Bay Of Plenty Regional Hazards Assessment
2014

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Acknowledgments

This report was compiled with the help of the Risk Profile Review Project Team consisting of Chris Jensen (Kawerau District Council), David Bewley (Whakatāne District Council), Jim Tetlow (Eastern Bay of Plenty Civil Defence Emergency Management), Marc Fauvel (Western Bay of Plenty District Council), Paul Baunton (Tauranga City Council), Paul Spurdle (Rotorua District Council), Shane Iremonger (Bay of Plenty Regional Council), Brad Scott (GNS) and Matthew Harrex (Bay of Plenty Civil Defence Group).

Individual hazard assessments were provided by numerous staff across all of the local authorities, Metservice, New Zealand Police, New Zealand Fire Service, Bay of Plenty and Lakes District Health Boards, GNS, and the Bay of Plenty Lifelines Group. The project team would like to thank all those that contributed to this report without which the review would not have ben possible.

1 Introduction

For the Bay of Plenty Civil Defence Emergency Management Group to manage risks effectively, it is essential to understand the hazard context across the region. The Bay of Plenty Civil Defence Emergency Management Group undertook to review the regions risk profile in the 2013-2014 financial year. In order to undertake a robust review of the risk profile hazard assessments were undertake for each of the identified hazards across the region. The following 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 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.

The template included six guiding headings.

1.1.1 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.

1.1.2 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.

Likelihood and Consequence Statements

What sort of return periods are certain levels of events likely and what are the consequences of these particular events at this scale? The hazard will also present a risk below the maximum credible event, this is to provide a background as to how often this might be the case and at what level.

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

Discussion around what sort of return periods are we likely to be impacted and what are the consequences of these impacts?

Likelihood was asked to be assessed against the table below, although a specific level for each scenario agencies were asked to provide information so that an assessment can be made.

Table 1.1: Measure of Likelihood – Likelihood of an occurrence over 50 years (from Wright et al 2010 GNS Science Report 2010 46p)

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).

Table 1.2: Measure of Consequence

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.

1.1.3 Manageability Statement

This section describes how difficult is the hazard to manage in terms of Reduction, Readiness, Response and Recovery, and how much current effort is currently put into managing the hazard in terms of Reduction, Readiness, Response and Recovery.

1.1.4 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.

1.1.5 Level of Confidence

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

2 Flooding – River/Stream

In the 2005 risk profile the flooding hazard was categorised as *"Flooding, Rangitaiki River (Whakatāne & Ōpōtiki)*. The 2014 assessment attempts to take more of a regional focus on the hazards and has 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 who provided the assessment information below.

This Hazard assessment was prepared by Bay of Plenty Regional Council as part of the 2013/14 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

2.1 Hazard Description

Bay of Plenty Regional Council manages the Kaituna, Rangitāiki-Tarawera, Whakatāne-Waimana, Waioeka-Otara river schemes and the Rangitāiki Drainage scheme. There have been numerous minor flood events and several significant ones that have had a widespread impact on the community.

Typical weather patterns causing flooding include:

North to northeast airstreams bring very humid air to the whole of the region and often produce widespread and heavy rain when the moist air is forced to ascend over the rising ground of the North Island.

Tropical cyclones moving onto northern New Zealand normally contain very moist air and can deliver heavy rainfalls to the Bay of Plenty.

Vulnerability to flooding varies throughout the region. The greatest threat exists to Opotiki and settlements on the Rangitaiki Plains, some parts of which are below sea level (in part a result of the 1987 Edgecumbe earthquake). Flash flooding can, however, affect any area where drainage is restricted or unable to cope with unusually heavy downfalls. Flooding may also bring with it problems and hazards of landslip on any of the steeper soils of the region. An eruption or earthquake may also cause or lead to rapid overspill of Lake Tarawera from the present outlet. This could flood Kawerau and the Tarawera river catchment.

We will not compartmentalise flooding into urban and rural. The major events will affect both areas simultaneously. Urban stormwater flooding (e.g. Utuhina Stream in Rotorua or Waimapu in Tauranga) are district events, assessed under a separate hazard catergory.

Indications of climate change by the Intergovernmental Panel on Climate Change (IPCC) are that the Bay of Plenty region may receive less rainfall in future, however, the intensity and frequency of high rainfall events are likely to increase. Sea level rise is predicted to rise with increased magnitude of tidal storm surges.

2.2 Likelihood and Consequence Statements

2.2.1 Maximum credible event

Maximum likely event scenario (*Peter Blackwood)*

A 300-year flood affecting the Eastern Bay that creates township flooding through overtopping of stopbanks at Whakatane and Opotiki. Also results in a breach of the Rangitaiki River stopbank, resulting in major rural flooding to many farms and rural-residential properties. There will be major ponding. Extreme rural damage in upper Waimana, with flooding of Waimana Township and possible flooding of Taneatua and Ruatoki. A 100-year event at the same time in Kaituna with major transport disruption. Note maximum credible would be worse, but the probability is remote. A probable maximum flood (PMF) is generally two to three times the Q100(1% AEP) flow in major river systems and the order of five to seven times Q100 in smaller, often urban catchments with localised thunderstorm mechanism in the smaller catchments. (*Peter Blackwood*)

Scenario – mid-range event

Major flooding in Western Bay and Rotorua in Q50. (2% AEP)

These scenarios are an abstract description of what a severe event could look like and may not reflect the maximum credible event. No studies have quantified the maximum credible event in the region to date, however, this work is expected to be carried out in future as part of the Natural Hazards Regional Policy Statement.

2.2.2 Consequences

Human
- Loss of life with many injured
- People displaced from their homes for several weeks
- Possible elderly people trapped in their homes
- Rural families isolated by slips, flood water and bridge collapses

Economic
- Negative impact upon regional reputation and tourism industry
- Major financial losses for many individuals and /or loss of employment
- Long term loss of services
- Permanent loss of many people’s homes

Social
- Loss of access
- Large scale unemployment
- Schools closed, children re-allocated to other schools.

Infrastructural
- Water supply possible contamination, waste water possible leakage (public health risk).
- Damage and disruption to road
- Access denied in and out
- Disruption of services for several days
- Some long term effects on services.

Geographic
- Possible wastewater contamination of streams
- Major impact on valued natural environment
- Complete loss of a valued natural attraction.

2.3 Manageability Statement

Bay of Plenty manages the Kaituna, Rangitāiki-Tarawera, Whakatāne-Waimana, Waioeka-Otara river schemes and the Rangitāiki Drainage scheme providing protection from flooding to urban and rural land. The Rivers and Drainage Asset Management Plan sets service level standards for each of the schemes and ensures that the rivers and drainage assets (i.e. stopbanks, pump stations, etc.) are maintained. Level of service for scheme assets range from 1 in 2 year to 1 in 100 year protection. Flood modelling work is regularly conducted based on scenario events to ensure that stopbanks meet their specified design levels and to estimate potential flood extents.
As part of the Regional Council flood risk reduction, an ongoing 24/7 flood warning service is maintained to provide early advice to the landowners, general public and emergency management authorities within the schemes of impending flood threats. BOPRC is responsible for rainfall data collection, river level and flow monitoring and flood forecasting.

2.4 Growth Statement

Future climate change effects of increased intensity and frequency of rainfall events as well sea level rise will increase the risk to development in coastal areas and within floodplains.
A River Scheme Sustainability study is currently underway to assess if or to what extent the existing flood protection measures throughout the region can be maintained into the future. This may lead to a reduction of level of service that scheme assets will provide, and therefore increase the risk to the community and infrastructure.

2.5 Level of Confidence

The information provided is based on the best information available and there is a medium degree of confidence in the assessment provided.

3 Flooding – Urban/Rural Ponding

In the 2005 risk profile the flooding hazard was categorised as *"Flooding, Rangitaiki River (Whakatāne & Ōpōtiki)*. The 2014 assessment attempts to take more of a regional focus on the hazards and has categorised flooding under two categories. Flooding – Urban/Rural Ponding intends to cover the hazard arising from more short intense rainfall events that cause flooding by overwhelming storm water drainage systems. This hazard is generally managed by territorial authorities, who provided the assessment information below.

3.1 Kawerau District Assessment

This Hazard assessment was prepared by Kawerau District Council as part of the 2013/14 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

3.1.1 Hazard Description

Kawerau has very porous soil so even during normal rainfall events no runoff from grassed areas occurs.
The roading network has good stormwater pits installed and they adequately cope with normal rain events provided the cess pit lids are clear of leaves.
All stormwater ends up in the Tarawera River which is does not flood even during significant rain events. This means that the stormwater system does not back up because outfall pipes are inundated. The Tareawera River is also significantly lower than the residential part of Kawerau enhancing surface flows to the river.
Kawerau has a natural slope in one direction. This means stormwater naturally migrates to the river.

