42% reduction in the short-term (the next 128 days), and a 35% reduction in the medium-term (183 days, or the rest of the year). In each term, the industry response significantly reduces the impact on GDP, compared with no response. This implies that by taking mitigating steps, businesses are better able to help themselves and the country to cope with a volcanic event. Again, the model shows that the direct impacts significantly underestimate the total impact of a volcanic event on GDP in all time periods (see Figure 6 and Tables 6 and 7). It is thus important to capture the entire impacts, in analysis of Exercise Ruauumoko.

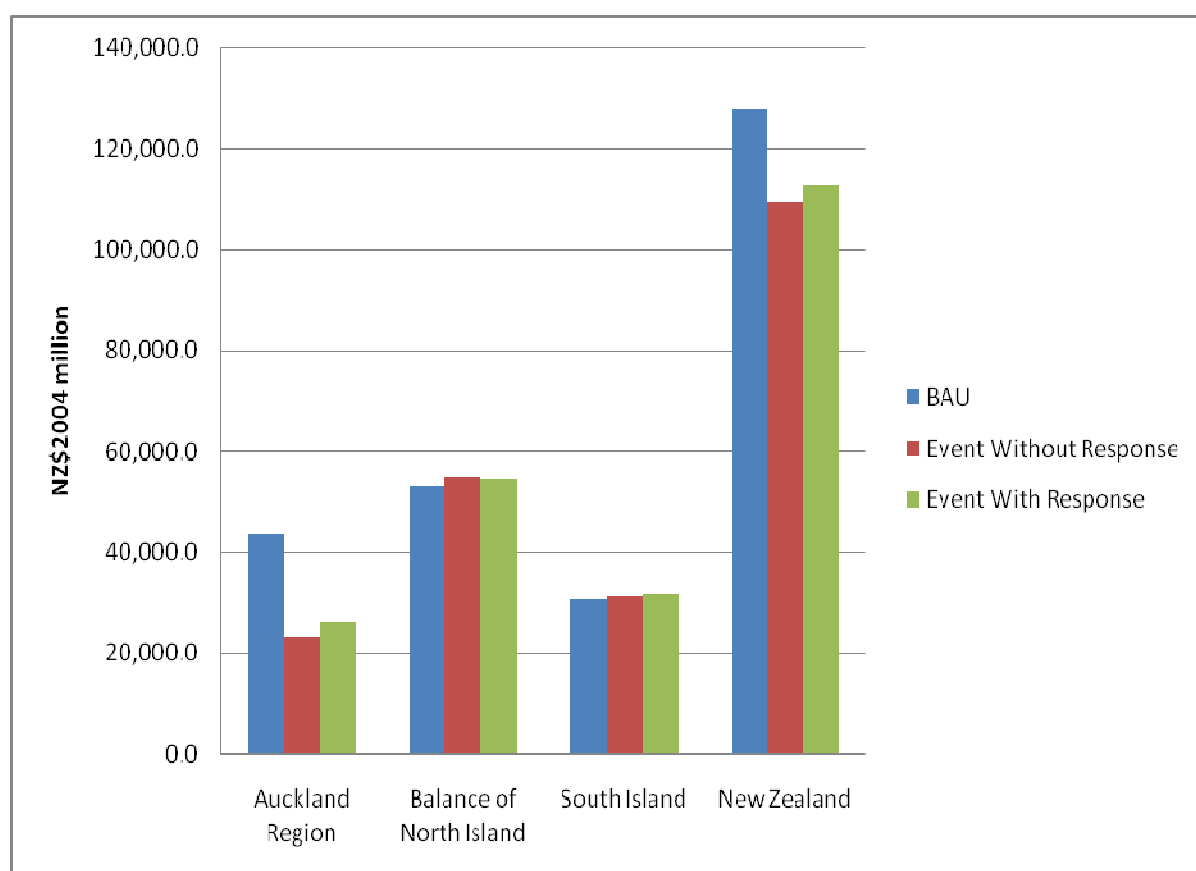


Figure 3: Total GDP Impacts by Region

Table 2: Total (Direct and Indirect) GDP Impacts by Zone (NZ\$2004 million)

	0-3km zone	3-5km zone	5-7km zone	Rest of Auckland
BAU (\$)	7,021	7,582	4,175	24,909
Event Without Response (\$)	0	0	2,266	20,821
Event Without Response (%)	-100%	-100%	-46%	-16%
Event With Response (\$)	21	21	2,922	23,295
Event With Response (%)	-100%	-100%	-30%	-6%

	Total Auckland	Rest of N. Island	South Island	Total New Zealand
BAU (\$)	43,687	53,292	30,791	127,770
Event Without Response (\$)	23,087	54,787	31,537	109,411
Event Without Response (%)	-47%	3%	2%	-14%
Event With Response (\$)	26,258	54,670	31,788	112,716
Event With Response (%)	-40%	3%	3%	-12%

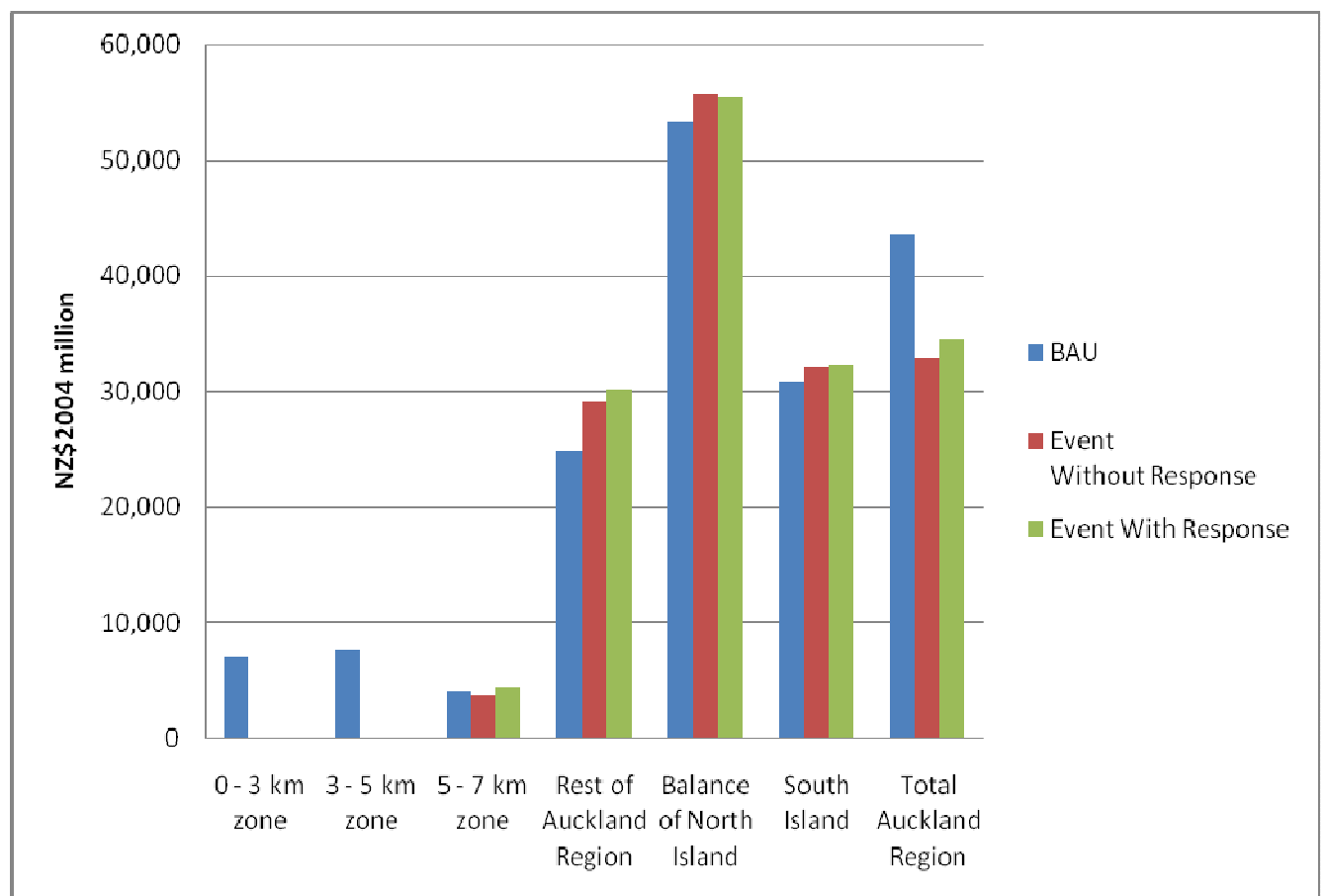


Figure 4: Direct GDP Impacts by Zone

Table 3: Direct GDP Impacts By Zone (NZ\$2004 million)

	0-3km zone	3-5km zone	5-7km zone	Rest of Auckland
BAU (\$)	7,021	7,582	4,175	24,909
Event Without Response (\$)	0	0	3,740	29,074
Event Without Response (%)	-100%	-100%	-10%	17%
Event With Response (\$)	31	31	4,392	30,143
Event With Response (%)	-100%	-100%	5%	21%

	Total Auckland	Rest of N. Island	South Island	Total New Zealand
BAU (\$)	43,687	53,292	30,791	127,770
Event Without Response (\$)	32,814	55,728	32,068	120,609
Event Without Response (%)	-25%	5%	4%	-6%
Event With Response (\$)	34,597	55,374	32,337	122,308
Event With Response (%)	-21%	4%	5%	-4%

Table 4: Indirect GDP Impacts By Zone (NZ\$2004 million)

	0-3km zone	3-5km zone	5-7km zone	Rest of Akl
Event Without Response (\$)	0	0	-1,474	-8,253
Event With Response (\$)	-10	-10	-1,471	-6,848

	Total Auckland	Rest of N. Island	South Island	Total NZ
Event Without Response (\$)	-9,727	-940	-530	-11,198
Event With Response (\$)	-8,339	-703	-550	-9,592

