www.bopcivildefence.govt.nz

Review of the regional hazard risk profile for the Bay of Plenty Region 2014

December 2014

Author: Matthew Harrex

(Project team: Brad Scott, GNS Science; Chris Jensen, Kawerau District Council; David Bewley, Whakatāne District Council, Jim Tetlow, Whakatāne District Council; Marc Fauvel, Western Bay of Plenty District Council; Paul Baunton, Tauranga City Council; Paul Spurdle, Rotorua District Council.)

Peer Review: Mark Ivamy, Hazards Advisor, Bay of Plenty Regional Council 31.08.2015

Executive Summary

This report summarises the process undertaken to review the regional hazard risk profile for the Bay of Plenty Region and presents the review results and identifies areas of development to improve the review process next time it is undertaken.

The Bay of Plenty regional hazard risk profile was last substantially reviewed in 2005. As part of the development of the 2nd generation group plan in 2012 a limited review of the risk profile was undertaken due to the restricted time frame.

The 2014 review followed the process identified in the CDEM Group Plan Review Guidelines [DGL 09/09] by reassessing the hazards identified, collating information on the hazard and assessing the likelihood, consequence, seriousness manageability and growth of each hazard. This work was undertaken through a collaborative process where the project team lead the collection of the information and facilitated a stakeholder workshop to assess the likelihood and consequence of each hazard.

The final output of the review is a matrix table that identifies where each hazard sits in terms of their associated likelihood and consequence and their final risk evaluation scores.

Contents

List of Tables

1 Methodology

The project generally followed the risk profile review process set out in the CDEM Group Plan Review Guidelines [DGL 09/09]. Adjustments to the process were made to align the assessment with the approach being developed through the Proposed Change 2 of the Regional Policy Statement (RPS).

The project methodology worked through the following steps:

1. Identify and describe the relevant hazards
2. Collect the existing information on each hazard
3. Assess the risk and seriousness of each hazard
4. Apply manageability and growth ratings
5. Present final hazard risk profile

1.1 Identify and Describe Relevant Hazards

The project team took the existing regional hazard profile as described in the Bay of Plenty CDEM Group Plan 2012-2017 and reviewed the existing list of hazards. Any hazards absent in the existing list list of the hazards were identified. Existing hazards that were similar or duplicates of each other were grouped together. This resulted in a list of hazards with a short description as to their scope.

1.2 Collect Existing Information on Each Hazard

A "key knowledge holder" was identified for each hazard and then contacted to provide an assessment of the hazard. The hazard assessment reports were compiled by the various agencies identified either as having the primary responsibility for managing each individual hazard or the best source of information for the project. The hazard assessment reports are intended to provide a description of the hazards that could impact on the Bay of Plenty and characterise their likelihood and consequences. Where possible a qualitative assessment of the risks was undertaken to evaluate the risk of each hazard against each other and identify management mechanisms available to reduce the impact of each hazard. It is important to note that the information requested and provided in the following document it of a summary level and conclusions for any other purpose other than this risk profile review should not be drawn from it.

Comparing hazards against each other is an invariably difficult task. To manage this task each of the agencies was given a template to complete with guidance notes on how to populate the hazard assessment. The hazard assessments are intended as a high level summary of the hazard using the best current knowledge available at the time. The reports are prepared for all Civil Defence Emergency Management (CDEM) agencies to have a reasonable understanding of the risk presented by this particular hazard, consequently some technical and detailed information may not be reflected in each report. The hazard assessment reports were based on the following template:

- Hazard description
- Maximum credible event
- Likelihood and consequence statement
- Manageability statement
- Growth statement
- Level of confidence

1.2.1 Hazard Description

The hazard description is to provide a short background, context and description of the hazard, areas particularly vulnerable to hazard and any past events of relevance.

1.2.2 Maximum Credible Event

What can be considered to be the maximum credible event, what is the likelihood and consequence of this particular event?

For the purposes of this work the maximum credible event is the largest size event that is known to be possible to occur.

1.2.3 Likelihood and Consequence Statements

For a range of different likelihoods how does the level of consequence change and at what point does the likelihood and consequence present the greatest risk. As the likelihood decreases do the consequences continue to increase or is there a point where consequences are greatest?

What is considered to be the maximum credible event for this hazard.

Consequences are assessed on how they will impact on the four environments (social, built, economic and natural).

Likelihood was asked to be described using the table below (Table 1-1), where specific scenarios were given by agencies they were asked identify the likelihood using the same description .

Table 1-1: Measure of Likelihood – Likelihood of an occurrence over 50 years (from Wright et al 2010 GNS Science Report 2010[1])

AEP	Return Period (Years)	Probability within 50 Years	Qualitative Description
1 in 2500	2500	0.02 or 2%	1 Rare
1 in 500	500	0.1 or 10%	2 Unlikely
1 in 100	100	0.39 or 39%	3 Possible
1 in 50	50	0.63 or 63%	4 Likely
1 in 20	20	0.92 or 92%	5 Almost Certain

The level of consequence was guided by the measure of consequence table included in the CDEM Group Plan Review, Director's Guideline (DGL 09/09), as outlined in Table 1-2 below.

Table 1-2: Measure of Consequence – Consequence of an event (from Directors Guidelines DGL 09/09[2])

Level	Descriptor	Detail description
1	Insignificant	No injuries, little or no damage, low financial loss.
2	Minor	First aid treatment, minor building damage, medium financial loss.
3	Moderate	Medical treatment required, moderate building and infrastructure damage, high financial loss.
4	Major	Extensive injuries, high level of building and infrastructure damage, major financial loss.
5	Catastrophic	Deaths, most buildings extensively damaged and major infrastructural failure, huge financial loss.

[1] Wright, K.C.; Johnston, D.M.; Dellow, G.D.2010. Hazard and risk in the Hawke's Bay: an update of the 2001 assessment. GNS Science Report 2010/06.

[2] Ministry of Civil Defence Emergency Management, CDEM Group Plan Review, Directors Guidelines for Civil Defence Emergency Management (CDEM) Groups [DGL 09/09]

1.2.4 Manageability Statement

This section describes how difficult the hazard is to manage and how much effort is currently put into managing the hazard. This was assessed against the four R's of Reduction, Readiness, Response and Recovery.

1.2.5 Growth Statement

Is the likelihood of the hazard expected to increase or decrease or stay the same over time and are the consequences of the hazard expected to change over time? This is likely to be driven by factors such as, increased population density, more reliance on specific infrastructure, growth of industry.

1.2.6 Level of Confidence

It was recognised that the understanding of hazard risk varies significantly across the range of hazards, so an estimated level of confidence was asked to be given.

1.3 Assess the Risk and Seriousness for Each Hazard

The risk and seriousness of each hazard was assessed on a three step basis. Firstly the project team undertook a preliminary assessment of the likelihood and consequence for each hazard based on the information provided in the hazard assessment reports using the criteria in section 1.2.3. During this process it was identified that the consequence criteria was very general. It gave a limited amount of guidance to assessing the consequence of each hazard across a range of environments, this lead to a range of opinions within a small group of people. The criteria above also suggested that as soon as a life was lost the consequence became catastrophic. While this is tragic it is not necessarily catastrophic on the regional scale of hazards. For example the criteria rated the consequence of a single car crash as the same as an event that could possibly kill tens or hundreds of people.