3.1.2 Likelihood and Consequence Statements

During significant rain events flooding has occurred on the roading network in low spots. However the depth of water typically is less than 500mm.
There have been no houses flooded in Kaweau in the last 25 years during rainfall events.
Once the rain ceases the stormwater drains quickly remove any surface water from the roads and typically 30 minutes after a rain event there is no surface flooding present.
The Rurunga stream has covered ground behind the chalets off SH 34 during heavy rain events. The water has got close to the chalets but the buildings were not flooded.
As stated above it is the 30 minute to 2 hour events that appear to cause the greatest problems for Kawerau.
An earthquake or eruption during a heavy rain event is probably the worst combination. This is because stormwater drains could become blocked or damaged resulting in ponding an house inundations.
Based on the consequence table a significant event may result in minor levels of damage but most instances it would be at an insignificant level.

3.1.3 Manageability Statement

Council clears all cess pits prior to events. Staff also work at clearing cess pits during the rain events. For long term rain events the Rurunga stream is monitored.

3.1.4 Growth Statement

The intensity of rain events due to climate change is probably the most significant impact for Kawerau as the population is steady so no new building occurring which would increase sealed areas

3.1.5 Level of Confidence

The information above is based on good industry knowledge and experience of living in an area for 25 years and has medium level of confidence

3.2 Ōpōtiki District Assessment

This Hazard assessment was prepared by Ōpōtiki District Council as part of the 2013/14 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.*

3.2.1 Hazard Description

Urban and rural ponding is caused mostly, but not exclusively, by high velocity, high volume rainfall over a short duration in low lying areas. The rainfall both exceeds the capacity of stormwater systems to remove it, or the ability of the ground to absorb it, and results in a "backing up" of the system.

Urban and rural ponding may also occur following high levels of rainfall over extended periods, where catchments are already saturated and stormwater systems are unable to remove water from urban areas into river and drainage systems due to high than normal flow levels.

The Ōpōtiki District is mainly susceptible to urban and rural ponding around the township of Ōpōtiki and throughout the farmland that runs adjacent to the main rivers located in the west of the district. Areas to the east of the District generally do not suffer from ponding, as this contains largely hilly and mountainous areas.

The district has experienced several events in the past that have resulted in ponding within Ōpōtiki town itself and across farmland throughout the district. These have affected traffic movements and in some cases caused minor damage to property.

3.2.2 Likelihood and Consequence Statements

Maximum credible event

In a dry catchment any rainfall event exceeding a rate of more than 25mm p/h over a period of more than an hour is very likely to cause surface ponding to occur.

In a saturated catchment any rainfall event exceeding a rate of more than 15mm p/h over a period of more than 1 hour is very likely to cause surface ponding to occur.

In both circumstances, the higher the rainfall rate and the longer the time period, the more likely ponding is to occur and the more severe the consequences are likely to be. Any event with rainfall amounts exceeding 50mm p/h for extended periods is likely to result in potentially severe urban and rural ponding and is likely to cause damage to property.

Likelihood and consequence assessment

Heavy rainfall events resulting in urban and rural ponding have a high likelihood of occurrence and are likely to increase in frequency with global warming. The likelihood of a rainfall event occurring in the Ōpōtiki District that results in surface ponding is almost certain to occur within 10 years, however, the maximum credible event that would result in damage may be more likely to occur within the next 50 years.

The table below outlines the likelihood and consequence of urban and rural ponding in the Ōpōtiki District.

Table 3.1: Flooding – Urban/Rural ponding risk assessment for the Optoiki District

Rainfall Intensity p/h	Duration	Likelihood of Consequence	Consequence	Risk Rating
Dry catchment 25mm to 40mm	< 1 hour	Almost Certain	Insignificant	Medium
Saturated catchment 15mm to 25mm	< 1 hour	Almost Certain	Insignificant	Medium
Dry catchment > 40mm	> 1 hour	Likely	Minor / Moderate	Medium
Saturated catchment 20mm – 40mm	> 1 hour	Likely	Minor / Moderate	Medium
Saturated catchment > 40mm	> 1 hour	Possible	Moderate	Medium

3.2.3 Manageability Statement

Reduction of the impacts of urban and surface ponding events can occur through council planning processes and during replacement of existing stormwater systems. There is no ability to reduce the risk of occurrence.

Ōpōtiki District Council maintains a stormwater network throughout the district, which includes a system of pump stations to aid the flow of water from urban areas. The Bay of Plenty Regional Council maintains a network of drainage channels in rural areas in conjunction with farmers and other land users. The ability of

both these networks to reduce the impact of events is dependent upon regular maintenance before, during and after major rainfall events.
Recovery from these events is normally fairly quick, with surface water remaining for less than 24 hours in most cases and mostly minor damage occurring to property and infrastructure as a result.

3.2.4 Growth Statement

Rainfall events that result in urban and rural ponding are expected to increase with climate change. This may result in the risk of more severe damage to infrastructure and property occurring more frequently.

3.2.5 Level of Confidence

The information above is based on knowledge of the area and the impacts of previous rainfall events. There is a medium level of confidence in the information contained within this document.

3.3 Rotorua District Assessment

This Hazard assessment was prepared by the Rotorua District Council as part of the 2013/14 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

3.3.1 Hazard Description

Flooding is the risk to the safety of people and property in the event of high rainfall. In a Rotorua context the largest flood event in recent times occurred in May 1999. A Civil Defence declaration was made in response to heavy flooding at Hamurana a rural residential settlement on the northern edge of Lake Rotorua. The heavy rainfall coincided with the Rotorua Marathon which was subsequently cancelled. Since this event, the storm water system has been upgraded. There have also been a few flooding events which have caused isolated domestic damage over the past decade.
Urban storm water systems are designed for 10 year events, and there are designated overland flow paths for 50 year events which avoid urban development. These overland flow paths are not in all areas.

3.3.2 Likelihood and Consequence Statements

Maximum Credible Event
Modelling has been undertaken for the 1 and 50 year flood level of Lake Rotorua and Lake Rotoiti which are the two lakes considered most susceptible to lake level rising (see figures below). The modelling shows that if these events were to occur there could be an impact to developed urban areas around the edges of those lakes. It must be acknowledged that 1 and 50 year is not the maximum credible event, and a 1 in 300 year event is more likely. Such an event will cause a much higher level of flooding around these lake margins.