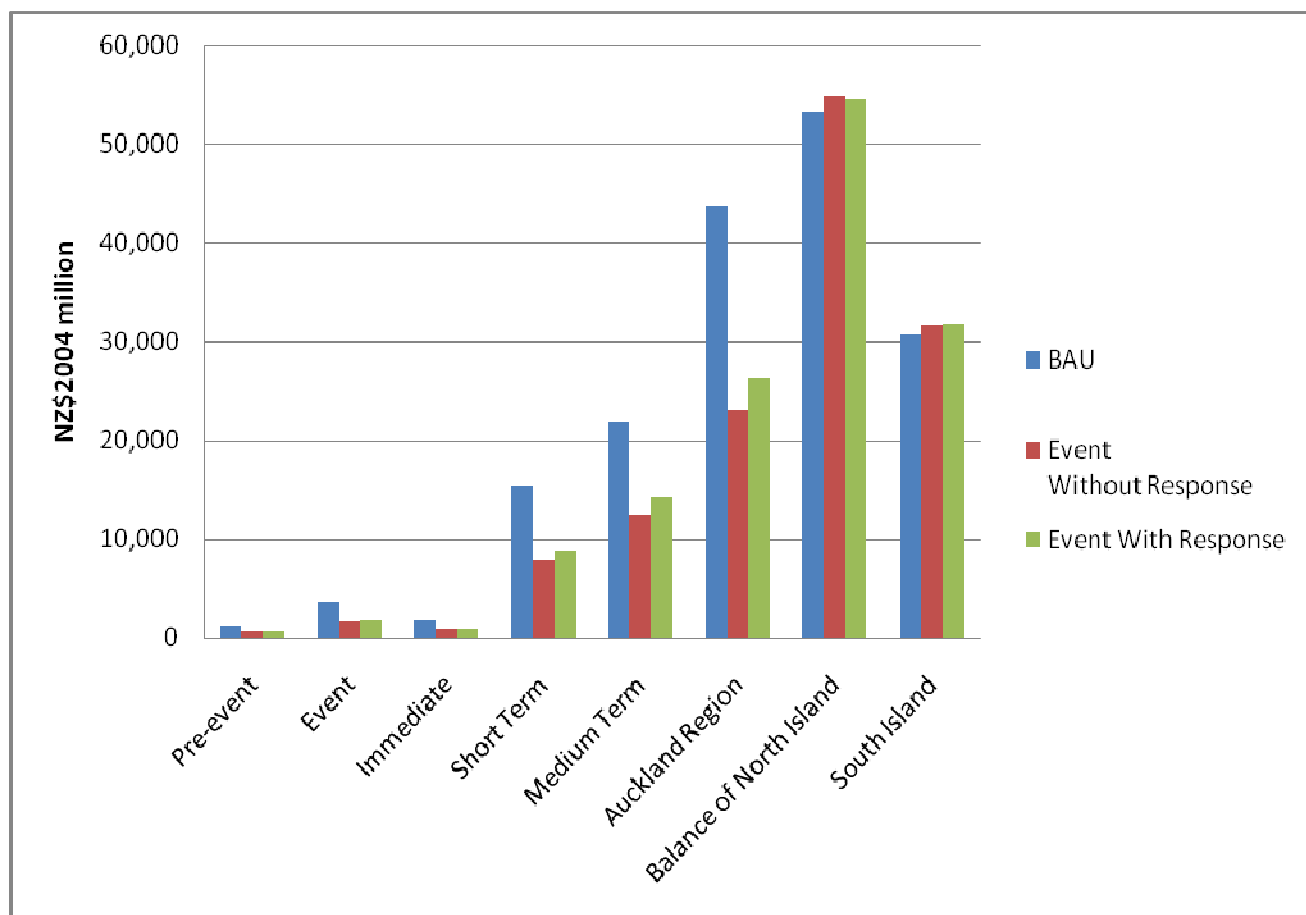


Figure 5: Total GDP Impacts by Time Period and Region

Table 5: Total (Direct and Indirect) GDP Impacts by Time Period (NZ\$2004 million)

	Pre-event	Event	Immediate	Short Term	Medium Term
BAU (\$)	1,197	3,591	1,676	15,323	21,907
Event Without Response (\$)	586	1,532	798	7,760	12,411
Event Without Response (%)	-51%	-57%	-52%	-49%	-43%
Event With Response (\$)	641	1,747	861	8,816	14,194
Event With Response (%)	-46%	-51%	-49%	-42%	-35%

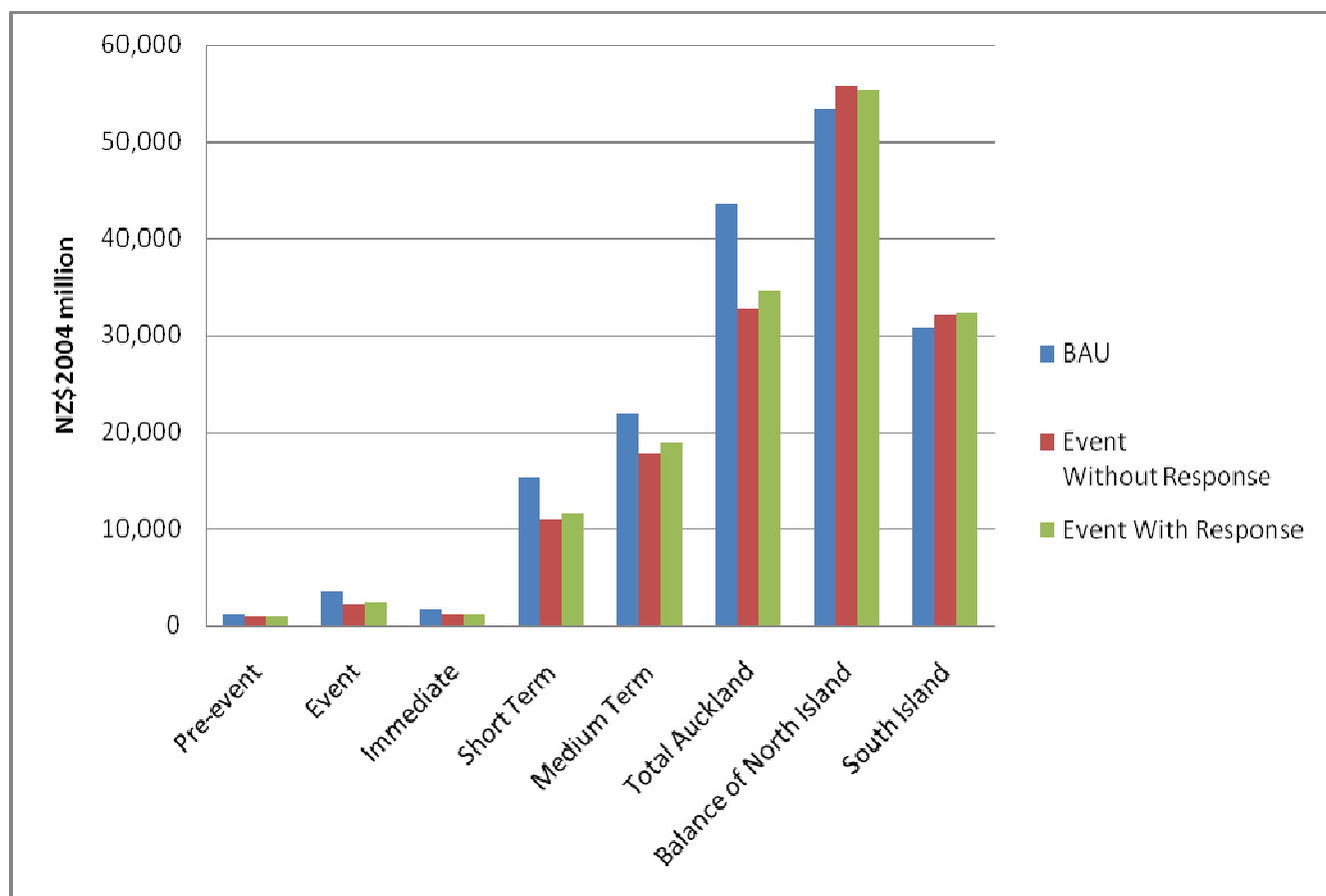


Figure 6: Direct GDP Impacts by Time Period

Table 6: Direct GDP Impacts by Time Period (NZ\$2004 million)

	Pre-event	Event	Immediate	Short Term	Medium Term
BAU (\$)	1,197	3,591	1,676	15,323	21,907
Event Without Response (\$)	835	2,102	1,116	10,963	17,797
Event Without Response (%)	-30%	-41%	-33%	-28%	-19%
Event With Response (\$)	845	2,257	1,118	11,555	18,823
Event With Response (%)	-29%	-37%	-33%	-25%	-14%

Table 7: Indirect GDP Impacts by Time Period (NZ\$2004 million)

	Pre-event	Event	Immediate	Short Term	Medium Term
Event Without Response (\$)	-249	-570	-318	-3,203	-5,387
Event With Response (\$)	-204	-509	-258	-2,739	-4,629

Part Two – Employment

Given the scenario of a volcanic event to which businesses respond proactively, employment is expected to reduce by 39% in the Auckland region (see Table 8 and Figure 7). This takes into account an almost complete loss of employment in the 0-3km zone and serious losses in the 3-5km zone. Some of this employment is likely to be relocated to the 5-7km zone (which itself is expected to experience some destruction), and some to the Rest of Auckland, Rest of North Island, South Island and overseas. This would result in small gains in employment counts in these areas. However, given the dominance of the Auckland economy in New Zealand, a volcanic event in Auckland is projected to result in an 11% fall in employment counts over the whole country (given proactive business response) or a 14% fall (without response).

Table 11 and Figure 9 show the total employment effects in the Auckland region, by time period: pre-event (10 days before the event), event (30 days), immediate (14 days following the event), short-term (next 128 days), and medium term (remainder of the year (183 days)). Unsurprisingly, the impact is projected to be the highest during the volcanic event, and then immediately afterwards. As critical infrastructure is restored, and as businesses start to relocate and rebuild themselves, employment gradually recovers. Note that employment is also anticipated to reduce significantly during the pre-event period, as residents are evacuated, and as earthquakes, uplift etc. cause damage, frighten residents, close schools and workplaces, etc.

Looking at the data by either time period or region affected, it is clear that business responses make a significant difference to the recovery of the economy.

Figures 8 and 10 and Tables 9 and 12 show the direct change in employment expected from a volcanic event. This captures employment in businesses directly impacted by the volcanic event (i.e. those located in zones of damage or destruction). Indirect employment (see Tables 10 and 13) relates to employment in businesses which are the purchasers or suppliers of the businesses directly impacted by the volcanic event. Indirect impacts may also include the second or subsequent chain of purchasers or suppliers. By including the indirect employment impacts, additional employment loss is made visible.