To address this issue and provide more guidance on the assessment of the consequence the project team decided to adopt a modified version of the consequence table presented in the GNS risk based planning toolbox (

Table 1-3: Hazard consequence table). This also aligned with the approach in the proposed natural hazards provisions in the RPS. Table 1-3 was used in the workshop stage of the risk assessment. For the purposes of this assessment the “hazard zone” was defined as the Bay of Plenty region due to the fact we were trying to compare the regional impact of each hazard. Dollar values were also provided around the proportion of Regional GDP for ease of assessment, these were taken from statistics New Zealand.

The second step of the risk assessment was to hold a workshop and facilitate a collaborative discussion around the likelihood and consequence for each hazard based on the hazard assessment report and the likelihood and consequence guidance.

Invitations were sent out to all Bay of Plenty CDEM Stakeholders to attend the workshop particularly those involved in hazard management including Territorial Authorities (TA’s), Flood Managers, Controllers, Scientists, District Health Board members, Emergency Services, CDEM staff and Technical Specialists. All authors of the hazard assessment reports were invited to attend as were other risk managers from out of the region. The workshop was attended by 33 people from a wide range of disciplines.

Table 1-3: Hazard consequence table (adapted from Suanders et al 2013[3])

Consequence level	Built			Lifelines utility	Economic	Health & safety
	Social/cultural	Buildings	Critical buildings		Regional GDP = $11.2b	
5 Catastrophic	≥25% of buildings of social/cultural significance within hazard zone have functionality compromised	≥50% of affected buildings within hazard zone have functionality compromised	≥25% of critical facilities within hazard zone have functionality compromised	Lifeline out of service for > 1 month (affecting ≥ 20% of the town/city population) OR out of service for > 6 months (affecting < 20% of the town/city population)	>10% of regional GDP (>$1.1 b)	>101 dead and/or >1001 injured
4 Major	11-24% of buildings of social/cultural significance within hazard zone have functionality compromised	21-49% of buildings within hazard zone have functionality compromised	11-24% of buildings within hazard zone have functionality compromised	Lifeline out of service for 1 week – 1 month (affecting ≥ 20% of the town/city population) OR out of service for 6 weeks to 6 months (affecting < 20% of the town/city population)	1-9.99% of regional GDP ($110 mill - $1.1b)	11-100 dead and/or 101-1000 injured
3 Moderate	6-10% of buildings of social/cultural significance within hazard zone have functionality compromised	11-20% of buildings within hazard zone have functionality compromised	6-10% of buildings within hazard zone have functionality compromised	Lifeline out of service for 1 day to 1 week (affecting ≥ 20% of the town/city population) OR out of service for 1 week to 6 weeks (affecting < 20% of the town/city population)	0.1-0.99% of regional GDP ($11.2 mill - $110 mil)	2-10 dead and/or 11-100 injured
2 Minor	1-5% of buildings of social/cultural significance within hazard zone have functionality compromised	2-10% of buildings within hazard zone have functionality compromised	1-5% of buildings within hazard zone have functionality compromised	Lifeline out of service for 2 hours to 1 day (affecting ≥ 20% of the town/city population) OR out of service for 1 day to 1 week (affecting < 20% of the town/city population)	0.01-0.09% of regional GDP ($1.1 mill - $10 mill)	<or = 1 dead and/or 1-10 injured
1 Insignificant	No buildings of social/cultural significance within hazard zone have functionality compromised	<1% of affected buildings within hazard zone have functionality compromised	No damage within hazard zone, fully functional	Lifeline out of service for up to 2 hours (affecting ≥ 20% of the town/city population) OR out of service for up to 1 day (affecting < 20% of the town/city population).	<0.01% of regional GDP (< $1.1 mill)	No dead No injured

After a brief introduction to the purpose and process the attendees were divided into six different groups and given four hazards to assess. Each group had a variety of disciplines and experience to engender as much discussion as possible. For each hazard the groups were given a workshop assessment form (table 1-4) with sections around risk seriousness to complete. For guidance the likelihood, consequence and rating for the current group plan assessment and the project teams' assessment were provided. The above consequence table enabled participants to complete and identify the consequence for each environment (Table 1-4: Workshop risk assessment form). The most serious

[3] Saunders, W. S. A.; Beban. J.G.; Kilvington, M. 2013. Risk-based approach to land use planning. GNS Science Miscellaneous Series 67.

consequence for any environment determined the final consequence rating. For example if the three built categories scored moderate, lifelines and health and safety were minor and economic was rated at major then the final consequence rating was determined as major.

Table 1-4: Workshop risk assessment form

Hazard: Flooding – River/Stream Flooding

Risk

Assessment	Likelihood	Consequence	Rating
Group Plan	Possible	Major	Extreme
Stage 1	Possible	Major	High
Group			
Group			

Seriousness

Assessment	1. Insignificant	2. Minor	3. Moderate	4. Major	5. Catastrophic
H&S					
Built					
Economic					
Natural					

Table 1-1: Measure of Likelihood – Likelihood of an occurrence over 50 years (from Wright et al 2010 GNS Science Report 2010) was provided to give guidance on the likelihood assessment and the final risk rating was determined on criteria set out in the directors guidelines (DGL 09/09). Where risk is a product of likelihood and consequence.

Table 1-5: Risk rating matrix taken from DGL 09/09

Rating			Consequence		
Likelihood	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
A Almost Certain	Moderate	High	Very High	Extreme	Extreme
B Likely	Low	Moderate	High	Very High	Extreme
C Possible	Low	Moderate	Moderate	High	Very High
D Unlikely	Very Low	Low	Moderate	High	Very High
E Rare	Very Low	Very Low	Low	Moderate	High

Once each group had completed the risk assessment for each of their four hazards they swapped their assessments with another group and did the same for four other hazards. The afternoon session was a facilitated discussion comparing the Groups assessments of each hazard to gain agreement across all participants on the likelihood, consequences and seriousness for each hazard.

The workshop identified some areas where some further work was needed to address variances in opinion between attendees on various consequence or likelihoods. Stage three of the risk assessment process was to go through and verify the final workshop assessments against the information provided in the assessment reports or against scientific knowledge where possible. Some assessments were verified with new information that had arisen since the workshop or from the workshop itself. This verification process was validated by the Project Team.

The final consequences identified for each hazard were then assigned a weighting as per the MCDEM guidance to determine the seriousness of each hazard, as shown in Table 1-6: Weightings assigned to each environment. The intention of this is to give more weight to events which have a higher consequence on health and safety. The result of the seriousness calculation was secondary weighting given to the consequences of an event.