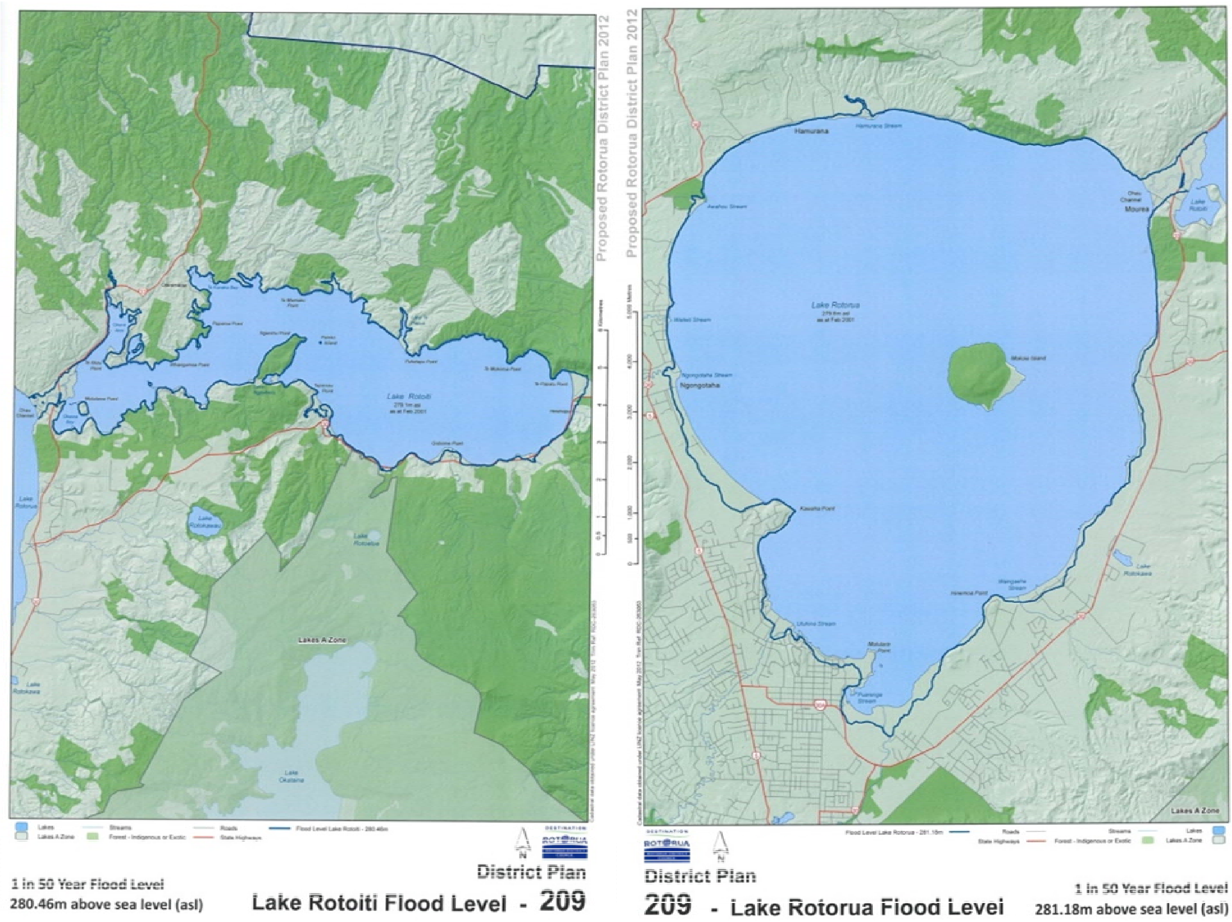

Figure 3.1: Lake Rotoiti and Rotorua 1 in 50 year flood level

Likelihood and Consequence Assessments

Flooding can occur at a range of levels resulting in various levels of impact. The return period of flooding that is likely to cause any consequences of note is likely to be 1 in 50. however, as the Rotorua urban area is at the top of the catchment, has free draining volcanic soils, and urban infrastructure designed to cater for a 50 year event the level of impact is considered to be insignificant-minor.

A 100 year event combined with high stream flows could lead to a moderate level of consequence.

3.3.3 Manageability Statement

The Rotorua District Council Asset Management Plan for Land Drainage and Stormwater provides direction on managing the risk of flooding. The Asset Management Plan outlines determined level of services for different catchments within the Rotorua District. The plan identifies those systems and areas which are susceptible to flooding in an event.

The urban streams and lake margins are particularly vulnerable to flooding, some streams have protection for a 100 year event where others do not. These unprotected streams will cause flooding and potential damage of properties in an even that has a return period of less than 100 years.

3.3.4 Growth Statement

Increased urban growth means that in the event of flooding, more property could be affected. However, the Proposed District Plan requires greenfield developments to take flooding into consideration before approval. Additionally, the infrastructure implemented as part of greenfield developments will need to be designed to cater for flooding events.

Further intensification of existing urban areas will mean that the impact of a flooding event could affect more property.

3.3.5 Level of Confidence

The above information is presented with a medium level of confidence. Flooding has not historically been an issue for the Rotorua area.

3.4 Tauranga City Assessment

This Hazard assessment was prepared by the Tauranga City Council as part of the 2013/14 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

3.4.1 Hazard Description

Flooding of localised residential, commercial and industrial areas within parts of the City that were first developed more than 20 years ago has been an ongoing issue for many years.
Council currently provides a varied level of service to stormwater management across the City consisting of:

- a minimum 50 year Annual Recurrence Interval (ARI) within new greenfield areas (overland flowpaths to cater to larger storm events and a 10 year piped network catering for more frequent events);
- A 2 year ARI piped network only within the old Tauranga County Council jurisdiction;
- A 5 year ARI piped network within the older Tauranga City jurisdictional area;

The largest flood event in recent times occurred in May 2005 and at that time was described as a 100 year event. Since this time, and following further assessment, it would now be considered a 50 year event.
Since 2005 localised flooding to a lesser extent has been experienced in 2010, 2011 and most recently in April 2013. The April event was described as ranging between a 5 and 20 year event depending on location within the City.
These main events have generally impacted on the Mount, Papamoa, Otumoetai and Matua areas of Tauranga City.
However modelling is currently underway, limited quality information on intense rainfall events is limited.

3.4.2 Likelihood and Consequence Statements

Maximum Credible Event
Tauranga City Council only models a 50 year event for intense rainfall events. This however is a 50 year event, occurring within 50 years time, and includes sea level rise and a maximum probable development (70% of residential areas covered in impervious surfaces). As a result, what is being modelled has never occurred, rather is a model that predicts, based on assumptions the effects (spatially) of intense rainfall events.

3.4.3 Manageability Statement

Background to Modelling Workstream

- Council has provided funding in the 2013/14 Annual Plan to urgently investigate and plan flood mitigation projects. Part of the work is to prepare 2D models in all of the flood sensitive urban areas in the city that have not already been modelled in 2D software. This will enable accurate consideration and testing of a range of potential avoidance, mitigation or elimination options and the development of Flood Hazard Maps (FHMs).
- TCC has recently completed a programme of upgrading old 1D stormwater models that were prepared following the May 2005 flood to new 2D models. The old 1D models provided realistic flood levels adjacent to streams and open drains, but were unable to show flood levels remote from the streams and open drains. Also they relied on the modeller's judgement in determining the location of overland flow paths. The new generation 2D models are an improvement in that they accurately show overland flow paths and they show realistic flood levels remote from the streams and open drains.
- Work has already been initiated for the Bureta/Pillans, Matua, 15th Avenue, Greerton, Pyes Pa, Mount Maunganui Industrial and Mount Maunganui South catchments.
- TCC has standardised modelling software produced by the Danish Hydraulic Institute (DHI) which is one of the leaders in the field internationally

This hazard is difficult to manage in terms of reduction, as the hazard occurs within brownfield areas, however the Council is currently investigating method to reduce the risk of the hazard through regulatory controls. If these are to proceed they will be two years away before being notified for public submission.
The hazard however is able to be managed in terms of readiness through education and through landowner on-site changes to remove structures blocking overland flow paths.

The Council runs a readiness (pre-event) process of ensuring areas of the City where flooding is known to occur through cleaning grates/catchpits. Heavy rain warnings can also be issued by the met service/civil defence in preparation of future events.
Recovery programmes need to be developed and coordinated.

3.4.4 Growth Statement

The impact of the hazard will increase over time through future development within brownfield only, however the 50 year event is planned for in new Urban Growth Areas, and thus is managed in these locations.

3.4.5 Level of Confidence

High – once modelling complete (currently low/moderate based on old mapping data and complaints).

3.5 Western Bay of Plenty District Assessment

This Hazard assessment was prepared by the Western Bay of Plenty District Council as part of the 2013/14 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

3.5.1 Hazard Description

The hazard relates to localised flooding of residential, commercial and industrial areas within parts of the District that were first developed prior to the latest design standards being implemented through Council's Development Code.
The latest standards require designs to meet the following Annual Exceedance Probability (AEP) return periods:

- Overall stormwater systems (primary and secondary) in all urban areas- 2% AEP storm
- The minimum design standard for stormwater systems to protect important recreational fields and streets without alternative access- 10% AEP storm
- Primary piped systems within the District- 20 % AEP storm
- Bridge structures and significant utilities- 1% AEP storm

Waihi Beach is the major centre in the district most susceptible to flooding. The existing infrastructure generally does not meet the standards. Furthermore, low lying areas in the town are impacted by tidal conditions. Other areas within the district with some sub-standard infrastructure include Katikati, Te Puke and Omokoroa and some of the smaller settlements e.g. Paengaroa.
The largest events that occurred in recent times were in August 2012 and April 2013. Both were determined to be 12.5% AEP storms i.e. 1 in 8 years events.
Council is in the process of having hydraulic models built to better manage its stormwater systems. Council utilises modelling software produced by the Danish Hydraulic Institute (DHI), which is one of the international leaders in the field.

3.5.2 Likelihood and Consequence Statements

Maximum Credible Event
The Council models a 50 year intense rainfall event; i.e. an event that has a 2% probability of occurring in any one year. Floodable areas are shown in Council's District Plan but these are largely based on local knowledge, old catchment management plans, outdated modelling and historical events. The areas are being updated as model builds are completed, calibrated and run for 50 year events. Rules are in place regarding construction, locating structures and alteration to landforms in floodable areas, overland flowpaths and water bodies.
Council has only recently been collecting and analysing detailed and accurate rainfall data. As such it is unable to identify a maximum credible event.

Likelihood and Consequence Assessment
As stated above, Council models 1 in 50 year events. Flooding caused by 50 year events is unlikely to result in death or injury. However it does have a financial impact on land and property that has been inundated. In low lying areas flooding is exacerbated by tidal conditions at times when storms and high tides occur

concurrently. The consequences of the potential events are unknown as Council is currently in the process of having models constructed and running event scenarios.

3.5.3 Manageability Statement

This hazard is difficult to manage in terms of reduction as it largely occurs within developed areas. Ongoing renewals and upgrades to meet minimum levels of service standards are budgeted for in Council's LTP and contribute to mitigation of the hazard.
The Council, through its Contractor, is proactive in reducing the hazard. Rainfall patterns are monitored to predict heavy rain events and heavy rain warnings are also issued by the Met Service /civil defence in preparation of future events.
Pre-heavy rainfall inspections are carried in areas of the District where flooding is known to occur to ensure the network can perform at its optimum capacity. Cleaning of grates/catchpits, open drains and screens will be carried out at these times.
The Council also has its Utilities Group Business Continuity Plan, which comes into effect in crisis situations such as severe flooding.