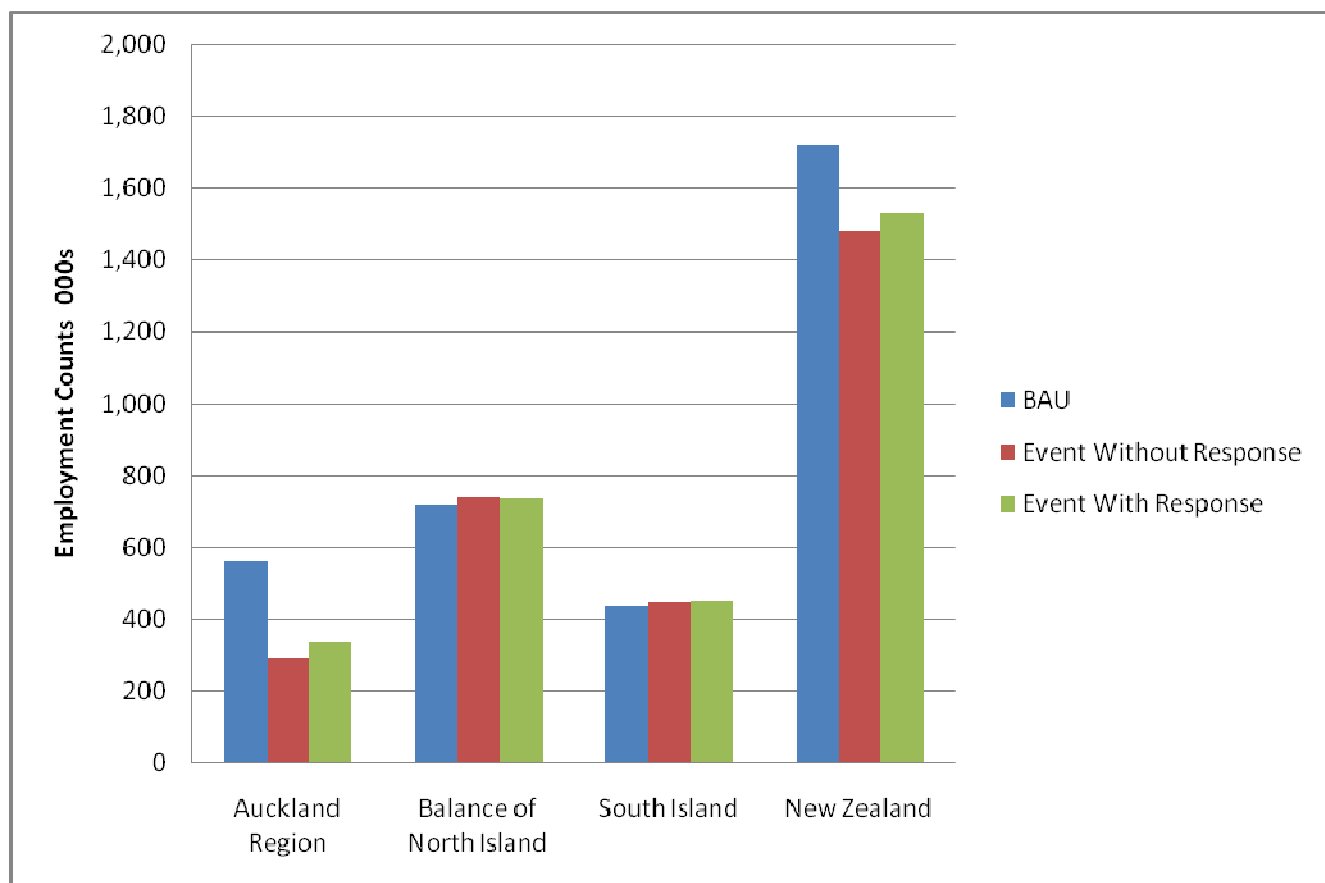


Figure 7: Total Employment Impacts by Region

Table 8: Total (Direct and Indirect) Employment Impacts by Zone

	0-3km zone	3-5km zone	5-7km zone	Rest of Auckland
BAU (Employment Counts)	98,920	91,220	52,470	318,290
Event Without Response (ECs)	0	0	30,800	262,030
Event Without Response (%)	-100%	-100%	-41%	-18%
Event With Response (ECs)	430	430	39,270	299,560
Event With Response (%)	-100%	-100%	-25%	-6%
	Auckland Region	Balance of North Island	South Island	Total New Zealand
BAU (Employment Counts)	560,920	719,130	439,250	1,719,300
Event Without Response (ECs)	292,840	740,650	449,040	1,482,520
Event Without Response (%)	-48%	3%	2%	-14%
Event With Response (ECs)	339,680	737,660	452,420	1,529,760
Event With Response (%)	-39%	3%	3%	-11%

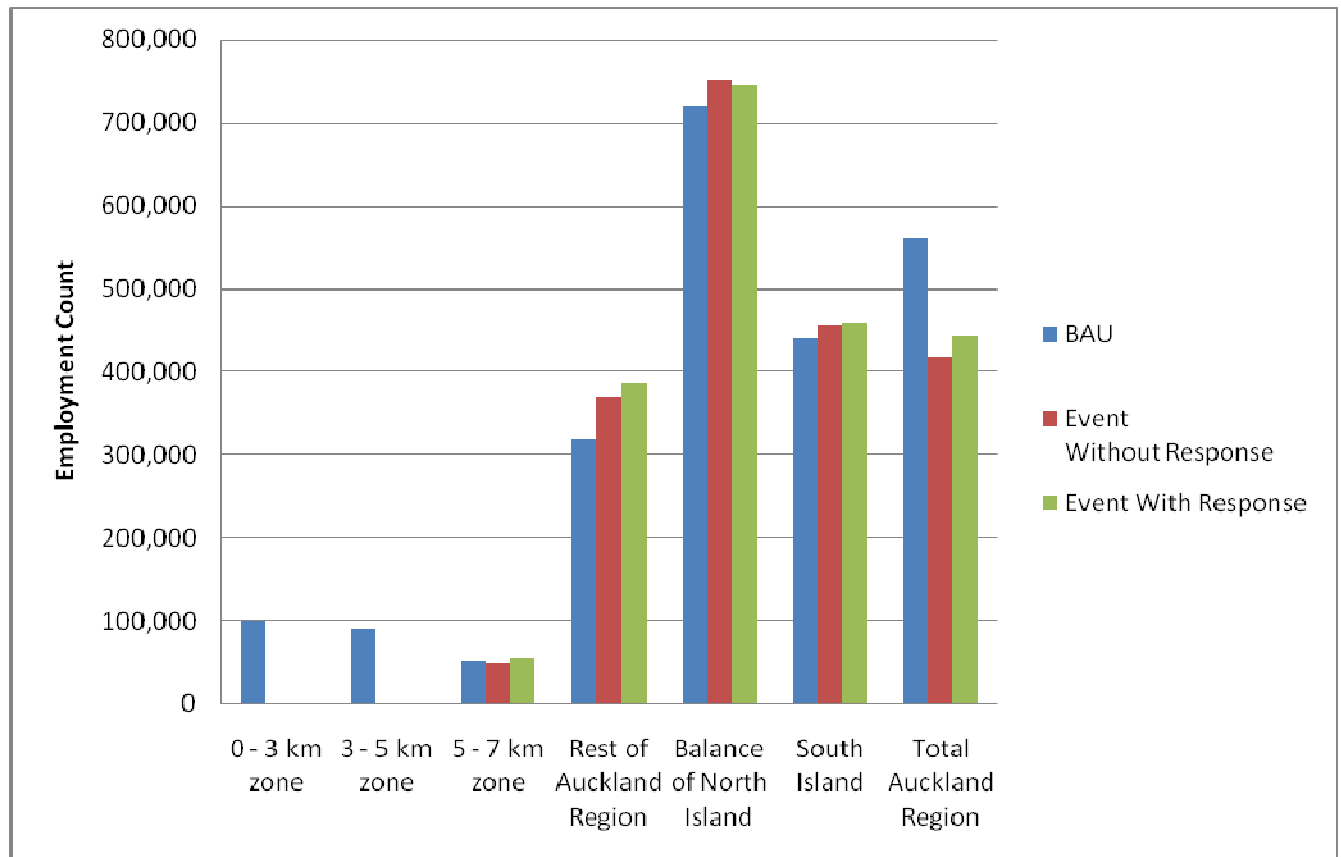


Figure 8: Direct Employment Impacts by Zone

Table 9: Direct Employment Impacts by Zone

	0-3km zone	3-5km zone	5-7km zone	Rest of Auckland
BAU (Employment Counts)	98,920	91,220	52,470	318,290
Event Without Response (ECs)	0	0	48,050	368,760
Event Without Response (%)	-100%	-100%	-8%	16%
Event With Response (ECs)	630	630	55,810	386,740
Event With Response (%)	-99%	-99%	6%	22%

	Total Auckland	Rest of N. Island	South Island	Total NZ
BAU (Employment Counts)	560,900	719,130	439,250	1,719,280
Event Without Response (ECs)	416,800	752,070	455,270	1,624,140
Event Without Response (%)	-26%	5%	4%	-6%
Event With Response (ECs)	443,800	745,670	458,860	1,648,330
Event With Response (%)	-21%	4%	4%	-4%

Table 10: Indirect Employment Impacts by Zone

	0-3km zone	3-5km zone	5-7km zone	Rest of Auckland
Event Without Response (ECs)	0	0	-17,240	-106,720
Event With Response (ECs)	-200	-200	-16,540	-87,180

	Total Auckland	Rest of N. Island	South Island	Total NZ
Event Without Response (ECs)	-123,970	-11,420	-6,230	-141,620
Event With Response (ECs)	-104,120	-8,010	-6,440	-118,570