Table 1-6: Weightings assigned to each environment

Environment	Weighting
Health and Safety	50%
Built	25%
Economic	15%
Natural	10%

1.4 Apply Manageability and Growth Rating

The manageability rating is based on the combination of management difficulty across the four R's and the current effort being applied. Using the criteria listed in Table1-7, the assessment of manageability was undertaken using the information provided in the hazard assessment reports and verified through the project team.

Table 1-7: Management Assessment Table

Difficulty	Current Effort	Rating
Low	High	1
Low	Medium	2
Medium	High	2
Medium	Medium	3
High	High	3
Low	Low	4
Medium	Low	4
High	Medium	4
High	Low	5

The growth rating is developed based on the probability of the likelihood increasing and the changes in community exposure or consequences. Using the criteria listed in Table 1-8, the assessment of growth was undertaken using the information provided in the hazard assessment reports and verified through the project team.

Table 1-8: Growth Assessment Table

Increase in likelihood	Increase in Consequence	Rating
Low	Low	1
Low	Medium	2
Medium	Low	2
Medium	Medium	3
Low	High	3
Medium	High	4
High	Low	4
High	Medium	4
High	High	5

2 Results and Discussion

2.1 Reviewed list of Hazards

The review of the hazards listed in the 2012-2017Group Plan identified several areas for improvement in the way our hazards were identified and described.

New Hazards to be assessed:

- Volcanic – Caldera unrest
- Slope Instability (Landslide, Debris Flow, Slumping)
- Drought, Regional Deformation
- Dam Failure
- Urban Fire
- Wind Storm
- Flooding was separated into River Stream flooding and Urban and rural ponding to reflect the different causes and management options between the two.
- Coastal Storm was separated into Coastal Erosion and Storm Surge to recognise the different consequences of the two hazards.
- Marine accident – Cruise Liner was renamed as Major Accident – Marine/Port.
- All of the lifelines failure categories were combined into a single hazard.
- Animal and plant pests were combined.
- Two earthquake hazards were combined.
- Major transport accidents for air road, rail were combined.

The following sections (2.1.1 – 2.1.25) Section 2.1 provide a short description of the hazards identified and assessed in the 2014 risk profile review. and a short description of each hazard. This is information summarised from the hazard assessment reports provided to the review team.

2.1.1 Flooding - River Stream

In the 2005 risk profile the flooding hazard was categorised as "Flooding, Rangitaiki River (Whakatāne & Ōpōtiki). The 2014 assessment attempted to take more of a regional focus on the hazard and categorised flooding under two categories. Flooding – River/Stream covers the more traditional understanding of the hazard and assesses the risk and manageability of the flooding originating from excess river or stream flows. The majority of this hazard is managed by the Bay of Plenty Regional Council.

2.1.2 Flooding – Urban Rural/Ponding

Flooding – Urban/Rural Ponding covers the hazard arising from more short intense rainfall events that cause flooding by overwhelming stormwater drainage systems. This hazard is generally managed by Territorial Authorities. Rain associated with a single thunderstorm falls over a small area. Thus, while no single thunderstorm will produce widespread flooding, the suddenness and sheer intensity of the rainfall over a localised area can be hazardous if it continues for long enough. In urban areas, the result is often an overloading of the stormwater system and surface flooding.

2.1.3 Coastal Erosion

Coastal erosion is a natural process resulting from a complex interaction of hydrodynamic processes (such as swell, waves, tides, storm surge, currents and storm sequences), geomorphology and the rate and balance of sediment supply. Most coastlines in the Bay of Plenty are dynamic features which periodically shift between phases of accretion and erosion.

2.1.4 Storm Surge

Storm inundation is also a natural process, although it is restricted to low lying areas. Strong winds and large sea waves generated by major depressions, in phase with the high tide, can lead to coastal inundation. The effect of the wind and waves, together with a locally raised sea level via the "inverted barometer" effect, may result in high water being as much as a metre above the usual high tide mark.

2.1.5 Wind Storm (Including Tornado)

Severe winds and tornado result from many different weather systems affecting the Bay of Plenty. Large, deep low pressure systems ("major depressions") can affect the Bay of Plenty region at any time of the year. Usually these systems originate in the tropics (sometimes as tropical cyclones) or sub-tropics to the north of New Zealand. They draw warm, moist air into New Zealand's latitudes as they pass by, and with it the potential for broad-scale heavy rainfall and/or strong winds and/or coastal inundation. Resulting in:

- Loss of electrical supply, with flow-on effects to essential utilities and agricultural/industrial sectors;
- Property damage i.e. roofs, windows, light frame structures;
- Short-term road closures (tree-falls and power lines);
- Disruption of air and port traffic;
- Potential for ignition of vegetation and structural fires from fallen power lines;
- Vehicles blown off roads; Damage to craft at moorings;
- High demand on emergency services, particularly Police, Fire, and local government contractors;
- Potential for human casualties.

In some circumstances, thunderstorms have strong winds associated with them. Whether straight-line or tornadic (rotating), these winds are sudden, violent and short-lived, can cause large amounts of damage to the built and natural environment, blow vehicles off roads, etc. As with the rain or hail from a single thunderstorm, the strong winds are generally confined to a small area. Strong straight-line winds tend to occur more often in association with fast-moving lines of thunderstorms, whereas tornadoes tend to occur more often with individual thunderstorms.

2.1.6 Tsunami – Distal

A tsunami source with more than 3 hours travel time from the Bay of Plenty is considered as a distal source. Displacement of the sea bed by an earthquake, subsequently generates a rapid displacement of the ocean and generates the tsunami. In the open ocean there is no hazard but as the waves collide with a shoreline inundation occurs. Tsunami travel very quickly (in excess of 500 km/h) and as they approach a shoreline the speed decreases and the height increases. The huge momentum of the water body involved creates the hazard. All parts of the Bay of Plenty coast are exposed to tsunami, but the vulnerability is not uniform. Unlike a local source tsunami, distal sources allow for some form of formal warning to be given.

2.1.7 Tsunami – Local

A tsunami source with a travel time of less than 3 hours from the Bay of Plenty coast is considered as a local source for this discussion. Traditionally a local source would be considered as less than 1 hour (1-3 hours as regional and over 3 hours as distal). Very large earthquakes are the most frequent, but not the only, cause of local tsunami. Submarine landslides and landslips from coastal cliffs, volcanic eruptions and bolide impacts are also possible sources, but are much less common. A very large earthquake associated with the Hikurangi-

Kermadec boundary is recognised as the most likely source with a travel time as little as 50 minutes. Displacement of the sea bed by an earthquake, subsequently generates a rapid displacement of the ocean and generates the tsunami. In the open ocean there is no hazard but as the waves collide with a shoreline inundation occurs. Response to local source tsunami relies on public recognition of the natural warning signs to take action without any formal warning.

2.1.8 Volcanic – Local

In the Bay of Plenty Region there are four active volcanic centres (active in last 20,000 years); the Okataina Volcanic Centre, Mt Edgecumbe (Putauaki), Mayor Island (Tuhua) and White Island (Whaakari). These represent four very different levels of hazard to the region.