3.5.4 Growth Statement

Council manages growth using a SmartGrowth Strategy. The residential population count in the 2006 census was 41,823 and this was forecast to increase to 60,268 by 2026. The count in the 2013 census was 43,692, which was below forecast.
Council manages the impact of growth through the capital works programme in its LTP. With respect to provision of stormwater infrastructure, growth in areas such as Omokoroa and Te Puke is catered for in Structure Plans. Due to the slowdown in growth, works in these areas have been postponed beyond the 2012-22 LTP. However due to Council's strategy the impact of the hazard is expected to remain the same over time.

3.5.5 Level of Confidence

High – once modelling complete (currently low/moderate based on old mapping data and modelling, local knowledge and complaints).

3.6 Whakatāne District Assessment

This Hazard assessment was prepared by Whakatāne District Council as part of the 2013/14 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

3.6.1 Hazard Description

The Whakatāne District Council manages six stormwater schemes within the district. Of the six stormwater schemes four schemes are considered to be large schemes with population over 1,000 and the Whakatāne urban stormwater scheme is the largest with population over 15,000. Within the past 20 years there have been a number of large stormwater events leading to wide spread flooding in parts of the District. The largest events were in April 2004 and June 2010 and both events were over one in hundred year return periods. The most affected urban catchments in these events in terms of flooding were Whakatāne and Edgecumbe urban catchments.
The Council's design standards for stormwater infrastructure in Town are as follows:

- Primary conveyance system comprising pipes and drains without surcharging in storm events with a return period of 10 years where practicable and economically feasible.
- Secondary conveyance system capable of conveying of stormwater from rainfall event with 100 year return period without flooding houses and other commercial buildings.

If these design standards are practically not achievable or economically not feasible, a lower design standard is determined by the Council.

Whakatāne Urban Catchment
The Whakatāne urban catchment is bounded by the escarpments from the eastern side and by the Whakatāne River Bank from other sides. Most of the areas in this catchment are low line areas and relies on gravity and pumped outlets into Whakatne River for stormwater discharge. The catchment has been devided

into four main sub-catchments and a number of smaller sub-catchemts for modelling and stormwater management purposes. The four main sub-catchments are Apanui catchment, Hinemoa catchment, City South catchment and Awatapu catchment.
Stormwater from upper Wainui Te Whara hill catchment flows through the town through Wainui Te Whara urban channel which flows into Awatapu lagoon and then into Whakatāne River via gravity cum pumped outlets and is a treat to the town in the storm events in excess of 20 year return period. Sullivan Lake which is situated in southern side of the Town acts as a stormwater storage basin for parts of City South catchment during high rainfall events.
The Council maintains reticulated pipe system of approximately 60km long, 18 stormwater pump stations, open drains of approximately 11km long, a number of detention ponds and a number of river outlets and associated structures for providing protection to the Township from stormwater.
Whakatāne River during spring high tides can be raised to the level similar to lowest ground levels in the catchment which is approximately RL1.5m preventing gravity flow into the river. During the periods of spring high tides or periods of elevated river levels, some parts of the catchment are entirely dependent on combination of storage and pumping systems to prevent extensive flooding in low lying areas. The availability storage areas in the town are limited apart from Awatapu lagoon and Sullivan Lake and the present pumping capacity is not sufficient to provide flood protection. There are also pockets of ponding areas in the town due to inadequate capacity in stormwater assets.
The Council has developed hydraulic 1D and 2D models to understand the flooding hazards in the town for different rainfall events and to use as a tool to understand the mitigation measures. Flood maps have been prepared for the town for the storm events of 100 year and 300 year return periods taking into account future climate changes.

Edgecumbe Stormwater
Edgecumbe Township which has a population over 1,600 people consists of mainly four stormwater catchments. They are Edgecumbe North-west catchment, Edgecumbe South-west catchment, Edgecumbe North-east catchment and Edgecumbe South-east catchment. East of Rangitāiki River where Fonterra site, Hydro Rd and Konini Place are situated, the ground level is relatively high and has a reasonable fall for stormwater drainage.
The west Edgecumbe urban area is a low lying area and during the 1987 Edgecumbe earthquake the ground levels dropped about 2m in places. This has created more drainage problems in the South-western and North-western catchments. Stormwater in these two catchments rely on rural drainage scheme of Omehu Canal system.
The town stormwater system consists of reticulated pipes of approximately 6.5km long, one pump station and an open drain system of approximately 4.5km long.
Edgecumbe has been experiencing flooding and ponding issues due to low lying nature of the area, inadequate stormwater system within the town and inadequate capacity in rural drainage scheme during high rainfall event. In the last two years a couple of projects have been implemented to reduce the flooding risk in Edgecumbe. However, more works are required to provide a satisfactory solution to stormwater issues in Edgecumbe. The town was flooded severely in 2004 and in 2011. There were property damages in both occasions.

3.6.2 Likelihood and Consequence Statements

Maximum Credible Event
<u>Whakatāne</u>
As mentioned in above section there were two large storm events in Whakatāne. The April 2004 event did major damages to the properties in Whakatāne especially in Awatapu area due to overtopping of Awatapu lagoon. People from Awatapu area were evacuated and many people were given temperaray accommodation. However, since 2004, the District Council has implemented projects to minimise the risk of overtopping of Awatapu Lagoon by upgrading the existing Awatapu pump station and constructing a new flood pump station at the downstream end of Awatapu Lagoon. Upgrading of the lagoon bank was also carried out.
In May and June 2010 event, Wainui Te Whara open channel was overtopped and there were severe damages to the properties in Alexander Av. and Douglas St. areas. Stormwater runoff from escarpment above Valley Rd has caused flooding of properties along Valley Rd. The ponding of stormwater occurred in many other areas of the town and property damages and restriction of traffic movement were reported.
Since the Council has carried out mitigation works at Awatapu and if similar event occurs the damage would be less than in 2004, the maximum credible event is June 2010 event whit a return period of over 100 years. The recorded maximum one hour rainfall in this event was 90mm which is well above 100 year event.

The likelihood of this event happening is possible and the consequence is Major as extensive property damages, public health issues and high financial loses can be expected.

Edgecumbe

In Edgecumbe, maximum credible event is 100 year return period, which occurred in 2004 causing severe damages to the properties and infrastructure.

The likelihood of this event happening is possible and consequence is major as extensive property damages and high financial loses can be expected.

Likelihood and Consequence Assessment

Table 3.2: Flooding - urban/rural ponding assessment for Whakatane

Event	Likelihood	Consequence	Risk Rating	Impact
5 year return period	Almost certain	Minor	Moderate	Minor damages to properties and social and minor health impacts
10 year return period	Almost certain	Minor	Moderate	Minor damages to properties and social and moderate health impacts
20 year return period	Almost certain	Moderate	High	Moderate damages to properties, health, social and environmental impacts
50 year return period	Likely	Major	Very high	Moderate damages to properties, health, social, economic and environmental impacts
100 year return period	Possible	Major	Very high	Major damages to properties, health, social, economic and environmental impacts

Table 3.3: Flooding - urban/rural ponding assessment for Whakatane

Event	Likelihood	Consequence	Risk Rating	Impact
5 year return period	Almost certain	Minor	Moderate	Minor damages to properties, social and health impacts
10 year return period	Almost certain	Minor	Moderate	Minor damages to properties, social and health impacts
20 year return period	Almost certain	Moderate	High	Moderate damages to properties, health, social and environmental impacts
50 year return period	Likely	Major	Very high	Moderate to major damages to properties/infrastructure, health, social and environmental
100 year return period	Possible	Major	Very high	Major damages to properties, moderate damages to infrastructure, health, social, environmental and economic impacts

3.6.3 Manageability Statement

Standard Operating Procedures and Emergency management Plans are in place prepared by the Bay of Plenty Civil Defence Emergency Management (CDEM) Group.

The District Council has produced an internal Emergency Response Plan for all three waters outlining procedures to follow when incidents occur.

The Council regularly implement training programmes for Council staff on emergency management and working at operations centre during civil defence emergencies.

The District Council has built hydraulic 1D and 2D models to understand the flood levels, affected areas and overland flow paths in Whakatāne and a part of Edgecumbe. Using the hydraulic models, the Council has identified the mitigation works and projects required to reduce the impact of high intensity storm events. Some of these works and projects have been implemented in Whakatāne and Edgecumbe. More projects are included in the Council's Long Term Plan. At present, the Council has initiated a project to build a detention structure in upper Wainui Te Whara catchment to minimise the risk of over topping of the wainui Te Whara urban channel in high intensity storm events.