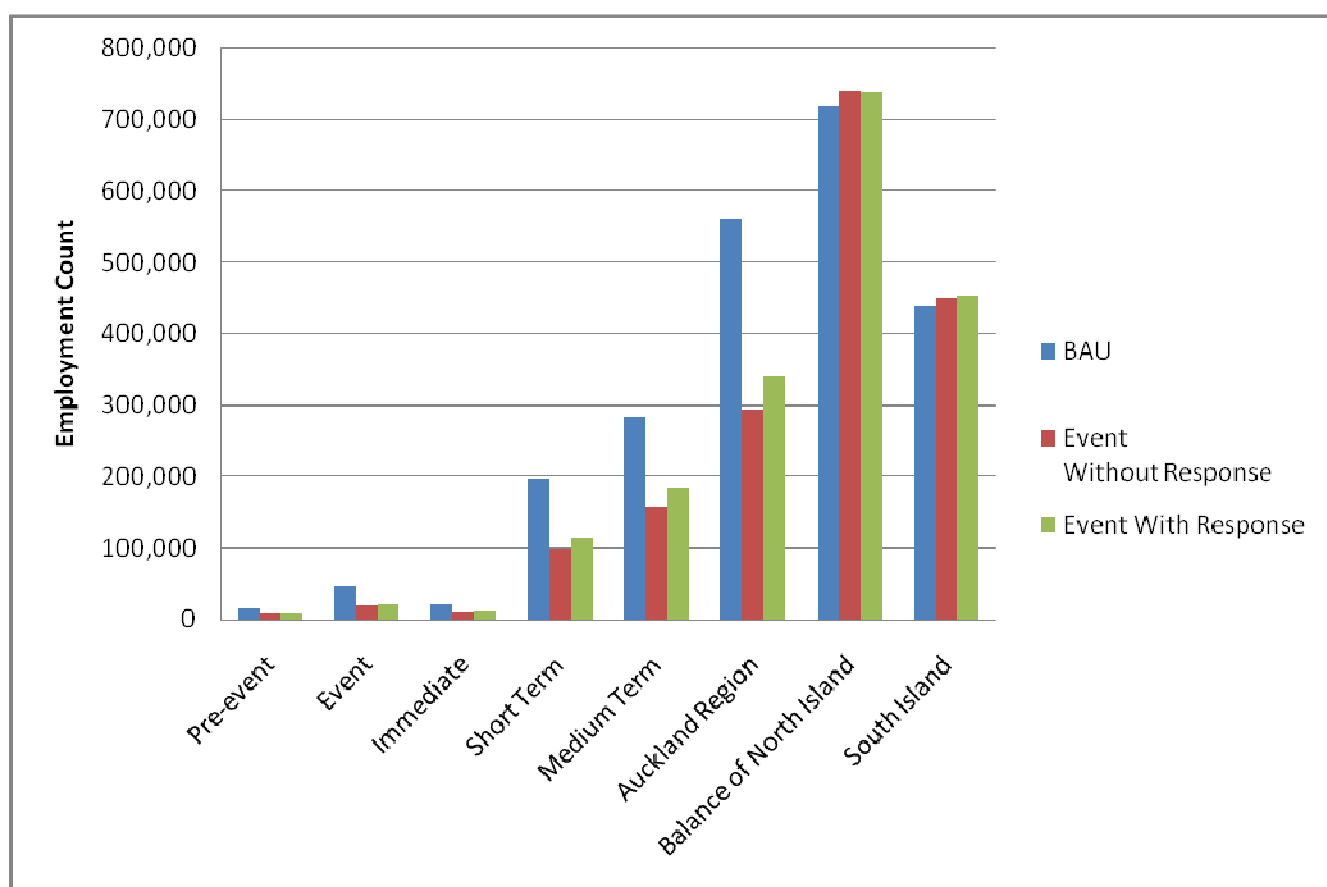


Figure 9: Total Employment Impacts by Time Period and Region

Table 11: Total (Direct and Indirect) Employment Impacts by Time Period

	Pre-event	Event	Immediate	Short Term	Medium Term
BAU (Employment Counts)	15,370	46,100	21,520	196,710	281,230
Event Without Response (ECs)	7,450	19,330	10,150	98,870	157,050
Event Without Response (%)	-52%	-58%	-53%	-50%	-44%
Event With Response (ECs)	8,150	22,020	10,960	114,520	184,030
Event With Response (%)	-47%	-52%	-49%	-42%	-35%

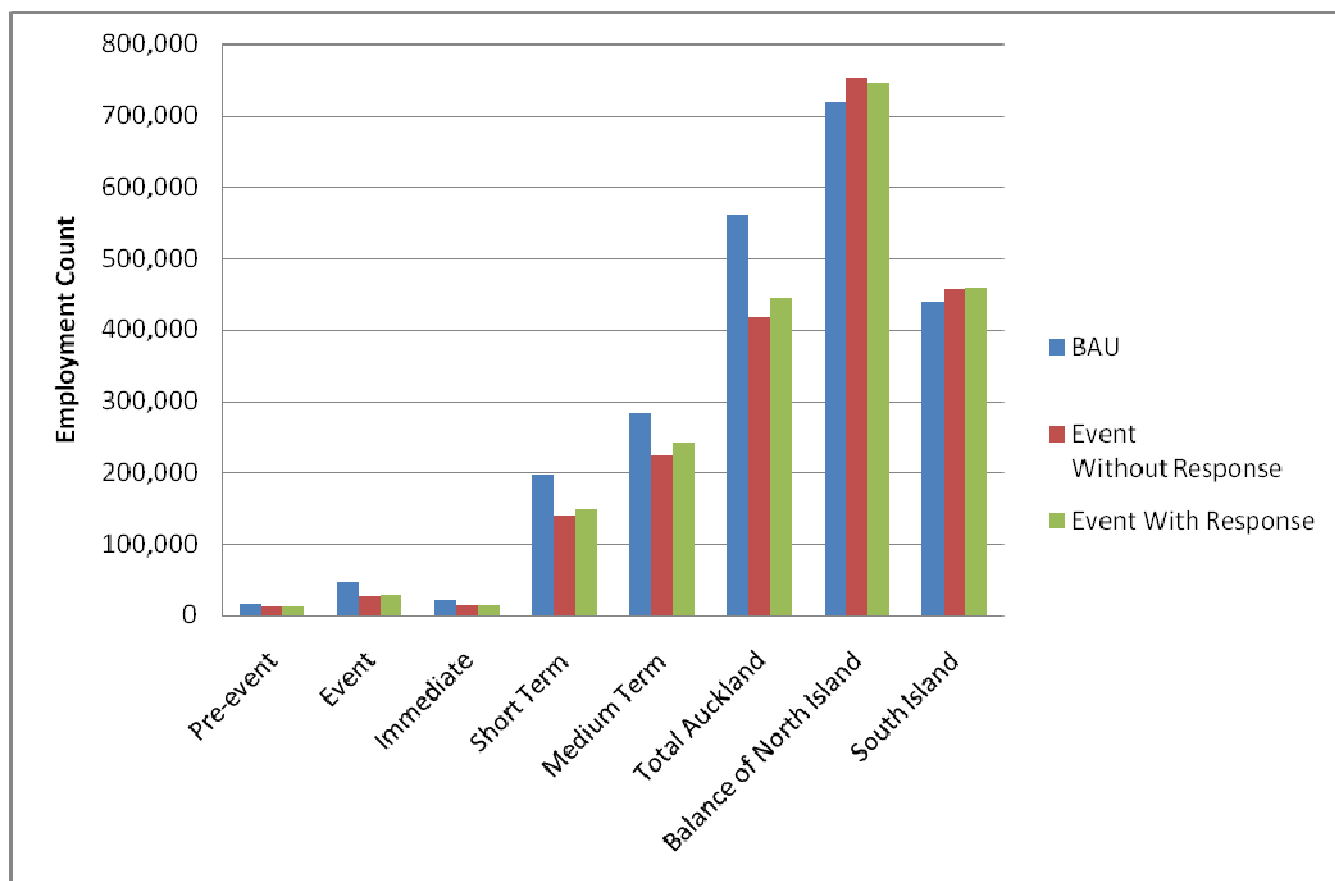


Figure 10: Direct Employment Impacts by Time Period

Table 12: Direct Employment Impacts by Time Period

	Pre-event	Event	Immediate	Short Term	Medium Term
BAU (Employment Counts)	15,370	46,100	21,520	196,710	281,230
Event Without Response (ECs)	10,670	26,850	14,280	139,990	225,020
Event Without Response (%)	-31%	-42%	-34%	-29%	-20%
Event With Response (ECs)	10,710	28,410	14,200	148,900	241,580
Event With Response (%)	-30%	-38%	-34%	-24%	-14%

Table 13: Indirect Employment Impacts by Time Period

	Pre-event	Event	Immediate	Short Term	Medium Term
Event Without Response (ECs)	-3,230	-7,520	-4,130	-41,120	-67,970
Event With Response (ECs)	-2,550	-6,400	-3,240	-34,380	-57,550

6. Use of Information by Other Sectors in Exercise Ruaumoko Planning

Although the Business Group recognises individual resilience is vital to recovery after an emergency, the huge impact which would be created by the Exercise Ruaumoko scenario would necessitate a large role for other agencies, particularly local and national government, in the recovery effort. The following are some of the suggested interventions to be made by other parties, in addition to those initiatives taken by individual businesses themselves.

6.1 Government Leadership (local and central government)

- Consideration as to how the cost of clean-up and rebuilding would be assessed and recovered. A system to record and administer this process is required. It will need to be structured in such a way as to mitigate against the risk of fraudulent activity.
- Consideration as to provision of financial support for businesses to re-establish themselves through measures such as emergency benefits and loans.
- Ensure affordable credit available to business for rebuilding.
- Promote economic recovery by projecting positive recovery images to the foreign media. This would help maintain foreign investment in New Zealand's economy, and encourage tourists to return to New Zealand.
- Determine priorities for reconstruction, and the costs and benefits of reconstructing large buildings (e.g. schools and hospitals) which could exhaust supplies, balanced against reconstruction of commercial buildings.
- The construction industry advised that it would need financial relief from conditions of contract for existing jobs, in order to transfer staff, plant and machinery resources to undertake construction in the rescue, recovery and rebuilding phases. Further compensation may need to be provided to the owners of these existing contracts, as their work will not be completed on time, and their cash flow may in turn be impacted. This financial relief may need to be provided by the government.
- Facilitate and coordinate the movement of appropriate skills from elsewhere in the country or maybe from overseas if specialist skills are not available in NZ. This may necessitate a change to immigration rules.
- Household relief to enable residents to purchase essential goods.
- Consider tax relief during the recovery period.
- Financial relief/assistance from the government for any additional costs incurred in continuing to supply products to the affected area (e.g. relocation of staff).
- Credit policies at a national level are likely to be needed. This could include for example the government making financial assistance available to particular sectors considered to be vital to the recovery effort.
- The Reserve Bank may need to prop up the NZ dollar (NZD), to prevent a falling NZD leading to significant cost increases and interest rate hikes, which could affect the financial viability and profitability of many businesses. This could also result in a significant slow-down in the economy. The government needs to respond to this threat by ensuring measures are in place to ensure financial stability of the NZ economy.
- Preservation of credit ratings by the Reserve Bank, to protect the integrity of the finance industry and its ability to serve the country.

- Funding (e.g. loans) to deal with current staff costs (e.g. wages, redundancies), and ongoing supplier debt.
- Consider developing a business 'restart' package, with perhaps a 5 year loan structure to enable businesses to be developed on a new site, with a large allocation of funds for marketing and advertising. This may involve specialist assistance with the development of innovative ideas (e.g. from the Business School at the University of Auckland).
- Other assistance could come from the Business School at the University of Auckland, allowing owners to work in rather than on (in the recovery phase) their business.

6.2 Infrastructure – Engineering Lifelines

- Auckland Engineering Lifelines Group to give priority to ensuring alternative networks are available in the event of an emergency.
- Prioritise the use of these alternative networks during an emergency.
- Government agencies (MCDEM, Auckland CDEM Group, Emergency Services) ensure priority access to these networks to ensure ongoing viability of the business sector.
- Auckland Engineering Lifelines Group to give consideration to inviting the banking industry to be members of the Group.
- Priority in planning be given to the provision of resources for the timely reinstatement of businesses critical to the ongoing operation of the business sector.
- Because infrastructure availability will be the key determinate as to how quickly businesses are able to operate after an event, priority should be afforded to its restoration.
- Critical infrastructure issues for business include:
 - Fuel for generators, water supply for cooling (eg air conditioning units for computer systems).
 - Ongoing operation of port and airport facilities.
 - Telecommunications for data transfer and bank systems (e.g. internet banking) is critical. Good communications facilities through cell phone networks and television and radio.
 - Electricity is essential to all businesses, and generators have limited capacity, so hasty restoration of power to affected areas is important.
 - Transport: timely provision of road access is important, and alternative routes will need to be identified and/or prioritised if main routes are unusable.
 - Restoration of other utilities and transport systems (e.g. energy networks (gas etc.), communication and data networks, water, wastewater, and road system).
 - Consider restocking the petroleum fuel resources.

6.3 Business Continuity and Contingency Planning

- Prioritise increasing awareness of the value of BCPs in the CDEM Group's marketing/education campaigns.
- The Ministry of Economic Development should be encouraged to develop guidelines for SMEs to aid production of BCPs, including development of a template/BCP kit.