The Okataina Volcanic Centre is a caldera volcano and produces infrequent but large volcanic eruptions. Mayor Island (Tuhua) lies offshore from the Tauranga-Whangamata area and had a moderate caldera forming eruption about 6,300 years ago. Future eruptions will significantly affect the island and may have some impact on the coastal areas. Mt Edgecumbe (Putauaki) is a young multiple vent complex near Kawerau. The main cone forms the largest part of the complex, which erupted as a series of lava flows and volcanic breccias. White Island (Whaakari) represents the summit of an active volcanic pile off shore from Whakatane. Typical historic eruptions have no significant impact on the North Island (Bay of Plenty Region) but can have a significant effect on the island.

2.1.9 Volcanic – Distal

Several active volcano systems exist in New Zealand outside of the Bay of Plenty. These primarily are the Kermadec's (Raoul Island and many submarine volcanoes), Auckland Volcanic Field, Taupo Volcanic Centre, the Tongariro National Park volcanoes and Taranaki (Egmont). These represent different levels of hazard to the region, but primarily the hazard is ashfall. Ashfall produces several hazards, ranging from light dusting that create visibility issues to thick falls that could collapse flat rooves. If sufficient ash falls there could be remobilisation of the ash into water ways, streams and rivers.

2.1.10 Volcanic – Caldera Unrest

The largest and possibly the most difficult to assess of New Zealand's volcanoes are the caldera volcanoes. Eruptions and the effects are understood and described in a separate section of this report (see Section 3 Volcanic Local). Eruptions at calderas are preceded by volcanic unrest which may give warning of the impending eruption. However Calderas often exhibit unrest without resulting in an eruption.

Frequently active cone volcanoes, such as Mt. Ruapehu and White Island will often erupt following volcanic unrest. Heightened volcanic unrest at a caldera volcano could in itself be hazardous, consisting of seismicity, deformation, and changes in the gas and hydrothermal systems. Unrest can have a duration of hours to decades at calderas, posing a challenge for its effective management. The Okataina Volcanic Centre and Mayor Island could be the source of this style of volcanic unrest.

2.1.11 Earthquake

Whereas previously the earthquake hazard was split between MM6 and MM8 taking a risk based approach to the hazards enabled the hazard to be assessed as a single category but still comparing the likelihood and consequence of various scenarios to identify the highest risk. The National Seismic Hazard Model for New Zealand (2010) recognises three source zones for earthquakes in the Bay of Plenty region. To the west is the 'extensional western North Island faults', through most of the region is the 'extensional Havre Trough – Taupo Rift faults', while to the east is the 'North Island dextral fault belt'. Further east outside of the Region is the 'Hikurangi subduction margin-forearc'. Damage to infrastructure from large earthquakes is related to aspects of the 'peak ground acceleration' (PGA) and spectral acceleration (SA) at different periods (0.5 and 1 sec) experienced by the structures.

The National Seismic Hazard Model recognises the greater Taupo Rift Faults as the most likely source of significant accelerations, at around a 475 year return period. The North Island dextral fault belt is likely to produce the largest events, but these are less frequent. Earthquakes from the extensional western North Island faults will be smaller than those from the dextral fault belt to the west, but again less frequent.

2.1.12 Slope Instability (Landslide, Debris Flow, Slumping)

The Bay of Plenty region has been formed in part by erosional processes and their interaction on groundwater levels, slope geometry and soil profiles and properties. Interactions between elements within the system primarily manifest themselves in land slippage. The extent and size of any land slippage is directly attributable to the landform shape, soil profile, the extent and manner that development has occurred and the distribution, intensity and length of rainfall event. In some cases land slippage is also triggered by harbour erosion processes that remove toe support from the slope causing the upper layers to slip.

The soils within many parts of the region, are known to be highly complex and very sensitive meaning that prediction of when land slippage will occur and its failure mechanisms requires the skills of a very competent and experienced geo-professional.

Slope instability hazard events that have occurred over recent years that have caused significant property damage and, in the case of Ohope, loss of life. The assessments found that the steep escarpment slopes that form the backdrop to Whakatane, Ohope and Matata have been, and will continue to be, susceptible to landslide events. These landslide hazards represent a significant risk to both people and property. The loss of life risk in some locations is well above international standards of acceptable risk.

Rainfall is the most common triggering mechanism for landslides, followed by earthquakes. Whether landslides are triggered by a rainfall event depends not only on the total rainfall produced, but also the intensity of the rain and antecedent rain, possibly for several months before the storm. Strong earthquakes typically occur on a much less frequent basis than heavy rainfall events, although when they do occur, strong earthquakes can be responsible for triggering multiple landslides. Strong earthquakes are also more likely to generate large to very large landslides than rainfall.

2.1.13 Geothermal

The Bay of Plenty region is home to several large and many smaller high temperature geothermal systems. The surface expression of active geothermal systems can include hot pools, hot mud pools, geysers and warm ground. Burns and scalds are common in geothermal areas and accidental falls into some features may result in death. During any one year small localised geothermal eruptions may occur and will typically affect areas from 5 -50 m from the source. These occur naturally but are more common in geothermal systems that have been disturbed or are actively exploited. Larger geothermal eruption deposits are known and extend from 1 to 30 m thickness and extend to about 1 km from source. These larger events appear to directly related to nearby large scale volcanic eruptions. Damage could result from steam surges, ballistic block fall and hot mudfalls and will be restrict to near the source.

2.1.14 Rural Fire

The Bay of Plenty region has around 20% of its land cover in production forests with indigenous forests covering approximately 47%, and mixed scrub covering a further 4% (based on 2005 figures). Therefore much of our rural area is subject to a degree of risk from fire. Kawerau for instance is situated on the western edge of the largest commercial forest in the world, an obvious fire threat exists. The predominant wind is from the south, which could easily fuel a major fire in the direction of Kawerau where the forest abuts to the east and south. Such an event would necessitate the temporary evacuation of the township.

Fire risk increases during periods of low rainfall and humidity. Fires may start naturally by volcanic activity, lightning strikes, floods and earthquakes causing electrical shorts, and high winds or volcanic activity causing power lines to arc. The deliberate lighting of fires can never be overlooked. Therefore, during dry summer/autumn months there exists a real extreme fire hazard condition over a wide are of Kawerau, Rotorua and Whakatane districts.

2.1.15 Drought

Drought is a prolonged period when rainfall is lower than normal for part, or the entire region. As a result soil moisture levels are much lower for longer than would usually be experienced, being insufficient for plant growth, and restrictions are often placed on water supply for domestic use, stock and irrigation.

Drought is a hazard when the effects of a continuing dry period become greater than people who live and work in the area are used to managing. For example reducing stocking rates often occur in anticipation of dry periods, but when the dry period becomes a drought, the farmer starts to incur high losses from lower-yielding crops, or from having to sell stock early, or pay more for supplementary feed. Droughts can be very costly as they can affect large areas at a time and the effects can linger for several years after the event.