All the stormwater pump stations, critical drain levels and Awatapu Lagoon levels are monitored continuously and alarmed through the telemetry system.

3.6.4 Growth Statement

More severe high rainfall incidents and can be expected in future due to climate change and sea level rise causing more flooding and ponding in urban and rural areas. More intense built up areas are expected in the urban environment to meet the social and economic demand in future aggravating the problem. The Council is taking proactive mitigation measures to minimise the impact of urban development on stormwater systems through the District Plan and other planning processes.

3.6.5 Level of Confidence

The information in this report on number of properties affected, flooding severity and extend etc. are based on the experience from recent storm events, subsequent data gathering and information derived from hydraulic modelling. The confidence of this information is high. However, there have been no extensive studies done to quantify the cost and severity of actual physical damages and economic damages due to these extreme events. The Council records, discussion with various people and approximate estimates have been prepared. Therefore, overall level of confidence is moderate.

4 Coastal Erosion

This Hazard assessment was prepared by staff from the Bay of Plenty Regional Council, Tauranga City Council and Western Bay District Council as part of the 2013/14 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

4.1 Hazard Description

The Bay of Plenty open coastline extends 259 kilometres from Waihī Beach in the north-west to Lottin Point in the north east. Beach types along this coastline consist of cliffs and shore platforms, sand and mixed sand-gravel beaches, barrier islands, spits and estuarine/river mouths. The coastline within harbours and estuaries is 369 kilometres in length, resulting in a total coastal perimeter of 688 kilometres.

The types of natural hazards that are generated in the Bay of Plenty coastal and harbour areas include tsunami[1], storm erosion and storm flooding. 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 are dynamic features which periodically shift between phases of accretion and erosion. Similarly, flooding (or storm inundation) is also a natural process, although it is restricted to low lying areas. Storm-related coastal inundation is caused by high tides (normally during spring or perigean tides), combining with storm surge and waves, through a combination of wave set-up (an increase in the water levels landward of where waves are breaking) and wave run-up over the upper beach, which can overtop low coastal barriers.

It is important to take into account the combined effects of storm erosion and flooding. This is because the extent of flooding will be influenced by the amount of erosion. In other words, if the flood height of a storm was not sufficient by itself to overtop the foredune it could well become so if the foredune is eroded down during the storm. Both erosion and flooding have become serious issues as a result of people's desire to locate near the coast, an event which turns such natural cycles into coastal hazards.

Both of these hazards are limited to the coastal hazards zones initially identified by the regional council[2] and subsequently modified by the coastal territorial authorities – Western Bay District Council[3], Tauranga City Council[4], Whakatāne District Council[5] and Ōpōtiki District Council[6]. These mapped zones include consideration of climate change impacts.

For example based on Regional Plan guidelines the Tauranga City Council has identified three zones along the coast being the following:

- CERZ (Coastal Erosion Risk Zone);
- 50 year ERZ (Erosion Risk Zone);
- 100 year ERZ (Erosion Risk Zone);
- Coastal Plan Protection Area (Te Tumu Coastline)

The CERZ is the area identified as being susceptible to coastal erosion on 'any given day', whereby the 50 year ERZ and 100 year ERZ factors in sea level rise as a result of climate change. Therefore,

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[1] Will be addressed in a separate section.

[2] Gibb, J G, 1994, Initial Assessment of Areas Sensitive to Coastal Hazards for Selected Parts of the Bay of Plenty Coast, Bay of Plenty Regional Council and Gibb, J.G., 1999, Review of Selected Factors for Assessment of Areas Sensitive to Coastal Hazards – Bay of Plenty Region, Bay of Plenty Regional Council.

[3] Healy, T.R., 1993, Coastal Erosion, Setback Determination, and Recommendations for Management of the Waihī Bowentown and Pukehina Beach and Dunes, prepared for Western Bay District Council, 55 pgs.

[4] Tonkin & Taylor, 2009, Coastal Erosion Hazard Zone Update, Tauranga Open Coast, report prepared for Tauranga City Council and Tonkin & Taylor, 2008, Reassessment of the Tauranga District Inundation Levels, report prepared for Tauranga City Council.

[5] Tonkin & Taylor, 2008, Whakatāne District Council Coastal Hazard Analysis, report prepared for Whakatāne District Council.

[6] Blackwood, P., 2007, Storm Surge Runup Levels for the Ōpōtiki District, Operations Publication, 2008/03, Environment Bay of Plenty and Eco Nomos Ltd, 2007, Ōpōtiki District Coastal Erosion Assessment and Setback Recommendations, prepared for Ōpōtiki District Council and Bay of Plenty Regional Council.

it is expected that the 50 year ERZ will be the location of the toe of the CERZ dune within 50 years time, and the same will occur in a 100 years time for the 100 year ERZ. As a result it is likely that any development within these areas will be significantly compromised by coastal erosion and land (as a property asset) will be lost.

Tauranga City Council GIS records show that there are:

- 195 residential dwellings located within the 100 year ERZ; and
- Of that 200 (identified above),
    - o 116 are within the 50 year ERZ.
    - o 38 are located forward of the CERZ or are partially located within of the CERZ.
- There are 380 properties located partially within or wholly within the 100 year ERZ.

Coastal hazards are predicted to be exacerbated by climate change effects including sea level rise (high tide erosion, inundation). Relative mean sea levels have risen by 0.16 m on average over the last 100 years around New Zealand and they will continue rise into the future.

The Ministry for the Environment[7] recommends a precautionary, risk-based approach to planning for future sea-level rise in which the consequences of a range of sea-level rise values are considered. For planning and decision timeframes out to 2090–2099, a base value sea-level rise of 0.5m relative to the 1980–1999 average should be used along with an assessment of potential consequences from a range of possible higher sea-level rise values. At the very least, all assessments should consider the consequences of a mean sea-level rise of at least 0.8m relative to the 1980–1999 average. Beyond the end of this century an additional allowance of 10mm per year should be used (MfE, 2009). It should be noted that these SLR figures will be modified in the near future following the finalising of the IPCC Fifth Assessment (AR5) Working Group Reports between September 2013 (Working Group I) and October 2014 (Synthesis Report).

4.2 Likelihood and Consequence Statements

4.2.1 Maximum Credible Event

Because of the timeframes typically associated with shoreline erosion (measured over years and decades with discreet events of major loss normally easily observed and documented), there is little threat to public safety. Inundation typically has a well monitored and modelled lead in to individual events with damage to assets and the environment from salt water flooding not uncommon within the identified coastal hazard zones (it should be noted that these zones do not include areas in close proximity to stream/river mouths and tidal inlets due to the extreme dynamics associated with these areas).

A different situation exists within the Tauranga Harbour. Many of the inner harbour islands and peninsular cliffs are subject to sudden catastrophic failure resulting in landslides. Due to their elevated cliff top position most of these sites have been heavily subdivided for residential development. Although these events are infrequent they can be relatively large scale and whilst they seem to be associated with heavy rainfall events they can occur without warning.

A number of storm events have been monitored within the last century within the Bay of Plenty. Cyclone Giselle 9 – 10 April 1968 (Wahine Storm) has often been used as a reference on which to gauge other storms. Blackwood (2000)[8] calculated that this event ranks 2 or 3 for intensity for the last 110 years and therefore it is likely to have a return period of approximately 50 years. For the western part of the region, the unnamed tropical cyclone 2 February 1936 is reported to be the most severe recorded at Tauranga, fortunately occurring during a neap tidal cycle thus limiting the total storm tide observed but still resulting in an unprecedented high tide with water inundating low lying areas along the waterfront which had not been inundated before.

One of the well documented erosion cycles within the Bay of Plenty are those at Ōhiwa Spit in the Ōpōtiki District. Ohiwa Spit has a long history of changes in the position of the coastline. Between 1867 and 1911, the coastline of the Spit tended to build seawards, or accrete. In the late 1800s, a hotel was built on the Spit and, in the early 1920s, the area was subdivided. Within a few years, erosion was so rapid that the Ferry Hotel was lost and the township abandoned. Further erosion took place until the late 1940s. Then, the Spit appeared to stabilise and during the early 1950s a new subdivision further down the Spit was developed. By 1965 erosion was again affecting property:

[7] MfE, 2009, Preparing for Coastal Change, A guide for local government in New Zealand, New Zealand Government,30 pgs.

[8] Blackwood, P., 2000, Storm surge estimates and records with particular reference to Whakatāne District Council coastline, Internal Bay of Plenty Regional Council memo, 3 pgs.

several houses were lost to the sea over the next decade, despite various attempts to protect parts of the coast with makeshift seawall and railway-iron protection. A series of storms in the mid- to late 1970s resulted in several properties falling into the sea (Figure 1). One particular storm over 4 days (18-21 April 1976) resulted in up to 29m of duneline retreat. Buildings that survived the storms were removed from the coastline in 1976.