6.4 Public Information Management

- The Business Group believes that government agencies should ensure accurate, deliberate, planned and sustained management of information relating to a volcanic emergency occurs, as this is critical in minimising the impacts and in maintaining and rebuilding businesses and the economy. It is important that the provision of information is geared towards ensuring community, customers, suppliers, investors and financiers have confidence that the Auckland and New Zealand economies can recover.

6.5 Welfare Provision

- Trauma counselling must be available for staff and business owners to assist in business continuity.
- Facilitate the provision of temporary accommodation for businesses and their staff and families.

6.6 General

- Relevant local and central government agencies and business sector groupings should forge closer disaster management working relationships, to facilitate better integration in the management of disaster recovery.
- The Business Group believes it is essential the interdependencies are recognised by emergency services, engineering lifelines, and government agencies when coordinating the recovery effort. A key role of these agencies would be to facilitate a co-operative approach to recovery of the business sector.

7. Conclusions

The impacts of a volcanic eruption in the Auckland isthmus would have serious consequences for the Auckland region and national economies. Economic modelling, based upon a volcano erupting in the vicinity of Mt Eden, would lead to a 47% reduction in regional GDP over the first year. Information provided by the Business Group reveals that by implementing mitigation responses this impact could be reduced to 40%. The volcanic event could lead to 268,000 jobs being lost, although 47,000 of these jobs could be saved by implementing mitigating responses. Further reductions in the impact are likely with a concerted campaign of preparedness, and with other migration arrangements put into place.

Because of the interconnected nature of the economy, the New Zealand GDP is expected to decline by 14% over the first year, or 12% if mitigation responses are put into place. 237,000 jobs are likely to be lost in New Zealand, reducing by 47,000 with effective response.

To put these figures into perspective, the consequences will be more severe to New Zealand than those of the great depression in the early 1930s when negative economic growth rates peaked at -7% across the nation.

The Business Group acknowledges the serious impacts and believes these can be reduced by the adoption of a more aggressive approach to risk management planning and processes by businesses themselves. Many acknowledge for example the absence of business continuity plans in a large proportion of Auckland businesses. All businesses, large and small have a role to play and individual resilience is a key component of such a programme.

However, because of the sheer size and physical impact of a volcanic event, much of the recovery effort will need to be coordinated at a national level by government agencies. For example, destruction of network infrastructure critical to the functioning of businesses can only be restored through serious government intervention, and the Business Group is keen to ensure government agencies acknowledge the role they will need to play in this restoration. The Group further believes greater effort needs to be made to prepare for large scale events such as a volcanic eruption – this would involve coordinated work across all sectors. It is estimated there is a 5% chance of another volcano erupting in the next 50 years in the Auckland region so it is important that arrangements for recovery are not only reviewed but are also exercised in the same way response arrangements have been exercised as part of Exercise Ruauumoko.

The data utilised in this project has been provided by a sophisticated Economic Futures Model developed by Market Economics Limited. The mitigation response inputs fed into the model are based upon the inputs of a small section of the business community. Further gains in reducing the impacts and thus speeding up recovery of the economy are possible if this work is extended to include a wider cross-section of businesses and sector groups and if greater focus is given to risk management and mitigation strategies by all sectors.

Acknowledgements

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- Tony Fenwick, Department of Prime Minister and Cabinet

Appendices

- on the following pages

Appendix A: Concordance between 48- and 21-Level Industry Classifications

48 Industry Sector Code	Ruaumoko Exercise Industry Code
1 Horticulture and fruit growing	12 Horticulture
2 Livestock and cropping farming	12 Horticulture
2 Livestock and cropping farming	13 Sheep, beef, dairy and other farming
3 Dairy cattle farming	13 Sheep, beef, dairy and other farming
4 Other farming	13 Sheep, beef, dairy and other farming
5 Services to agriculture, hunting and trapping	19 Services
6 Forestry and logging	12 Horticulture
6 Forestry and logging	19 Services
7 Fishing	19 Services
8 Mining and quarrying	19 Services
8 Mining and quarrying	14 Mining
9 Oil and gas exploration and extraction	19 Services
10 Meat and meat product manufacturing	15 Food processing
11 Dairy product manufacturing	15 Food processing
12 Other food manufacturing	15 Food processing
13 Beverage, malt and tobacco manufacturing	15 Food processing
14 Textile and apparel manufacturing	17 Manufacturing - not easily relocated
14 Textile and apparel manufacturing	16 Manufacturing - relocatable
15 Wood product manufacturing	16 Manufacturing - relocatable
16 Paper and paper product manufacturing	17 Manufacturing - not easily relocated
17 Printing , publishing and recorded media	17 Manufacturing - not easily relocated
18 Petroleum and industrial chemical manufacturing	17 Manufacturing - not easily relocated
19 Rubber, plastic and other chemical product manufacturing	17 Manufacturing - not easily relocated
20 Non-metallic mineral product manufacturing	16 Manufacturing - relocatable
20 Non-metallic mineral product manufacturing	17 Manufacturing - not easily relocated
21 Basic metal manufacturing	17 Manufacturing - not easily relocated
22 Structural, sheet, and fabricated metal product manufacturing	16 Manufacturing - relocatable
23 Transport equipment manufacturing	17 Manufacturing - not easily relocated
24 Machinery and equipment manufacturing	17 Manufacturing - not easily relocated
25 Furniture and other manufacturing	17 Manufacturing - not easily relocated
25 Furniture and other manufacturing	16 Manufacturing - relocatable
26 Electricity generation and supply	1 Electricity
27 Gas supply	2 Gas supply
28 Water supply	3 Water supply
29 Construction	7 Construction
30 Wholesale trade	11 Trade
31 Retail trade	11 Trade
32 Accommodation, restaurants and bars	18 Accommodation
32 Accommodation, restaurants and bars	21 Entertainment services
33 Road transport	8 Road transport
34 Water and rail transport	9 Water and rail transport
35 Air transport, services to transport and storage	10 Air transport
36 Communication services	6 Communication services
37 Finance	19 Services
38 Insurance	19 Services
39 Services to finance and investment	19 Services
40 Real estate	19 Services
41 Ownership of owner-occupied dwellings	22 Ownership of owner-occupied dwellings
42 Business services	19 Services
42 Business services	11 Trade
43 Central government administration, defence, public order and safety services	19 Services
44 Local government administration services and civil defence	19 Services
45 Education	20 Education
46 Health and community services	5 Health services (incl. hospitals)
46 Health and community services	19 Services
47 Cultural and recreational services	19 Services
47 Cultural and recreational services	21 Entertainment services
48 Personal and other community services	19 Services
48 Personal and other community services	4 Waste disposal

Appendix B: Definition of Scenarios Analysed

Business as Usual (BAU) is defined as the scenario in which there is no volcanic event. Business continues in the same way, as it did the previous year. This study has used 2004 data as the base year for the BAU scenario, against which the event scenarios are compared, to determine the impacts of a volcanic event on each of the study areas.

In the “Event without response” scenario, a volcanic event occurs, and businesses are generally deemed not to have taken any mitigating actions. This scenario assumes that few businesses would have created a business continuity plan or emergency plan, and few businesses would have identified alternate approaches they could take (such as sites they could relocate to, how they would contact their customers and suppliers, alternate suppliers they could call upon, planning finances, emergency supplies, etc).

The “Event with response” scenario is one in which a volcanic event occurs, and businesses respond. Business responses incorporated into this scenario include those indicated by industry representatives during Exercise Ruaumoko workshops and from questionnaires. This scenario takes into account the mitigating factors and plans that businesses could take, to reduce the consequences of a volcanic event. For example, they may have a business continuity plan, an emergency action plan, back-up power generators, or regularly updated lists of customers, staff and suppliers. They may also have identified alternate sites from which they could operate, alternate suppliers from which they could obtain critical inputs, cooperative agreements with competitors in the event of an emergency, etc.

Appendix C: Effects and Relocation Matrices

The Effects Matrix is a table of 48 industry sectors (listed vertically) by time periods (listed horizontally). Within each zone (0-3km, 3-5km, 5-7km, Rest of Auckland, and Rest of New Zealand), the matrix is split into five time periods: pre-event (10 days), event (30 days), immediate (14 days), short-term (128 days) and medium-term (183 days). Each cell within the matrix is filled with a number between zero and six, representing the proportion of normal output that is expected to be produced during each time period, where '0' represents 0%, '1' is 0-20%, '2' is 21-40%, and so on, up to '6' which represents 100%. The figures within the matrix are derived from the scenario development stage: primarily from Business Group representatives' comments and responses during Exercise Ruauumoko workshops and from their responses to the impacts and responses questionnaire. The Effects Matrix is shown in Figure B.1 below.

The Relocation Matrix shows the zones where displaced businesses are likely to migrate to. These businesses would have been located in the 0-3km, 3-5km, and 5-7km zones, where the volcanic event had damaged or destroyed their plant and/or facilities. The Relocation Matrix is a table of industry sectors (listed vertically) by zones (listed horizontally). Each cell within the matrix is a percentage, representing the proportion of output which the industry has produced in a zone. This output may be produced by businesses which continue to operate at their existing facilities in the zone, or output produced by businesses which have immigrated to the zone. Businesses may have been able to move back into their old facilities to resume production. In other cases, competitors may be running extra production runs, thereby increasing output in their zones. Figures within the matrix were derived by analysis of the volcanic event scenarios, developed in Step 1. For this study, two Relocation Matrices were prepared for each of the volcanic event scenarios. The first matrix captures relocations from the pre-event period to the short-term period; and the second captures relocations during the medium-term period. A relocation matrix is depicted in Figure B.2.