2.1.16 Regional Deformation

As a consequence of the New Zealand straddling a plate boundary there is a high level of ground deformation occurring. This can be gradual accumulation over years to centuries or catastrophic during a large shallow earthquake or major caldera eruption. The advent of GPS surveying and some satellite based technologies has enabled a better understanding of the areas affected and the rates of deformation. The Taupo Volcanic Zone, a 30-60km wide zone extending south from the Bay of Plenty coast to Tongariro National Park is actively widening about 8-10 mm per year and subsiding at a similar rate in the BOP region. Deformation is also occurring in the eastern axial ranges at lesser rates. Differential height changes are affecting levels of the Rotorua lakes. Large scale geomorphic areas like the Rangitaiki Plains, Tauranga basin and the Waikite-Ngakuru area are controlled by ground deformation processes. Deformation can also be generated by large scale extraction of fluids (geothermal or groundwater).

2.1.17 Lifeline Utility Failure

A failure of any lifeline utility service that affects a significant part of the Bay of Plenty. This may include:

- Water supply
- Wastewater systems
- Storm Water
- Electrical supply
- Gas supply
- Telecommunications (including radio) system
- Transportation centres or routes (Port, Airport, Highways, rail systems)
- Fuel supply
- Roading
- Information technology and financial systems

Failure may be due to internal system failure. Failures of particular importance are those of a single asset with minimal redundancy that directly impacts on other utilities (possibly leading to cascading failure). Multiple simultaneous failures are also possible. Failures of systems can lead to overload and disruption and may be caused accidentally or deliberately. Some lifelines utilities have multiple pathways to deliver their service (e.g. telecommunications, electricity).

Failures may cause large-scale disruption and economic effects. Consequences and recovery may be long term.

2.1.18 Hazardous Substance Release

In addition to the Port of Tauranga bulk storage fuel terminal there are several pockets of industrial activities that store, transport and use a wide range of hazardous substances across the region including the pulp and paper mills in Kawerau as well as the large number of traffic movements across the region. The nature and scale of these hazards is largely dependent on the substance itself and quantity released. This is however a significant hazard present in the Bay of Plenty Region managed by a wide range of agencies including the New Zealand Fire Service, Local authorities and Worksafe New Zealand.

2.1.19 Major Accident - Air Road Rail

Causes of accidents can be human error, mechanical failure, system/procedural failure, effect of natural hazard (e.g. earthquake or storm event) etc. Most accidents are events that rapidly cause their maximum effects (sudden impact). They rarely have long warning periods. Seriousness of accident depends on amount of people on board the service.

Event characteristics are likely to include:

- High proportions of injuries and deaths
- Extraction and rescue (land or marine)
- Transportation to medical treatment and on site treatment
- Fire fighting
- Scene control and access restrictions
- Destruction of structures in the vicinity of accident (including utility services)
- Disruption to subsequent transportation services
- Possible environmental contamination or secondary hazardous substances incident
- Significant interest and presence of family/ 'meters and greeters'
- Crime scene investigation
- A large number of emergency services agencies in attendance
- Intense media interest (possibly international also)
- Economic impact on commercial enterprise. Economic recover affects a return to normality.
- Social impact on members of the public affected by an incident

2.1.20 Maritime Accident

Port of Tauranga is New Zealand's largest in terms of total cargo volume. For the year ended June 2013, 1,529 vessels called at Port of Tauranga. During the 2012/13 cruise ship season a total of 84 cruise ships visited the port of Tauranga.

In addition to a very busy port a narrow entrance into the Tauranga harbour and shallow bar crossings across the region contribute to a significant hazard of a maritime accident to the Bay of Plenty Region. The Bay of Plenty Regional Council (BOPRC) assesses the risk of hazards in the Tauranga harbour on a regular basis. The major maritime accidents can be categorised into 5 general categories:

1. Grounding
2. Collision
3. Contact berthing
4. Fire or Explosion
5. Pollution

In October 2011 the container ship MV Rena ran aground on the Astrolabe reef off the Bay of Plenty coast spilling more than 350 tonnes of heavy fuel oil, losing containers overboard with oil and debris subsequently washing up on the coastline. This is considered New Zealand's worst maritime environmental disaster. The tier three response lead by Maritime New Zealand required significant resources from all emergency management agencies in the region and across the country.

Vessels enter and exit the Tauranga Harbour through the narrow entrance between Mount Maunganui and Matakana Island. Any steering, engine or operator failure while passing through this passage could result in a ship grounding,

It is also through this passage (where recreational fishing vessels often anchor) a collision between a large commercial vessel is most likely.

2.1.21 Dam Failure

Dam failure is a hazard due to the potential for an unexpected and sudden release of water and/or sediment into a waterway or on to land. A dam failure may trigger further dam failure (of dams downstream), flooding or erosion which may result in bridge collapse or road washout.

Dam failure is most likely to be triggered by heavy rain events but may also be triggered by earthquakes. Dams are constructed to hold water or sediment. Some dams are normally empty and are used for stormwater detention.

There have been two significant dam failures in the Bay of Plenty region. The Ruahihi Canal failed in 1981 within days of being commissioned. As a result of many small and one massive slope failure up to one and a half million cubic metres of debris descended down the valley and across SH29 and into the Wairoa River. There were no injuries.

Also in 1981 the headrace of the newly completed Whaeo Power Station (on the Rangitāiki River in Kaiangaroa forest) failed sending millions of cubic meters of water down the penstock face and dislodging the power station from its foundations and covering it with debris. The failure was in part due to huge caverns under the headrace, which were located and pumped full with grout when the headrace was reinstated.

There is anecdotal evidence of a few small dam failures, in some cases unintentional dams (that formed due to natural processes and physical restrictions eg. railway embankment) and one record of a small debris dam failure. These did not result in injuries.

2.1.22 Urban Fire

In densely populated urban areas, heavily developed industrial area or large scale factories and mills there is always the potential for a small scale fire to spread to a point where it difficult for the fire service to control the fire let alone extinguish it. Two recent examples of this include the fire at the abandoned Southdown freezing works in Onehunga, Auckland, and the Tamahere cool store fire just out of Hamilton.

2.1.23 Civil Unrest/Terrorism

The threat of Civil Unrest and Terrorism is managed by New Zealand Police. The hazard assessment of this category is somewhat sensitive and cannot be described fully within this document. However for the sake of comparison with other hazards within the region the assessment of this hazard has not varied significantly since the 2005 assessment, with the exception of the likelihood changing from rare to unlikely, but the overall risk rating remains at moderate. All other scores for the seriousness and manageability assessments can be considered to be the same as identified within the 2012-2017 Group Plan.

2.1.24 Plant and Animal Pests and Disease

New incursions of plants and animals pests or diseases are a genuine threat that could be introduced through a number of vectors, both accidentally and intentionally. They have the ability to significantly influence and change the environment and the ability for humans to interact with that environment (didymo), have a significant negative impact economically through increased control costs or a reduction in productivity (Psa-V), and can potentially transfer to and infect humans impacting human health (avian influenza).