Figure 4.1: Ōhiwa Spit , 21 April 1976.

Councils currently plan for a 100 year planning horizon with this natural hazard. It is a long term hazard in that it the consequence of the hazard will occur concurrently with sea level rise and slowly erode the dune system. Therefore this is no maximum credible event that can be defined with this event, rather it is more appropriate to state that, provided sea level rise occurs as predicted, the following will be subjected to consequence (land/buildings) during that 100 year time period which will result in loss of land and loss of buildings:

- The BOPRC Coastal Hazard Risk Indicator Review, using a 2007 dataset, highlighted 1401 dwellings in a coastal hazard zone[9].

4.2.2 Likelihood and Consequence Assessment

The likelihood and consequence Statements outlined in this section are not applicable to this hazard. It is highly unlikely that death or injury will result through open coastal erosion and there is no return period associated with it.

For Tauranga City Council (and likely others) the Council holds records in regarding to resource consents granted or relocateable buildings within the zone and therefore those that will be able to be relocated out of the hazard zone if erosion occurs, this information is not readily available to be able to provide at this point in time to determine the wider actual risk. Further, limited knowledge is known on those older buildings built prior to the Council planning processes and therefore some of those buildings may also be able to be relocated out of the hazard zone.

When assessing the Bay of Plenty coastline as a whole, the likelihood of such events (erosion and/or inundation) described above is a “likely” measure of likelihood (using the qualitative descriptor), combined with a “moderate” measure of consequence. This equates to a qualitative risk level of “high”.

[9] Schick, L. & Iremonger, S., 2007, 2007 Coastal Hazard Risk Indicators Review, Environmental Publication 2009/07. Bay of Plenty Regional Council, 57 pgs.

4.3 Manageability Statement

Taking a precautionary approach to planning new development, infrastructure and services to avoid coastal hazards over their intended lifetime is the most effective and sustainable long-term approach[10]. This approach is relevant to all coastal development situations, from completely undeveloped coastal margins to high-density urban areas.

A common approach where existing or proposed development is exposed to coastal hazards, is to apply information on potential coastal erosion in the form of coastal setbacks through a range of rules in planning documents, and, for inundation, specifying minimum floor and ground levels in land-development or engineering quality standards. In heavily developed areas, coastal hazard maps may be used simply for public education and awareness purposes, or to inform evacuation for storm-tide or tsunami warnings.

4.4 Growth Statement

Along the Bay of Plenty coast, as in many other coastal margins around New Zealand, there has been rapid growth over the last five or six decades in coastal-related development, particularly in areas backing sandy beaches or offering harbour views. Within New Zealand much of the increase in coastal hazard risk particularly that associated with coastal erosion and inundation is due to:

- Subdivision, development and infrastructure located too close to the shoreline to accommodate the full range of natural changes that occur over the lifetime of the development.
- Human alteration of, or interference, in natural coastal dynamics and function of beach systems.
- Past development of low-lying coastal swamps and coastal-wet plains, that are naturally prone to inundation.

Blackett and Hume (2006) noted that this level of risk is being exacerbated over time as coastal development intensifies[11].

Smartgrowth has identified sub-regional urban growth nodes, that primarily build on existing residential areas, as being the preferred areas for expansion. This gives the opportunity for new development to be focused on areas more resilient to coastal hazards.

4.5 Level of Confidence

A region wide coastal hazard report was commissioned by the Bay of Plenty Regional Council in 1994 and updated in 1999 which provided an Area Sensitive to Coastal Hazards (ASCH)[2]. This zone has been further refined by individual district and city councils. These latter reports[3,4,5,6] have been complimented over time by site specific property assessments and additional research commissioned by both regional and territorial authorities covering topics such as risk indicators, storm surge, beach profile monitoring and a suite of reports looking at harbour processes particularly within the Tauranga Harbour.

Central government agencies and research institutions investigations and monitoring covering topics such as hazard assessment methodologies[12] and climate change[13] (particularly sea level rise[14]) have added to the knowledge dataset.

This combination of information results in a high level of confidence for this current hazard assessment.

[10] MfE, 2008, Coastal Hazards and Climate Change. A Guidance Manual for Local Government in New Zealand. 2nd edition. Revised by Ramsay, D, and Bell, R. (NIWA). Prepared for Ministry for the Environment. viii+127 p.

[11] Blackett, P., Hume, T., 2006, Community involvement in coastal hazard mitigation: An initial scoping of processes and pitfalls. NIWA Client Report HAM2006-083, June 2006.

[12] Ramsay, D.L., Gibberd, B., Dahm, J., Bell, R.G.,2012, Defining coastal hazard zones and setback lines. A guide to good practice. National Institute of Water & Atmospheric Research Ltd, Hamilton, New Zealand.

[13] The New Zealand Climate Change Centre, www.nzclimatechangecentre.org.

[14] Hannah, J., and R. G. Bell,2012, Regional sea level trends in New Zealand, J. Geophys. Res., 117, C01004, doi:10.1029/2011JC007591

5 Major Depressions

This Hazard assessment was prepared by Meteorological Service of New Zealand Limited and Bay of Plenty Regional Council as part of the 2013/14 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

5.1 Hazard Description

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.

The duration, extent and magnitude of rainfall and/or strong winds and/or large sea waves depend upon the low pressure system's track, speed of movement, size, central pressure and so on.

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[15], may result in high water being as much as a metre above the usual high tide mark.

5.2 Likelihood and Consequence Statements

Major depressions are relatively common weather events for the Bay of Plenty, the frequency and intensity of these events is influenced by La Nina/El Nino weather patterns.

5.2.1 Maximum Credible Event

Scenario	Consequences
Tropical Cyclone 'Hilde' forms south of the Solomon Islands and moves southeast between Vanuatu and New Caledonia. North of New Zealand, the cyclone meets a cold front and intensifies. Tracking across Northland and Coromandel, 'Hilde' stalls between Whakatane and Tauranga for an appreciable period before moving off to the southeast. Storm force winds and torrential rain impact the majority of the Bay of Plenty over a 48-hour period.	Initial impacts include minor property damage and loss of power in some areas due to tree falls. Wind damage is minor at first, but increases over time. Rivers and smaller watercourses rise rapidly, flooding low-lying areas and forcing evacuation of those at risk. The degree of property damage increases as wind and water attack structures. Infrastructure is severely affected, with power, telecommunications, roading, rail, and water supplies affected to varying degrees. High seas and storm surge cause severe coastal erosion and destroy or otherwise damage beachfront property. Emergency services are overwhelmed in the first 12 hours and a state of emergency is declared across the region. The regional emergency is terminated after 14 days, however Tauranga-Western Bay of Plenty imposes a local declaration for a further 7 days because of ongoing water supply problems in both districts. Across the region there are 14 emergency-related fatalities. Some 8,000 persons are evacuated during the emergency; a post-emergency survey identifies 430 residential properties as destroyed or severely damaged. Long-term relief accommodation is required for 1,100 people. The agricultural sector is severely affected, with an estimated 35% loss of production over the following 12 months. Full recovery is estimated as requiring up to 3 years. Losses are estimated as exceeding $120,000,000.

[15] Adjustment of sea level to changes in barometric pressure; in the case of full adjustment, an decrease in barometric pressure of 1 hPa corresponds to a rise in sea level of 0.01 m.

5.2.2 Likelihood and Consequence Assessment

To give some idea of frequency of these events it is useful to look at the number of significant rainfall events experienced in the Bay of Plenty in recent times.
Since 1993;

For Tauranga,

- 1 event over 300mm in 24 hours at Tauranga (*producing* 346.8mm in 24 hours; 18 May 2005, and The same event produced 133.4mm in 3 hours)
- 4 events exceeding 50mm in 1 hour, (biggest 67mm on 3rd May 2005), the others occurred in,January, May and October.

For Whakatane

- No events exceeding 200 or 300mm in 24 hours.
- 1 event exceeding 50mm in 1 hour (89.9mm Jun 2010)
- 1 event with exceeding 100mm in 3 hours (139mm On the 1 June 2010).

For Rotorua

- One event exceeding 200mm in 24 hours (220.4mm 1 May 1999)
- One event exceeding 100mm in 3 hours (109.2 on the same day)

The principal effects of major depressions in the Bay of Plenty include:

Rainfall *(affecting all or any part of the region)*

- Flooding in major rivers and watercourses *(may be influenced by tidal conditions preventing escape of flood-waters in low-lying areas)*
- Water-related property and crop damage, and potential for livestock losses
- Localised ponding and flooding due to inability of drainage systems to cope. May affect ground-mounted electrical transformers and underground services.
- Landslip and/or erosion, dependent on soil type and ground cover. Potential to affect property and both underground and above-ground services
- Short-term closure of transportation routes
- Short- to medium-term impact on municipal water supplies and sewage facilities
- High demand on emergency services, particularly Police, Fire, and local government contractors
- Potential public health implications

High Winds *(affecting all or any part of the region)*

- 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

Storm Surge and Storm Tides *(affecting coastal areas)*

All coastal areas are at a degree of risk from this hazard, with the level of risk being highest where population and infrastructure is concentrated in lower-lying areas.