Figure C.1: An Effects Matrix

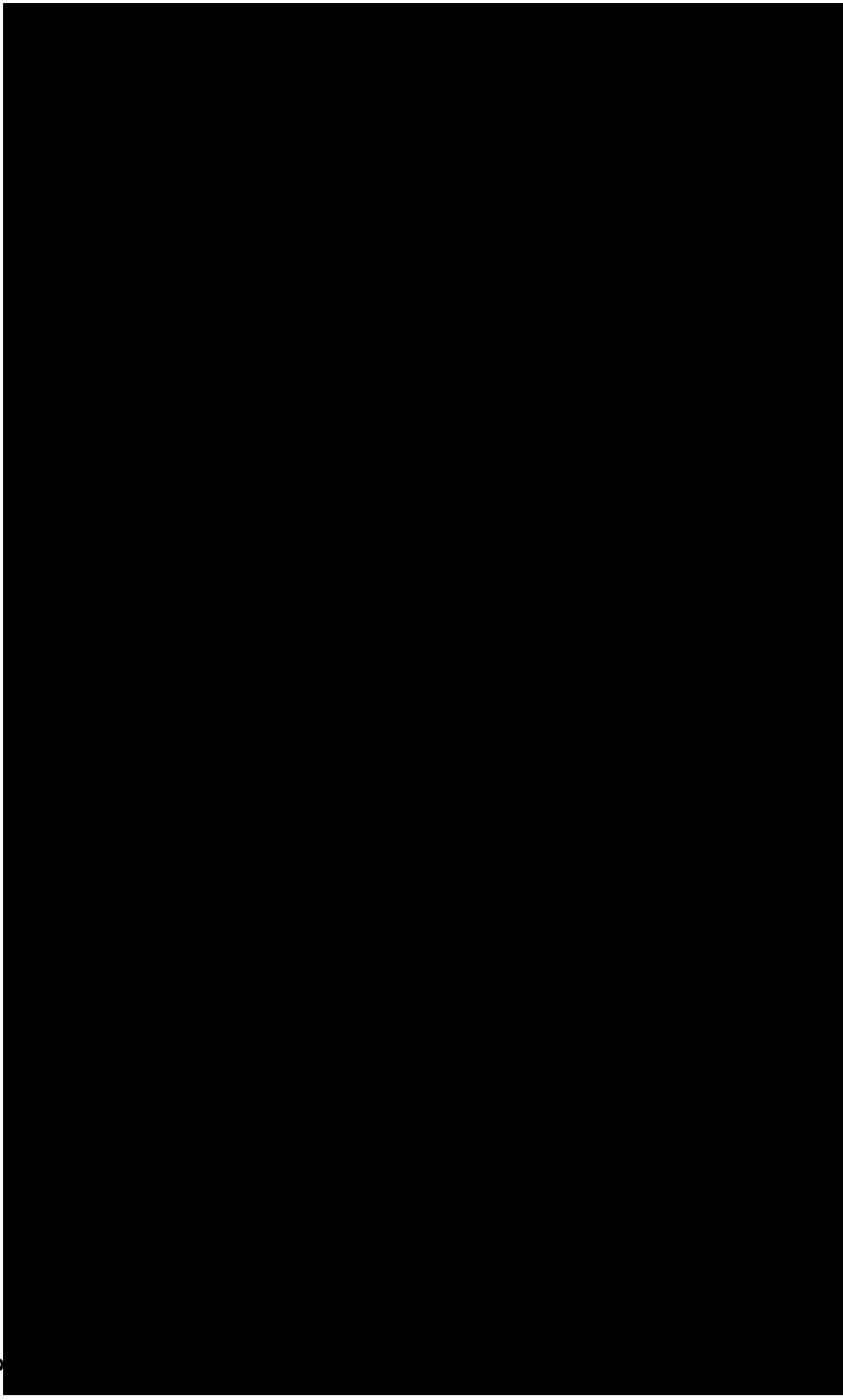
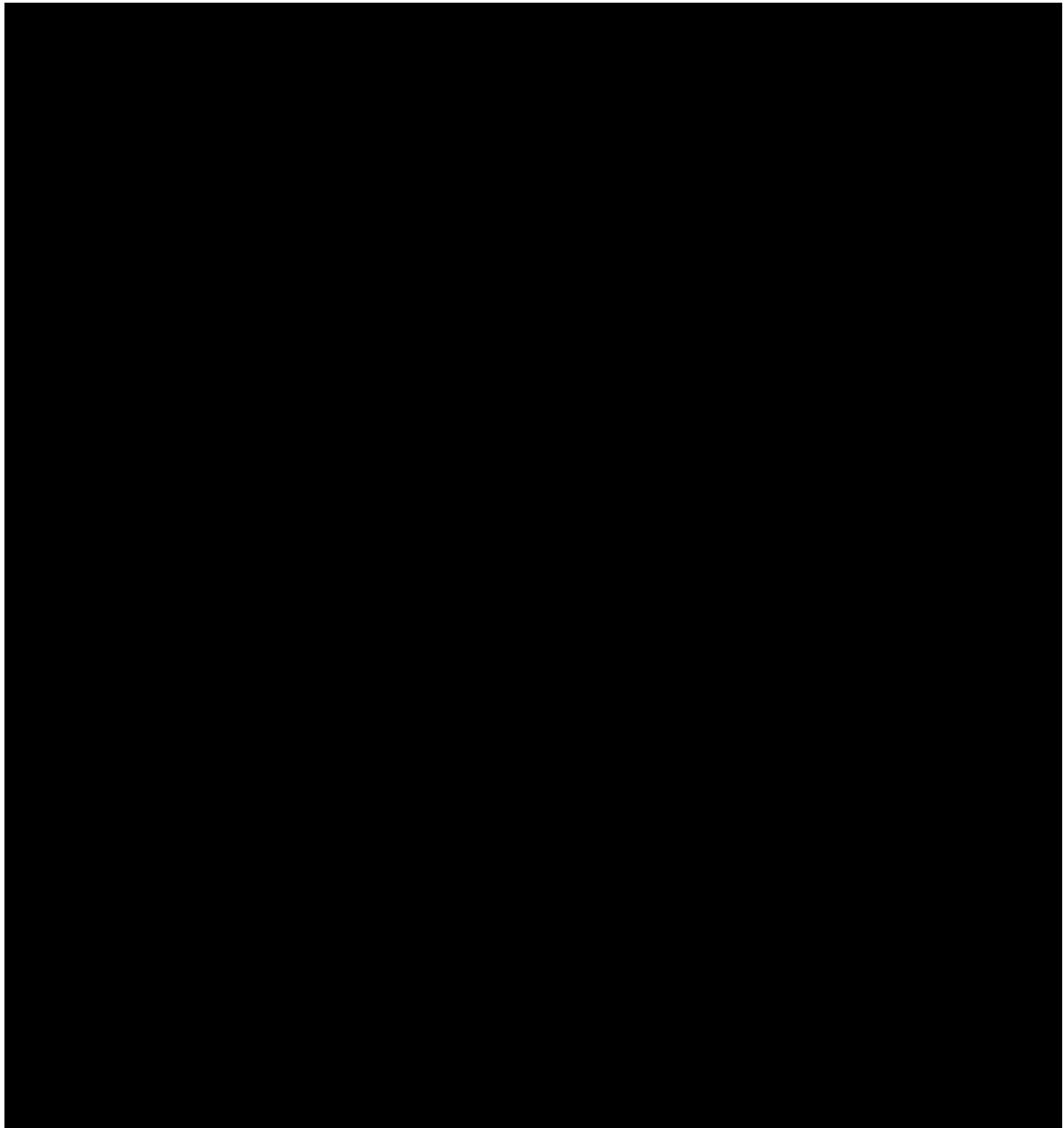


Figure C.2: A Relocation Matrix



Appendix D, Table 1: Development of the ‘Event Without Response’ Effects Matrix

Pre-Event	Event	Immediate	Short-Term	Medium-Term
0-3km	<ul style="list-style-type: none"> Many businesses are expected to reduce operations significantly, owing to earthquakes etc. Exceptions include: health services, transport, sheep and dairy farming and the service sector (insurance, accounting and legal firms, consultants, etc). 	<ul style="list-style-type: none"> Economic activity is expected to be either nil or very low. 	<ul style="list-style-type: none"> A reinstatement of industries is expected, to approximately 50-80% of status quo levels in most sectors, except trade, farming, horticulture, mining, some manufacturing, and accommodation services. 	<ul style="list-style-type: none"> Most sectors are expected to be almost fully operational again, with the exception of trade, horticulture, some manufacturing and accommodation services.
		<ul style="list-style-type: none"> Only the health services and construction industries would operate at a substantial level. Water transport, air transport and services would operate at a lower level. 		<ul style="list-style-type: none"> The trade sector is expected to operate at lower levels, due to loss of warehousing (trade sector). The horticulture sector is expected to operate at lower levels due to loss of arable land (horticulture sector). Manufacturing is expected to operate at lower levels due to difficulty in replacing specialised machinery required for some manufacturing. Accommodation services are expected to operate at lower levels due to delay in rebuilding hotels etc (accommodation services). Mining activities are not expected to restart in the medium-term, given the need to apply for new resource consents.
3-5km	<ul style="list-style-type: none"> Many businesses are expected to reduce operations significantly, owing to earthquakes etc. Exceptions include: health services, transport, sheep and dairy farming and the service sector (insurance, accounting and legal firms, consultants, etc). 	<ul style="list-style-type: none"> Economic activity is expected to be either nil or very low. 	<ul style="list-style-type: none"> A reinstatement of industries is expected, to approximately 50-80% of status quo levels in most sectors, except trade, farming, horticulture, mining, some manufacturing, and accommodation services. 	<ul style="list-style-type: none"> Most sectors are expected to be almost fully operational again, with the exception of trade, horticulture, some manufacturing and accommodation services.
		<ul style="list-style-type: none"> Little activity is expected in the ‘immediate’ time period. Only the health services and construction industries would operate at a substantial level. Water transport, air transport and services would operate at a lower level. 		<ul style="list-style-type: none"> The trade sector is expected to operate at lower levels, due to loss of warehousing (trade sector). The horticulture sector is expected to operate at lower levels due to loss of arable land (horticulture sector). Manufacturing is expected to operate at lower levels due to difficulty in replacing specialised machinery required for some manufacturing. Accommodation services are expected to operate at lower levels due to delay in rebuilding hotels etc (accommodation services). Mining activities are not expected to restart in the medium-term, given the need to apply for new resource consents.
5-7km		<ul style="list-style-type: none"> Businesses located in the 5-7km zone are expected to recover much more quickly. It is anticipated that road transport and the trade sector will almost fully recover. Agricultural, horticultural and mining activities are expected to resume in the short-term. Manufacturing is expected to operate at higher levels in the short-term. General services, education and entertainment sectors are expected to resume. 	<ul style="list-style-type: none"> Businesses located in the 5-7km zone are expected to recover much more quickly. It is anticipated that road transport and the trade sector will almost fully recover. Agricultural, horticultural and mining activities are expected to resume in the short-term. Manufacturing is expected to operate at higher levels in the short-term. General services, education and entertainment sectors are expected to resume. 	<ul style="list-style-type: none"> Almost all businesses are expected to be nearly fully operational again.

Appendix D, Table 2: Development of the ‘Event Without Response’ Relocation Matrix

	Critical Infrastructure	Transport and Trade	Primary Industries	Manufacturing	Service Sector
Pre-Event to Short Term	<ul style="list-style-type: none">• Critical Infrastructure Services were expected to mostly relocate to the greater Auckland area, and to the rest of the North Island.• Construction was expected to disperse mostly through the 5-7km zone, as reconstruction begins.	<ul style="list-style-type: none">• Transport Services and Trade were expected to disperse throughout New Zealand zones.	<ul style="list-style-type: none">• Agricultural and Horticultural Activities were expected to disperse throughout New Zealand zones.• A significant proportion of horticultural produce would likely be imported.• Mining would likely relocate offshore, and mined products would be imported.	<ul style="list-style-type: none">• Manufacturing and Food Production activities were expected to relocate across New Zealand, with some imports required.• Manufacturing involving specialised equipment was expected to be difficult to relocate. Subsequently, it was anticipated that 50% of production was likely to be imported.	<ul style="list-style-type: none">• It was anticipated that the Service Sectors would relocate mostly through greater Auckland North Island, with some Service and Entertainment activities relocating to the Island and offshore.
Medium Term	<ul style="list-style-type: none">• It was anticipated that the majority of Critical Infrastructure would relocate back to the 5-7km zone and greater Auckland.• Some Health Care and Electricity Supply would likely remain in the rest of the North Island.	<ul style="list-style-type: none">• Some Transport and Trade was expected to relocate back to the 5-7km zone and greater Auckland area.	<ul style="list-style-type: none">• Agricultural and Horticultural activities were expected to remain spread throughout New Zealand during this time, with significant imports of horticultural produce.• Mining was not anticipated to return to New Zealand in the medium-term.	<ul style="list-style-type: none">• Imports of Manufactured goods were expected to ease as manufacturing and food processing gradually returns to the 5-7km zone.	<ul style="list-style-type: none">• Service Sectors (including Accommodation, Education, Entertainment and other services) were expected to relocate more of their activities to the 5-7km zone.