Agriculture and horticulture, particularly monocultures, are more vulnerable to pests and diseases. Intensified single species agriculture or horticulture, such as forestry, kiwifruit, or dairy farms provides an ideal platform for an introduced pest or disease to thrive. A number of hosts are available and in close proximity helping the organisms to potentially establish, and spread.

Hazards associated with new incursions of animal or plant pests are hard to quantify and vary considerably depending on the organism. Introduced pests often behave very differently, compared to their natural environment; therefore their effect once established can be difficult to estimate. Regardless of this, the threat is real and potentially significant.

The costs associated with managing these pests and diseases is significant, as an example it is estimate that over $1 billion dollars will be spent on the eradication of bovine tuberculosis by the time the level of infection is reduced to 'official freedom' levels.

2.1.25 Human Pandemic

A pandemic is an epidemic that becomes very widespread and affects a whole region, a continent or the world. An influenza pandemic is the most likely event to cause a large-scale health emergency. Three major influenza pandemics occurred in the 20th century, reaching New Zealand in 1918, 1957 and 1968. Recent estimates put mortality from the 1918 pandemic at between 50 million and 100 million worldwide. In New Zealand, the 1918 pandemic is estimated to have infected between a third and one half of the entire population, causing about 8000 deaths, of which at least 2160 were Maori. However, the first wave of influenza A (H1N1) 2009 reminds us that some pandemics may have only a small impact on death rates.

Influenza pandemics are characterised by the global spread of a novel type of virus, and may cause unusually high morbidity and mortality for an extended period. Most people are immunologically naive to the novel virus, and are therefore susceptible to infection. A severe pandemic can overwhelm the resources of a society due to the exceptional number of people affected. A pandemic entails not only the emergence of a new viral subtype, but also the capacity of that virus to spread efficiently from person to person and cause significant human illness

2.2 Collate Existing Hazard Information

The current hazard information was collated into the Bay of Plenty Regional Hazards Assessment 2014 report (objective Ref A1824888). The hazard assessment reports are intended to provide a description of the hazards that could impact on the Bay of Plenty and characterise their likelihood and consequences. Where possible a qualitative assessment of the risks was undertaken to evaluate the risk of each hazard against each other and identify management mechanisms available to reduce the impact of each hazard. It is important to note that the information requested and provided in the document is of a summary level and conclusions for any other purpose other than this risk profile review should not be drawn from it.

Comparing hazards against each other is an invariably difficult task, to manage this each of the agencies was given a template to complete with guidance notes on how to populate the hazard assessment. The hazard assessments are intended as a high level summary of the hazard using the best current available knowledge at the time. The reports are prepared for all Civil Defence Emergency Management (CDEM) agencies to have a reasonable understanding of the risk presented by this particular hazard, consequently some technical and detailed information may not be reflected in each report.

2.3 Risk and Seriousness Assessment

The full spreadsheet detailing the results of the three rounds of assessment is stored in by Bay of Plenty Regional Council in Objective (objective Ref A1999382). This details all calculation outlined in the methodology section. Table 2-1 shows all 25 hazard assessments for likelihood and consequence and the final risk rating. This table is ranked by the risk rating, from extreme to low. Table 2-1 illustrates that the final rating of risk is not necessarily a function of either likelihood or consequence on their own and it is important to consider both factors when assessing the risk of a particular hazard. The two highest risk hazards are not the most likely hazards. The hazards of windstorm and local source tsunami illustrates clearly how two hazards with different likelihoods and consequence can present the same level of risk. The Bay of Plenty has two hazards rated as extreme in Plant and Animal Pest and Disease, and Human Pandemic, four hazards with a very high risk and 12 rated as high. Therefore 18 of the 25 hazards are classified in the high or above risk rating.

Table 2-1: 2014 Hazards Likelihood, Consequence and Final Risk Rating

Hazard	Likelihood	Consequence	Risk Rating
Plant & Animal Pests & Diseases	Likely	Catastrophic	*Extreme*
Human Pandemic	Likely	Catastrophic	*Extreme*
Tsunami - Local	Unlikely	Catastrophic	*Very High*
Wind storm (including tornado)	Almost Certain	Moderate	*Very High*
Drought	Almost Certain	Moderate	*Very High*
Flooding - Urban/Rural Ponding	Almost Certain	Moderate	*Very high*
Dam Failure	Rare	Catastrophic	*High*
Volcanic - Local	Rare	Catastrophic	*High*
Tsunami - Distal	Unlikely	Major	*High*
Earthquake - Severe	Possible	Major	*High*
Hazardous Substances Release	Likely	Moderate	*High*
Flooding - River/Stream	Possible	Major	*High*
Volcanic - Distal	Likely	Moderate	*High*
Lifeline Utility Failure	Likely	Moderate	*High*
Slope Instability (Landslide, Debris Flow, Slumping)	Almost Certain	Minor	*High*
Storm Surge	Almost Certain	Minor	*High*
Coastal Erosion	Possible	Major	*High*
Volcanic - Caldera Unrest	Likely	Moderate	*High*
Major Accident (Marine/Port)	Possible	Moderate	*Moderate*
Major Transport Accident (Air, Road, Rail)	Possible	Moderate	*Moderate*
Rural Fire	Possible	Moderate	*Moderate*
Urban Fire	Unlikely	Moderate	*Moderate*
Civil Unrest/Terrorism	Unlikely	Moderate	*Moderate*
Regional Deformation (Long Term)	Almost Certain	Insignificant	*Moderate*
Geothermal	Unlikely	Moderate	*Low*

The interesting part of this process is that the main driver for a catastrophic consequence for some hazards was not necessarily loss of life. The most serious consequence for the Plant & Animal Pests & Disease was on the economic environment, similarly with drought. The impact from Local Source Tsunami and Human Pandemic were most serious in the health and safety category as well as the economic environment. Hazards such as Fluvial Flooding, Distant Source Volcanoes and Lifeline Failure were seen to have the most impact on the built and economic environments.

Table 2-12 shows the hazards ranked on their seriousness score after they were assessed for the level of consequence and given a weighting for each category described in Table 1-6. Assigning a seriousness score to each hazard results in those hazards which result in loss of life and damage to property are determined to be more serious. This significantly shuffles the order of the table compared to Table 2-1, local source tsunami now becomes the top ranked hazard and Plant & Animal Pests and Disease drops down to number eight on the list. Flooding – urban/rural ponding also gets pushed from number six down to twenty four in the list.