Consequences are assessed as:

- Exacerbation of river flooding
- Increased coastal erosion, long-term effects
- Property damage, minor to destructive
- Disruption of transportation routes in coastal areas
- Disruption of underground services
- Salt-water inundation

- Extensive sand, gravel, and debris deposition
- Damage to craft at moorings, possible escape of fuels
- Potential for human casualties

Using the Measure of Likelihood and Consequence tables major depressions can be classified as likely to almost certain while the consequences are in the moderate to major range.

5.3 Manageability Statement

The manageability of major depressions is directly linked to managing and planning for the major effects, which are described in more detail in the flooding and coastal erosion sections.

The primary means of managing for this hazard includes taking a precautionary approach to planning new development, infrastructure and services, in addition to disseminating severe weather warnings and taking preventative actions prior to the arrival of these events.

Relatively accurate forecasting enable significant prior warning to be given and many of the consequences minimised as far as practicable.

5.4 Growth Statement

An excerpt from "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation", a Special Report of the Intergovernmental Panel on Climate Change (© Intergovernmental Panel on Climate Change 2012) is below.

Summary for Policymakers; Climate Extremes and Impacts (page 8)

"There is evidence from observations gathered since 1950 of change in some extremes. Confidence in observed changes in extremes depends on the quality and quantity of data and the availability of studies analyzing these data, which vary across regions and for different extremes. Assigning 'low confidence' in observed changes in a specific extreme on regional or global scales neither implies nor excludes the possibility of changes in this extreme. Extreme events are rare, which means there are few data available to make assessments regarding changes in their frequency or intensity. The more rare the event the more difficult it is to identify long-term changes. Global-scale trends in a specific extreme may be either more reliable (e.g., for temperature extremes) or less reliable (e.g., for droughts) than some regional-scale trends, depending on the geographical uniformity of the trends in the specific extreme."

Reference: http://www.ipcc.ch/pdf/special-reports/srex/SREX_Full_Report.pdf

6 Severe Thunderstorms

This Hazard assessment was prepared by Meteorological Service of New Zealand Limited as part of the 2013/14 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

6.1 Hazard Description

Individual thunderstorms are short-lived, existing for no more than one or two hours. Organised lines or groups of thunderstorms can last for a number of hours. Depending upon the speed and direction of their movement, groups or lines of thunderstorms may present an increased hazard risk to a given area, or no more risk than an individual thunderstorm.

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 storm-water system and surface flooding. The same amount of rainfall in the catchment of a small stream can rapidly transform it into a raging torrent. As stated earlier, rain associated with a line or group of thunderstorms may present an increased hazard risk to a given area, or no more risk than that from an individual thunderstorm.

In New Zealand, the hail associated with thunderstorms is generally of small size by international standards. Nevertheless, it can be large enough to devastate crops, damage roofs and break glass. When it falls in large quantities, small hail can be centimetres deep, causing a significant driving hazard, closing aerodromes, creating enough load on roofs to collapse them, overload urban drainage systems, etc.

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.

There are many tens of thousands of lightning strikes per year in New Zealand, with one death reported every five to ten years.

If the thunderstorm is moving, the extent of rain, hail or strong winds is typically no more than a few hundred metres wide and a few kilometres long.

6.2 Likelihood and Consequence Statements

6.2.1 Maximum Credible Event

Rain: Matata, 18 May 2005. The rainfall in this event resulted from a quasi-stationary line of thunderstorms – that is, a number of individual thunderstorms contributed to the rain total. See http://info.geonet.org.nz/download/attachments/2196288/Matata_poster.pdf

Hail: perhaps the most notable recent significant hail event in Bay of Plenty occurred on 11 May 2009, when thunderstorms affected a coastal strip along much of the length of the Bay of Plenty – see, for example, http://tvnz.co.nz/national-news/storm-lashes-bay-plenty-2726755

Wind: Hobsonville, 06 December 2012. While this event did not occur in Bay of Plenty, a wind storm later the same day near Ngongotaha had similar characteristics to the Hobsonville event and resulted from the passage across the area of the weather system that caused the Hobsonville event.

6.2.2 Likelihood and Consequence Assessments

No attempt has been made to state likely return period or probability within 50 years of severe local storm events. But in summary, severe local storms are of low likelihood and minor to major consequence. This is not to say that severe local storms are necessarily extremely rare: over the extent of the Bay of Plenty region, they occur from time to time. But their occurrence in any one place is of lower frequency than their overall occurrence.

6.3 Growth Statement

An excerpt from "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation", a Special Report of the Intergovernmental Panel on Climate Change (© Intergovernmental Panel on Climate Change 2012) is below.

Summary for Policymakers; Climate Extremes and Impacts (page 8)

"There is evidence from observations gathered since 1950 of change in some extremes. Confidence in observed changes in extremes depends on the quality and quantity of data and the availability of studies analyzing these data, which vary across regions and for different extremes. Assigning 'low confidence' in observed changes in a specific extreme on regional or global scales neither implies nor excludes the possibility of changes in this extreme. Extreme events are rare, which means there are few data available to make assessments regarding changes in their frequency or intensity. The more rare the event the more difficult it is to identify long-term changes. Global-scale trends in a specific extreme may be either more reliable (e.g., for temperature extremes) or less reliable (e.g., for droughts) than some regional-scale trends, depending on the geographical uniformity of the trends in the specific extreme."

Reference: http://www.ipcc.ch/pdf/special-reports/srex/SREX_Full_Report.pdf

7 Tsunami – Distal

This Hazard assessment was prepared by GNS Science as part of the 2013 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

7.1 Hazard Description

Very large earthquakes are the most frequent, but not the only cause of distal tsunami. Submarine landslides and landslips from coastal cliffs, volcanic eruptions and bolide (space) impacts are also possible sources, but are much less common. Very large earthquakes associated with the Pacific Plate boundary are recognised as the most likely source, however events in the Indian Ocean may also impact New Zealand. 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 vulnerable to tsunami, but the vulnerability is not uniform.

Tsunami damage and casualties are usually generated by the impact of the fast flowing 'torrent' of water that both inundates and recedes. The inundating and receding flood cause substantial flooding of the coast area, erosion and erosion of the sea bed. Debris impacts from large inundations will cause many casualties and building damage. Fire and contamination can occur when installations are floated or breached or sea water enters an area. Several distal tsunami have reached the BOP coast in the last few years (e.g. 2004 Indian Ocean, 2009 South Pacific and 2011 Tohoku).

7.2 Likelihood and Consequence Statements

7.2.1 Maximum Credible Event

New Zealand has a short historical record of tsunami impacts from distal events, however the global data set is more complete. About 80% of the large to great (M>8) global earthquakes originate in the Pacific Ocean, at plate boundaries. These are able to produce tsunami heights greater than 2m in the Bay of Plenty region. For distal source tsunami a 5.5m-9m wave could be generated from the coast of Chile or Peru but would have in the vicinity of 12 hours travel time before they arrived at the coast, for a 2500 year return period.

7.2.2 Likelihood and Consequence Assessment

The history of tsunami events indicates that future tsunami will occur and may be hazardous to the BOP coastline. Probabalistic modelling suggests for a 500 year return period the maximum expected wave height is about 4.6 m (50^{th} percentile) or up to 6m (84^{th} percentile) for all tsunami sources that could reach the BOP coast. Probabalistic modelling suggests for a 2500 year return period the maximum expected wave height is about 6.8 m (50^{th} percentile) or up to 9m (84^{th} percentile) for all tsunami sources that could reach the BOP coast. For both return periods Peru and Chile make up the highest proportion of distal source for these events.

Hence this would be classed as a unlikely event. The consequence of one of these large but unlikely events would be major. The societal impact would be severe as large numbers of people would be effected, by displacement or fatalities, significant damage to infrastructure and properties, the local through to national economy would be impacted, along with high clean up and recovery costs. There could also be serious environmental impacts.

7.3 Manageability Statement

A distal tsunami of the size that have typically occurred in NZ's recorded history are difficult to manage in terms of reduction and readiness, except for land use planning and tsunami detection monitoring and warning. The near coastal areas (below about 5 m) will be the only impacted areas and the reduction of significant infrastructure or adding additional robustness in these areas should

continued. In terms of response, these low probability but high consequence events need to be acknowledged in hazard and response planning. The development of education and evacuation plans for specific areas will help considerably to reduce the impacts. Recovery is very difficult to plan for as the outcome of an inundation will be varied and are difficult to predict in detail.
As there is a reasonable time before the arrival, there will be some form of warning and the loss of life can be minimised.