The ‘Event Without Response’ Effects Matrix and Relocation Matrix summarise industry representatives’ comments and responses during an initial workshop, and the Exercise Ruaumoko information provided.

Appendix E: Industry Responses

The workshops and questionnaires involved experts from various industrial sectors including: supermarkets, manufacturing, construction, land development, roading, water, telecommunications, insurance, banking, tourism, retail, and small to medium sized service sector businesses. This data was used to produce the 'Event With Response' scenario, and subsequently to produce the effects and relocation matrices.

1. Businesses Own Mitigating Actions:

The questionnaires commenced by asking industry representatives what actions their business could take to reduce the effects of a volcanic event on their business. Responses included: preparing, rehearsing and regularly updating a business continuity plan (BCP); moving stock, operations and/or staff to other branches; maintaining current lists of staff, customers and suppliers; preparing a list of alternate suppliers, etc.

2. Mitigating Actions Taken by Other Organisations

The questionnaire also asked what actions others (e.g. government agencies, suppliers, and other businesses) could take to reduce the effects of a volcanic event on their business. Responses included: changes to their suppliers' supply chain processes, rapid restoration of key infrastructure requirements, tax and financial relief from the government, etc.

3. Location and Ability to Operate Given a Volcanic Event

The questionnaire surveyed industry representatives on the current location of their business, and their expectations of their business' ability to operate at each time period: pre-event, event, immediate, short-term and medium-term. Industry representatives were also asked where they expected their business would relocate to, in the short-term and medium-to-long-term. The questionnaire sought qualifying reasons for the industry representatives' answers to these questions. Finally, the questionnaire asked industry representatives whether their business had a BCP, and whether the BCP or other risk management plans included a section on natural hazards.

a. Critical Infrastructure

The communication services sector response indicated that they anticipate operating at 100% during the pre-event time period, and at even greater levels during and after the event, due to increased demand. The sector indicated that operations would increase in Auckland initially, but would revert back to normal once recovery was complete.

Watercare communicated that depending on the location of an eruption and the level of destruction it causes, restoration of water and wastewater infrastructure could take years to reinstate. Watercare and Metrowater would relocate to other business administration facilities, elsewhere in the Auckland region.

The construction sector's response indicated a reduction in activity during the event and immediately thereafter, due to: inability to reach their place of work, disruption to services and supplies, and diversion of focus to issues arising from the volcanic event. Thereafter, rebuilding would commence, and demand would be high in the 5-7km and wider Auckland area.

b. Transport and Trade

The road transport sector communicated that a volcanic event would likely see funds transferred away from new projects, to the reconstruction of damaged or destroyed road networks. It hopes to operate at 80% efficiency in the short-term period. Transit would like to resume operations at their head office (located 3km from the volcanic event) in the medium-term, if the building and infrastructure could be restored.

c. Manufacturing

Manufacturing is likely to resume operations in the short-term once infrastructure services have been restored, assuming buildings and equipment are not damaged. Production is likely to exceed status quo where demand is high (e.g. for construction materials). Manufacturing is likely to relocate mostly to greater Auckland, gradually moving to the 5-7km zone when possible.

d. Service Sector

The impact of a volcanic event on the service sector would vary widely. Some businesses (e.g. consultants) are able to work remotely, from home with minimal disruption to business. Other businesses (e.g. banking) are able to transfer operations to another hub (e.g. Wellington), and may experience an increase in activity. Other businesses (e.g. hairdressers) are unable to operate at the same capacity without their facilities, staff and customer contact; demand for their services may fall during a volcanic event, when people have less time or money to spend on themselves. Some of these businesses may choose not to reopen, while others may take years to return to normal output levels.

Appendix F: Economic Futures Model

The Economic Futures Model (EFM) is a multi-regional scenario model which traces the economic implications of growth by economic sector and households over a 20 year timeframe. The model adopts a 'systems' perspective in its evaluation of the impacts of growth, acknowledging that many of the issues we face today are highly interconnected and complex. It uses an integrated approach to assess the possible implications of plausible scenarios, given a range of assumptions. The model helps to identify possible criticalities and limiting factors which may result from economic growth using 'what if' scenario analysis. The EFM is based on a multi-regional economic input-output table, capturing the impacts of growth on the study area, as well as on the wider regional and national economies. The model uses input-output mathematics to capture not only the direct effects of final demand growth in a given sector, but also the indirect (i.e. upstream flow-on) and induced (i.e. resulting from consumer spending) multiplier effects associated with this growth. The impacts resulting from each scenario are compared with the 'baseline' Business-As-Usual (BAU) scenario, which is established by estimating sectoral domestic and export final demand as derived from quantitative projections of population and export growth. This baseline analysis can be augmented by including qualitative information on prevailing or imminent economic conditions gathered through literature searches, industry reports, media commentaries, and dedicated workshops and interviews with key regional stakeholders. The EFM enables users to quickly evaluate implications of various growth scenarios against the BAU, or between competing alternative scenarios. It models impacts on population, employment, Gross Regional Product, employee compensation along with a number of environmental indicators. The model can also generate high, medium and low projections, allowing users to track the sensitivity of the BAU to changes in key growth determinants.

Appendix G – Results by Industry Sector: Gross Impact

Total (Direct and Indirect) Gross Output Impacts by Industry Sector and Zone, Without Response

% Difference									
Industry_codon	Industry_name	0 - 3 km zone	3 - 5 km zone	5 - 7 km zone	Rest of Auckland Region	Rest of North Island	Rest of New Zealand	Total	Auckland Region
1	Electricity	-100%	-100%	-44%	-57%	1%	4%	-19%	-79%
2	Gas supply	-100%	-100%	0%	-4%	0%	0%	-5%	-62%
3	Water supply	0%	-100%	-84%	27%	0%	0%	-22%	-49%
4	Waste disposal	-100%	-100%	-86%	-12%	0%	0%	-11%	-28%
5	Health services (incl. hospitals)	-100%	-100%	31%	23%	4%	2%	-6%	-29%
6	Communication services	-100%	-100%	37%	-9%	11%	0%	-15%	-43%
7	Construction	-100%	-100%	0%	17%	1%	0%	0%	-3%
8	Road transport	6%	-41%	-100%	-28%	2%	0%	-10%	-38%
9	Water and rail transport	-100%	-100%	320%	3%	7%	1%	-15%	-65%
10	Air transport	-100%	-100%	-100%	4%	5%	11%	-12%	-28%
11	Trade	-100%	-100%	-68%	-10%	3%	5%	-15%	-39%
12	Horticulture	0%	-100%	-100%	-15%	0%	0%	-2%	-28%
13	Sheep, beef, dairy and other farming	-100%	0%	0%	-8%	0%	0%	0%	-8%
14	Mining	-100%	-100%	-100%	-24%	0%	0%	-5%	-37%
15	Food processing	-100%	-100%	-60%	-6%	1%	2%	-3%	-19%
16	Manufacturing - relocatable	-100%	-100%	-72%	-10%	4%	6%	-6%	-27%
17	Manufacturing - not easily relocated	-100%	-100%	-76%	-14%	3%	4%	-12%	-33%
18	Accommodation	-100%	-100%	60%	-9%	1%	0%	-12%	-67%
19	Services	-100%	-100%	-2%	-18%	3%	6%	-21%	-60%
20	Education	-100%	-100%	423%	25%	2%	0%	-5%	-19%
21	Entertainment services	-100%	-100%	194%	0%	6%	5%	-16%	-53%
22	Ownership of owner-occupied dwellings	-100%	-100%	-82%	7%	1%	1%	-5%	-15%
	TOTAL	-100%	-100%	-35%	-7%	2%	3%	-11%	-39%

The above table shows the modelled percentage change in gross output caused by a volcanic event, by industry sectors and by zone, assuming no industry response. Gross output is presumed to fall to zero in the 0-5km zones for almost every industry over the year of the volcanic event. The following columns show where industries suffered, but also where businesses relocated to (depicted as positive percentage changes). For example, education (code 20) is expected to relocate much of its services to the 5-7km zone.

Total (Direct and Indirect) Gross Output Impacts by Industry Sector and Time Period, Without Response

Industry_codn	Industry_name	Pre-event	Event	Immediate	Short Term	Medium Term	Total Auckland	Rest of North Island	Rest of New Zealand
1	Electricity	-86%	-87%	-86%	-82%	-75%	-79%	1%	4%
2	Gas supply	-82%	-83%	-82%	-77%	-46%	-62%	0%	0%
3	Water supply	-52%	-63%	-63%	-52%	-44%	-49%	0%	0%
4	Waste disposal	-29%	-34%	-33%	-29%	-26%	-28%	0%	0%
5	Health services (incl. hospitals)	-34%	-51%	-28%	-28%	-25%	-29%	4%	2%
6	Communication services	-43%	-43%	-43%	-43%	-43%	-43%	11%	0%
7	Construction	-10%	-24%	-26%	-7%	6%	-3%	1%	0%
8	Road transport	-42%	-47%	-45%	-41%	-33%	-38%	2%	0%
9	Water and rail transport	-63%	-84%	-79%	-73%	-55%	-65%	7%	1%
10	Air transport	-36%	-42%	-39%	-36%	-18%	-28%	5%	11%
11	Trade	-46%	-47%	-45%	-41%	-35%	-39%	3%	5%
12	Horticulture	-29%	-29%	-29%	-28%	-28%	-28%	0%	0%
13	Sheep, beef, dairy and other farming	-8%	-8%	-8%	-8%	-8%	-8%	0%	0%
14	Mining	-37%	-37%	-37%	-37%	-37%	-37%	0%	0%
15	Food processing	-25%	-25%	-23%	-19%	-17%	-19%	1%	2%
16	Manufacturing - relocatable	-31%	-35%	-33%	-28%	-25%	-27%	4%	6%
17	Manufacturing - not easily relocated	-42%	-42%	-40%	-33%	-31%	-33%	3%	4%
18	Accommodation	-73%	-73%	-73%	-72%	-62%	-67%	1%	0%
19	Services	-62%	-71%	-69%	-63%	-55%	-60%	3%	6%
20	Education	-53%	-53%	-53%	-21%	-8%	-19%	2%	0%
21	Entertainment services	-69%	-71%	-69%	-60%	-44%	-53%	6%	5%
22	Ownership of owner-occupied dwellings	-25%	-25%	-23%	-21%	-9%	-15%	1%	1%
	TOTAL	-45%	-50%	-47%	-41%	-34%	-39%	2%	3%

The above table shows the modelled percentage change in gross output caused by a volcanic event across the Auckland region, by industry sectors and by time period, assuming no industry response.