Table 2-2: Hazards and associated scores for consequences across the four environments

Hazard	H&S	Built	Economic	Natural	*Sub-total*
Tsunami - Local	5	4	5	3	9.1
Dam Failure	5	2	4	2	7.6
Volcanic - Local	3	4	5	4	7.3
Human Pandemic	5	1	5	1	7.2
Tsunami - Distal	4	3	4	2	7.1
Earthquake - Severe	3	4	4	2	6.6
Major Accident (Marine/Port)	3	2	4	4	6
Plant & Animal Pests & Diseases	3	1	5	2	5.4
Hazardous Substances Release	3	2	3	2	5.3
Wind storm (including tornado)	3	2	3	1	5.1
Major Transport Accident (Air, Road, Rail)	4	1	1	1	5
Flooding - River/Stream	2	3	3	2	4.8
Volcanic - Distal	2	3	3	2	4.8
Lifeline Utility Failure	2	3	3	1	4.6
Rural Fire	2	2	3	3	4.5
Urban Fire	2	2	3	1	4.1
Slope Instability (Landslide, Debris Flow, Slumping)	2	2	2	1	3.8
Civil Unrest/Terrorism	2	2	2	1	3.8
Geothermal	2	2	2	1	3.8
Drought	2	1	3	2	3.8
Volcanic - Caldera Unrest	2	1	3	1	3.6
Coastal erosion	1	2	4	2	3.6
Storm surge	1	3	3	1	3.6
Flooding - Urban/Rural Ponding	1	2	3	1	3.1
Regional Deformation (Long Term)	1	1	1	1	2

2.4 Apply Manageability and Growth Ratings

Table 2-3 shows the manageability ratings assigned to each hazard across the four R's. The manageably score is an average of each of the fours scores. Each individual score represents a combination of the difficulty and effort in managing each hazard under each of the R's, as illustrated in Table 1-7. The far right column shows the rating assigned to indicate the growth factor associated with each hazard. The growth factor is based on the probability of an increase in likelihood or an increase in consequence for each hazard. Table 2-3 is not displayed or sorted in any specific order and demonstrates the level of manageability applied to each hazard. The growth column show which hazards are likely to become more significant over time.

Table 2-3: Manageability and Growth Ratings

Hazard	Reduction	Readiness	Response	Recovery	Growth
Tsunami - Local	4	3	3	4	2
Tsunami - Distal	4	1	1	4	2
Plant & Animal Pests & Diseases	3	2	2	3	2
Hazardous Substances Release	3	2	1	3	1
Slope Instability (Landslide, Debris Flow, Slumping)	3	2	3	3	1
Civil Unrest/Terrorism	3	3	3	2	1
Human Pandemic	2	2	2	2	3
Major Accident (Marine/Port)	2	2	1	2	3
Volcanic - Distal	2	1	1	2	2
Lifeline Utility Failure	2	2	1	3	2
Volcanic - Caldera Unrest	2	2	1	2	2
Geothermal	2	2	1	2	1
Storm surge	2	1	1	2	4
Regional Deformation (Long Term)	2	2	2	2	1
Dam Failure	1	3	3	2	1
Major Transport Accident (Air, Road, Rail)	1	2	1	2	2
Volcanic - Local	1	1	1	4	2
Earthquake - Severe	1	1	1	4	2
Wind storm (including tornado)	1	1	1	2	3
Flooding - River/Stream	1	1	1	2	3
Rural Fire	1	1	1	2	2
Urban Fire	1	1	1	2	1
Drought	1	2	2	2	4
Coastal erosion	1	1	1	2	4
Flooding - Urban/Rural Ponding	1	1	1	2	4

2.5 Present Final Hazard Risk Profile

Table2 -4 shows the final hazard ranking by priority when risk, seriousness, manageability and growth are all taken into account. Table 2-6 presents all of the results in a single table as is currently displayed in the 2012-2017 Group Plan. The results of this work clearly demonstrates that depending on which aspect of the hazard you want to look at the ranking of each hazard varies considerably and is seldom the same. This difficulty with presenting results in a table of priority is that the understanding behind how the priority is assigned is lost and it is simply interpreted as the highest risk hazards.

A more simple way to present the results could be to present a top 10 list of hazards according to likelihood, consequence and seriousness only. Taking this approach would be displayed at is shown in Table 2-5. Another approach could be to present Table 2-4 not as a list but just with the hazards group into high medium and low priority hazards and remove the scores and ratings. This could be best combined with a matrix table showing where each of the hazards fit in terms of likelihood and consequence as shown in Table 2-7 where the hazards associated priority score is listed in brackets beside the hazard name and the colour of each square represent the hazard risk rating as determined in Table 1-5.

Table 2-4: Hazards ranked by priority

Hazard	Rating	Score
Higher Priority Hazards		
Tsunami - Local	*Very High*	14.6
Human Pandemic	*Extreme*	12.2
Tsunami - Distal	*High*	11.6
Volcanic - Local	*High*	11.1
Dam Failure	*High*	10.9
Major Accident (Marine/Port)	*Moderate*	10.8
Earthquake - Severe	*High*	10.4
Plant & Animal Pests & Diseases	*Extreme*	9.9
Drought	*Very High*	9.6
Wind storm (including tornado)	*Very High*	9.4
Storm surge	*High*	9.1
Flooding - River/Stream	*High*	9.1
Medium Priority Hazards		
Coastal erosion	*High*	8.9
Lifeline Utility Failure	*High*	8.6
Hazardous Substances Release	*High*	8.6
Slope Instability (Landslide, Debris Flow, Slumping)	*High*	8.6
Civil Unrest/Terrorism	*Moderate*	8.6
Major Transport Accident (Air, Road, Rail)	*Moderate*	8.5
Flooding - Urban/Rural Ponding	*Very high*	8.4
Volcanic - Distal	*High*	8.3
Rural Fire	*Moderate*	7.8
Volcanic - Caldera Unrest	*High*	7.4
Low Priority Hazards		
Geothermal	*Low*	6.6
Urban Fire	*Moderate*	6.4
Regional Deformation (Long Term)	*Moderate*	5.0

Table 2-5: Top 10 Bay of Plenty Hazards by Risk and Seriousness

	Hazard
1	Tsunami - Local
2	Dam Failure
3	Volcanic - Local
4	Human Pandemic
5	Tsunami - Distal
6	Earthquake - Severe
7	Major Accident (Marine/Port)
8	Plant & Animal Pests & Diseases
9	Hazardous Substances Release
10	Wind storm (including tornado)