Appendix H – Results by Industry Sector: Employment Impacts

Total (Direct and Indirect) Employment Impacts by Industry Sector and Zone, Without Response

Industry_codon	Industry_name	0 - 3 km zone	3 - 5 km zone	5 - 7 km zone	Rest of Auckland Region	Rest of North Island	Rest of New Zealand	Total	Auckland Region
1	Electricity	-100%	-100%	-44%	-57%	2%	4%	-20%	-79%
2	Gas supply	-100%	-100%	0%	-4%	0%	0%	-4%	-62%
3	Water supply	0%	-100%	-84%	27%	0%	0%	-24%	-49%
4	Waste disposal	-100%	-100%	-86%	-12%	0%	0%	-11%	-28%
5	Health services (incl. hospitals)	-100%	-100%	28%	20%	4%	1%	-5%	-28%
6	Communication services	-100%	-100%	37%	-9%	9%	0%	-15%	-43%
7	Construction	-100%	-100%	-3%	18%	1%	0%	0%	-3%
8	Road transport	-11%	-55%	-100%	-27%	2%	0%	-10%	-38%
9	Water and rail transport	-100%	-100%	282%	0%	6%	1%	-14%	-67%
10	Air transport	-100%	-100%	-100%	4%	5%	11%	-11%	-28%
11	Trade	-100%	-100%	-64%	-9%	2%	4%	-12%	-37%
12	Horticulture	0%	-100%	-100%	-9%	0%	0%	-1%	-11%
13	Sheep, beef, dairy and other farming	-100%	0%	0%	-7%	0%	0%	0%	-7%
14	Mining	-100%	-100%	-100%	-24%	0%	0%	-5%	-37%
15	Food processing	-100%	-100%	-56%	-7%	1%	2%	-3%	-22%
16	Manufacturing - relocatable	-100%	-100%	-69%	-9%	5%	6%	-7%	-28%
17	Manufacturing - not easily relocated	-100%	-100%	-74%	-14%	3%	4%	-12%	-34%
18	Accommodation	-100%	-100%	60%	-9%	1%	0%	-12%	-67%
19	Services	-100%	-100%	-15%	-19%	3%	5%	-19%	-60%
20	Education	-100%	-100%	316%	19%	2%	0%	-5%	-19%
21	Entertainment services	-100%	-100%	94%	-5%	4%	4%	-11%	-46%
22	Ownership of owner-occupied dwellings	0%	0%	0%	0%	0%	0%	0%	0%
	TOTAL	-100%	-100%	-25%	-6%	3%	3%	-11%	-39%

The above table shows the modelled percentage change in employment caused by a volcanic event, by industry sectors and by zone, assuming no industry response.

Total (Direct and Indirect) Employment Impacts by Industry Sector and Time Period, Without Response

Industry_codn	Industry_name	Pre-event	Event	Immediate	Short Term	Medium Term	Total Auckland	Rest of North Island	Rest of New Zealand
1	Electricity	-86%	-87%	-86%	-82%	-75%	-79%	2%	4%
2	Gas supply	-82%	-83%	-82%	-77%	-46%	-62%	0%	0%
3	Water supply	-52%	-63%	-63%	-52%	-44%	-49%	0%	0%
4	Waste disposal	-29%	-33%	-33%	-29%	-26%	-28%	0%	0%
5	Health services (incl. hospitals)	-33%	-50%	-28%	-28%	-24%	-28%	4%	1%
6	Communication services	-43%	-43%	-43%	-43%	-43%	-43%	9%	0%
7	Construction	-10%	-25%	-26%	-7%	7%	-3%	1%	0%
8	Road transport	-42%	-49%	-46%	-42%	-32%	-38%	2%	0%
9	Water and rail transport	-63%	-85%	-79%	-74%	-59%	-67%	6%	1%
10	Air transport	-36%	-42%	-39%	-36%	-18%	-28%	5%	11%
11	Trade	-44%	-45%	-43%	-39%	-33%	-37%	2%	4%
12	Horticulture	-11%	-11%	-11%	-11%	-11%	-11%	0%	0%
13	Sheep, beef, dairy and other farming	-7%	-7%	-7%	-7%	-7%	-7%	0%	0%
14	Mining	-37%	-37%	-37%	-37%	-37%	-37%	0%	0%
15	Food processing	-29%	-29%	-26%	-22%	-20%	-22%	1%	2%
16	Manufacturing - relocatable	-32%	-35%	-34%	-28%	-25%	-28%	5%	6%
17	Manufacturing - not easily relocated	-43%	-43%	-41%	-33%	-32%	-34%	3%	4%
18	Accommodation	-73%	-73%	-73%	-72%	-62%	-67%	1%	0%
19	Services	-62%	-71%	-68%	-63%	-55%	-60%	3%	5%
20	Education	-49%	-49%	-49%	-20%	-9%	-19%	2%	0%
21	Entertainment services	-61%	-63%	-60%	-52%	-37%	-46%	4%	4%
22	Ownership of owner-occupied dwellings	0%	0%	0%	0%	0%	0%	0%	0%
	TOTAL	-47%	-52%	-49%	-42%	-35%	-39%	3%	3%

The above table shows the modelled percentage change in employment caused by a volcanic event across the Auckland region, by industry sectors and by time period, assuming no industry response.

Appendix I – Results by Industry Sector: GDP

Total (Direct and Indirect) GDP Impacts by Industry Sector and Zone, Without Response

Industry_codenn	Industry_name	0 - 3 km zone	3 - 5 km zone	5 - 7 km zone	Rest of Auckland Region	Rest of North Island	Rest of New Zealand	Total	Auckland Region
1	Electricity	-100%	-100%	-44%	-57%	1%	4%	-19%	-79%
2	Gas supply	-100%	-100%	0%	-4%	1%	0%	-5%	-62%
3	Water supply	0%	-100%	-84%	27%	0%	0%	-22%	-49%
4	Waste disposal	-100%	-100%	-86%	-12%	0%	0%	-11%	-28%
5	Health services (incl. hospitals)	-100%	-100%	49%	22%	4%	2%	-6%	-29%
6	Communication services	-100%	-100%	37%	-9%	10%	0%	-15%	-43%
7	Construction	-100%	-100%	-3%	17%	1%	0%	0%	-3%
8	Road transport	6%	-41%	-100%	-28%	2%	0%	-10%	-38%
9	Water and rail transport	-100%	-100%	282%	0%	6%	1%	-15%	-67%
10	Air transport	-100%	-100%	-100%	4%	5%	11%	-12%	-28%
11	Trade	-100%	-100%	-68%	-10%	3%	5%	-14%	-39%
12	Horticulture	0%	-100%	-100%	-14%	0%	0%	-3%	-25%
13	Sheep, beef, dairy and other farming	-100%	0%	0%	-7%	0%	0%	0%	-7%
14	Mining	-100%	-100%	-100%	-24%	0%	0%	-5%	-37%
15	Food processing	-100%	-100%	-52%	-7%	1%	2%	-3%	-20%
16	Manufacturing - relocatable	-100%	-100%	-71%	-9%	5%	6%	-6%	-28%
17	Manufacturing - not easily relocated	-100%	-100%	-75%	-15%	3%	4%	-13%	-35%
18	Accommodation	-100%	-100%	63%	-7%	1%	0%	-12%	-67%
19	Services	-100%	-100%	-2%	-18%	3%	6%	-20%	-59%
20	Education	-100%	-100%	375%	23%	2%	0%	-5%	-19%
21	Entertainment services	-100%	-100%	252%	3%	7%	5%	-16%	-54%
22	Ownership of owner-occupied dwellings	-100%	-100%	-82%	7%	1%	1%	-5%	-15%
	TOTAL	-100%	-100%	-30%	-6%	3%	3%	-12%	-40%

The above table shows the modelled percentage change in GDP caused by a volcanic event, by industry sectors and by zone, assuming no industry response.

Total (Direct and Indirect) GDP Impacts by Industry Sector and Time Period, Without Response

Industry_codn	Industry_name	Pre-event	Event	Immediate	Short Term	Medium Term	Total Auckland	Rest of North Island	Rest of New Zealand
1	Electricity	-86%	-87%	-86%	-82%	-75%	-79%	1%	4%
2	Gas supply	-82%	-83%	-82%	-77%	-46%	-62%	1%	0%
3	Water supply	-52%	-63%	-63%	-52%	-44%	-49%	0%	0%
4	Waste disposal	-29%	-34%	-33%	-29%	-26%	-28%	0%	0%
5	Health services (incl. hospitals)	-34%	-51%	-28%	-28%	-25%	-29%	4%	2%
6	Communication services	-43%	-43%	-43%	-43%	-43%	-43%	10%	0%
7	Construction	-10%	-24%	-26%	-7%	6%	-3%	1%	0%
8	Road transport	-42%	-47%	-45%	-41%	-33%	-38%	2%	0%
9	Water and rail transport	-63%	-85%	-79%	-74%	-59%	-67%	6%	1%
10	Air transport	-36%	-42%	-39%	-36%	-18%	-28%	5%	11%
11	Trade	-46%	-48%	-45%	-41%	-35%	-39%	3%	5%
12	Horticulture	-25%	-25%	-25%	-25%	-25%	-25%	0%	0%
13	Sheep, beef, dairy and other farming	-7%	-7%	-7%	-7%	-7%	-7%	0%	0%
14	Mining	-37%	-37%	-37%	-37%	-37%	-37%	0%	0%
15	Food processing	-27%	-27%	-25%	-21%	-19%	-20%	1%	2%
16	Manufacturing - relocatable	-32%	-35%	-34%	-28%	-25%	-28%	5%	6%
17	Manufacturing - not easily relocated	-44%	-44%	-41%	-34%	-32%	-35%	3%	4%
18	Accommodation	-72%	-72%	-72%	-72%	-61%	-67%	1%	0%
19	Services	-61%	-71%	-68%	-62%	-55%	-59%	3%	6%
20	Education	-52%	-52%	-52%	-21%	-9%	-19%	2%	0%
21	Entertainment services	-71%	-73%	-71%	-61%	-44%	-54%	7%	5%
22	Ownership of owner-occupied dwellings	-25%	-25%	-23%	-21%	-9%	-15%	1%	1%
	TOTAL	-46%	-51%	-49%	-42%	-35%	-40%	3%	3%

The above table shows the modelled percentage change in GDP caused by a volcanic event, by industry sectors and by zone, assuming no industry response.