Table 2-6: Complete Risk Profile Table of Bay of Plenty Hazards

Hazard Identification	Risk Analysis 2014 (Verification)			Risk Evaluation											
Bay of Plenty Hazards	Likelihood	Consequence	Rating	Seriousness					Manageability					Growth	Total
				H&S	Built	Economic	Natural	*Score*	Reduction	Readiness	Response	Recovery	*Score*	*Score*	
Higher Priority															
Tsunami - Local	Unlikely	Catastrophic	*Very High*	5	4	5	3	9.1	4	3	3	4	3.5	2	14.6
Human Pandemic	Likely	Catastrophic	*Extreme*	5	1	5	1	7.2	2	2	2	2	2	3	12.2
Tsunami - Distal	Unlikely	Major	*High*	4	3	4	2	7.1	4	1	1	4	2.5	2	11.6
Volcanic - Local	Rare	Catastrophic	*High*	3	4	5	4	7.3	1	1	1	4	1.75	2	11.1
Dam Failure	Rare	Catastrophic	*High*	5	2	4	2	7.6	1	3	3	2	2.25	1	10.9
Major Accident (Marine/Port)	Possible	Moderate	*Moderate*	3	2	4	4	6	2	2	1	2	1.75	3	10.8
Earthquake - Severe	Possible	Major	*High*	3	4	4	2	6.6	1	1	1	4	1.75	2	10.4
Plant & Animal Pests & Diseases	Likely	Catastrophic	*Extreme*	3	1	5	2	5.4	3	2	2	3	2.5	2	9.9
Drought	Almost Certain	Moderate	*Very High*	2	1	3	2	3.8	1	2	2	2	1.75	4	9.6
Wind storm (including tornado)	Almost Certain	Moderate	*Very High*	3	2	3	1	5.1	1	1	1	2	1.25	3	9.4
Storm surge	Almost Certain	Minor	*High*	1	3	3	1	3.6	2	1	1	2	1.5	4	9.1
Flooding - River/Stream	Possible	Major	*High*	2	3	3	2	4.8	1	1	1	2	1.25	3	9.1
Medium Priority															
Coastal erosion	Possible	Major	*High*	1	2	4	2	3.6	1	1	1	2	1.25	4	8.9
Lifeline Utility Failure	Likely	Moderate	*High*	2	3	3	1	4.6	2	2	1	3	2	2	8.6
Hazardous Substances Release	Likely	Moderate	*High*	3	2	3	2	5.3	3	2	1	3	2.25	1	8.6
Slope Instability (Landslide, Debris Flow, Slumping)	Almost Certain	Minor	*High*	2	2	2	1	3.8	3	2	3	3	2.75	2	8.6
Civil Unrest/Terrorism	Unlikely	Moderate	*Moderate*	2	2	2	1	3.8	3	3	3	2	2.75	2	8.6
Major Transport Accident (Air, Road, Rail)	Possible	Moderate	*Moderate*	4	1	1	1	5	1	2	1	2	1.5	2	8.5
Flooding - Urban/Rural Ponding	Almost Certain	Moderate	*Very high*	1	2	3	1	3.1	1	1	1	2	1.25	4	8.4
Volcanic - Distal	Likely	Moderate	*High*	2	3	3	2	4.8	2	1	1	2	1.5	2	8.3
Rural Fire	Possible	Moderate	*Moderate*	2	2	3	3	4.5	1	1	1	2	1.25	2	7.8
Volcanic - Caldera Unrest	Likely	Moderate	*High*	2	1	3	1	3.6	2	2	1	2	1.75	2	7.4
Low Priority															
Geothermal	Unlikely	Moderate	*Low*	2	2	2	1	3.8	2	2	1	2	1.75	1	6.6
Urban Fire	Unlikely	Moderate	*Moderate*	2	2	3	1	4.1	1	1	1	2	1.25	1	6.4
Regional Deformation (Long Term)	Almost Certain	Insignificant	*Moderate*	1	1	1	1	2	2	2	2	2	2	1	5.0

Table 2-7 Risk Matrix of Bay of Plenty Hazards

	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	Regional Deformation **(5.0)**	Slope Instability **(8.6)** Strom Surge **(9.1)**	Wind Storm **(9.4)** Drought **(9.6)** Flooding - Urban/Rural Ponding **(8.4)**		
Likely			Hazardous Substance Release **(8.6)** Volcanic - Distal **(8.3)** Lifeline Utility Failure **(8.6)** Volcanic - Caldera Unrest **(7.4)**		Plant and Animal Pests and Disease **(9.9)** Human Pandemic **(12.2)**
Possible			Major Accident - Marine **(10.8)** Major Transport Accident **(8.5)** Rural Fire **(7.8)**	Earthquake - Severe **(10.4)** Flooding - River/Stream **(9.1)** Coastal Erosion **(8.9)**	
Unlikely			Geothermal **(6.6)** Urban Fire **(6.4)** Civil Unrest/Terrorism **(8.6)**	Tsunami - Distal **(11.6)**	Tsunami - Local **(14.6)**
Rare					Volcanic-Local **(11.1)** Dam Failure **(10.9)**

3 Observations

As with any project several issues arose along the way but through having a project team to work through the issues and make a consensus based decision the process was able to be flexible while continuing to focus on delivering valuable and useful outputs. The project set out to utilise existing information and not require agencies to go through a process of seeking out or commissioning work to gather new information. The primary reason for this was to ensure that the review was able to be delivered within a reasonable amount of time but also to ensure that the task of gathering information was not too onerous on those requested to do so. To support this, the development of a template and guidance notes to aid completion was also very useful. However, there was still some difficulty in getting information around various hazards and this is evident in the level of information provided in each of the hazard assessment reports.

Looking at hazards through the lens of risk (i.e. likelihood x consequence) is not necessarily common territory for all stakeholders. So throughout the process participants, particularly at the workshop, needed prompting to go through a number of scenarios with a combination of likelihood and consequences to determine which presented the highest risk.

Using the consequence table to give a better guidance on the impacts was found to be very useful and also helped align the assessment with the Proposed Change 2 of the Regional Policy Statement approach. However this decision was only made half way through the process after the hazard assessment reports had been submitted. Had the authors of the assessment reports been able to align the reports to the consequence table it would have made the workshop assessment more streamlined. Looking through the consequence assessments and discussing with attendees at the workshop the economic consequence was largely due to damage to built infrastructure, which was already assessed through the built environment category. Essentially this resulted in the economic and built consequences being counted twice, this was moderated through the seriousness part of the assessment when weightings for built and economic were lower than the loss of life consequence. Drought and Animal & Plant Pest and Disease are to exceptions where there was no damage to built assets but significant economic consequences.

Gaining engagement from stakeholders in this type of work is always difficult, but due to arranging the workshop with a reasonable lead time and making contact with specific groups who did not see it as a priority minimised this issue. However there were still some groups under represented at the workshop. Despite all attendees at the workshop having their own copy of the hazard assessment, possibly due to the group nature of the workshops, often valid information in these reports was not recognised during the assessment process. This was managed to a certain extent having a facilitated workshop discussion of the groups assessments, groups reviewing each assessment and the final verification process of the results undertaken by the project team.

This aim of this review was always seen as step in the region's development in risk assessment of hazards and there are several limitations to the process. However, it is believed that a valid reassessment of the hazard profile has been undertaken that now recognises the full scope of the regions hazards and presents them in a meaningful way for end users, stakeholders and the community.

There are many opportunities for improving this process including improving the information around the likelihood and consequence of all the hazards but some stand out more than others as evident in the Hazard Assessment report. Less time and effort was spent looking into the manageability of each of the hazards. The development of some guidance or assessment criteria further to that provided in the directors guidelines would help address this to a certain extend and make it less subjective. Similarly the assessment of the growth assessment could benefit from some quantitative guidance around what constitutes high medium and low growth in likelihood and consequence.

Even though this process is partially quantitative there is a substantial qualitative component to it. Therefore, it is somewhat dangerous to rank each hazard in a list according to a score they have been given. Grouping them into general clusters of hazards of high medium and low priority is probably preferable to listing them in a table. Combining this with the risk matrix is a useful way of showing the spectrum of hazards in respect of their likelihood and consequence.