7.4 Growth Statement

The likelihood and style of hazards from tsunami arriving on the BOP coast are unlikely to change with time. However the consequence will continue to increase as growth continues in the region.

7.5 Level of Confidence

The above information was complied with current scientific knowledge obtained through published research documents, it is of a moderate to high level of confidence.

8 Tsunami – Local

This Hazard assessment was prepared by GNS Science as part of the 2013 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

8.1 Hazard Description

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. Very large earthquakes associated with the Hikurangi-Kermadec boundary is recognised as the most likely 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 vulnerable to tsunami, but the vulnerability is not uniform.

Tsunami damage and casualties are usually generated by the impact of the fast flowing ‘torrent’ of water that both inundates and recedes. The inundating and receding flood cause substantial flooding of the coast area and erosion of the sea bed. Debris impacts will cause many casualties and building damage. Fire and contamination can occur when installations are floated or breached or sea water enters an area.

8.2 Likelihood and Consequence Statements

8.2.1 Maximum Credible Event

The Bay of Plenty has a short and incomplete historical record of tsunami impacts from local sources. These are likely to produce tsunami heights greater than 2m in the Bay of Plenty region and could reach as high as 6+ m. Current work has focussed on a variation of the Kermadec trench scenario generated by a Mw 9.0 siesmic event, 30m slip which would produce wave heights of 8-13m across the Bay of Plenty Coast. More recent research has identified that the likelihood of this scenario is in excess of 1 in 2500 years, possible but at the far end of probability. Travel time for local source tsunami is around 50 minutes, limiting official warning capability and evacuation.

8.2.2 Likelihood and Consequence Assessment

The history of local tsunami events in New Zealand indicates that future tsunami will occur and may be hazardous to the BOP coastline. Probabalistic modelling suggests for a 500 year return period the maximum expected wave height is about 4.6 m (50th percentile) or up to 6m (84th percentile) for all tsunami sources that could reach the BOP coast. Probabalistic modelling suggests for a 2500 year return period the maximum expected wave height is about 6.8 m (50th percentile) or up to 9m (84th percentile) for all tsunami sources that could reach the BOP coast. For both return periods the Kermadec fault makes up the highest proportion of local source for these events.

Hence this would be classed as a rare-unlikely event. The consequence of one of these large, but rare-unlikely events would be moderate to catastrophic. The societal impact would be severe as large numbers of people would be effected, by displacement or fatalities, significant damage to infrastructure and properties, the local through to national economy would be impacted, along with high clean up and recovery costs. There could also be serious environmental impacts.

8.3 Manageability Statement

A near source tsunami of the size that have typically occurred in NZ’s recorded history are difficult to manage in terms of reduction and readiness, except for land use planning, tsunami detection and warning. The near coastal areas (below 20 m) will be the only impacted areas and the reduction of significant infrastructure or adding additional robustness in these areas should be continued. In terms of response, these low probability but high consequence events need to be acknowledged in hazard and response planning. The development of education and evacuation plans will contribute to lowering the level of impact on lives. Recovery is very difficult to plan for as the outcome of an inundation will be varied and is difficult to predict in detail.

8.4 Growth Statement

The likelihood and style of hazards from tsunami arriving on the BOP coast are unlikely to change with time. However the consequence will continue to increase as growth continues in the region.

8.5 Level of Confidence

The above information was complied with current scientific knowledge obtained through published research documents, it is of a moderate to high level of confidence.

9 Volcanic Local

This Hazard assessment was prepared by GNS Science as part of the 2013 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

9.1 Hazard Description

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. The last eruption was in 1886 and created significant impacts in the BOP region. Moderate to large eruptions usually occur every 700-3000 years and will have a significant impact. The hazard may also present as 'caldera unrest (treated separately, see Section 5 Caldera Unrest).

Mayor Island (Tuhua) lies offshore from the Tauranga-Whangamata area and had a moderate caldera forming eruption about 6300 years ago. Smaller but undated eruptions (500-1000 years old) have followed the caldera forming eruption. 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, erupted as a series of lava flows and volcanic breccias. A lava plug and two small craters occupy the summit. Geological evidence suggests much of the cone has grown in the last 5000 years, with recent eruptions dated around 2300-3100 years ago. No activity is apparent since 1850 years ago.

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 (BOP Region) but can have a significant effect on the island. Pre 1975 historic eruptions were very small and short lived. A sustained eruptive episode occurred between 1975 and 2000 created a new active crater complex and lake. A further eruptive episode started in 2012 and continues (2014).

9.2 Likelihood and Consequence Statements

9.2.1 Maximum Credible Event

The Okataina Volcanic Centre (OVC) is thought to have started erupting about 550000 years ago, with significant caldera forming eruptions at c. 322000 and c. 61000 years ago. Post 61000 years ago there have been two sustained periods of 'post caldera forming' eruptive activity, the first lasting until about 27000 years ago and the second from 27000 years to the present. In the last 27000 years there have been 11 eruptions that have individually produced 0.5 to 18 km3 of eruptive deposit. The average eruption size is about 8 km3, while the largest is 18 km3. The OVC is considered active and the last eruption was in 1886 from Mt Tarawera. Future eruptions are expected from the volcanic centre and can be classed into two types: caldera forming and 'post caldera forming'. Only eruptions of the 'post caldera forming' style are considered here. They will have a very significant effect on the BOP region. The near vent area (within 5-10 km) may be totally destroyed and all distal portions of the BOP region may receive significant ashfalls (0.1-1 m). The topography impounding existing lakes may be impacted by an eruption, leading to large scale break-out floods. Remobilisation of ashfall deposits will create erosional issues for year to decades.

Mayor Island (Tuhua) is the summit of a moderate to large volcanic complex. The island is dominated by a 3 km wide collapse caldera and contains several vents. Three cycles of eruptive activity are recognised over the last 130000 years (130000-36000, 33000-8000 and 6300 years to present). The most significant problem at Mayor Island is the wide range of eruption sizes and styles recorded in the recent past, making it difficult to forecast the style and size of the next event. Three eruption scenarios are recognised; small-moderate phreatomagmatic (wet eruptions) events which may extend beyond the summit caldera, the extrusion of lava domes within the caldera, and a repeat of the 6300 year caldera forming eruption. Small to moderate phreatomagmatic eruptions are the more likely scenario. Near vent areas (2-5 km) will be significantly impacted and BOP coastal areas may receive ashfalls (1-20 mm).

Mt Edgecumbe (Putauaki) is a young, rapidly constructed volcanic complex. The preserved eruption deposits indicate that no wide spread impacts from eruptions have occurred. Future eruptions may differ from those in the recent past. The most likely scenarios for eruptions include hot pyroclastic flows, and block and ash flows off the cone and light ashfalls. Hydrothermal eruptions may also be triggered in the nearby Kawerau Geothermal system. If lava flows are produced and did flow off the cone they could extend into the Tarawera River, damming the river or diverting its direction of flow.

White Island (Whaakari) represents New Zealand's most frequently active volcano in the last few decades, it has not always held this title. Several crater forming eruptions have occurred on the island during our recorded history, however most were short lived eruptions until 1975. From 1975 to 2000 the volcano was in a continuous episode of eruption; with activity varying from weak gas and steam emission, to ash emission and explosive block and ash ejecting events. These are relatively small explosive eruptions on a global scale, typically occurring several times per year during an eruptive episode. Another eruptive episode started in 2012 and continues (2014). Explosive block and ash ejecting eruptions and while a crater lake is present surges that impact the Main Crater floor can be expected.

9.2.2 Likelihood and Consequence Assessment

The history of volcanic activity at the OVC indicates that future eruptions will occur and may be of two styles; Caldera forming and smaller 'post caldera' eruptive episodes. Only the latter is considered here as it is more likely, but still a rare occurrance. At least 19 post caldera eruptive episodes have occurred at OVC in the last 60000 years, suggesting an average frequency of about 1 per 3000 years. During the past 22000 years the average interval between eruptions has been 2090 ± 770 years. The probability of an eruption in the next 50 years is about 2.4% (based on the last 22000 years), hence this would be classed as a rare-unlikely event. The consequence of one of these very large, but rare volcanic eruptions would be major-catastrophic. The societal impact would be severe as large numbers of people would be effected, by displacement or fatalities, significant damage to infrastructure and properties, the local through to national economy would be impacted, along with high clean up and recovery costs. There would also be serious environmental impacts and large areas impacted.

The geological history of Mayor Island (Tuhua) off the Bay Of Plenty coast confirms that future eruptions will occur. Three eruptive episodes are recognised in the last 130000 years with at least 52 eruptions having occurred. The average interval between eruptions is of the order 2500 years. It is not known how many eruptions have occurred since the summit caldera forming eruption 6300 years ago. Based on the longer term rate this indicates 2-3 eruptions have probably occurred. The probability of an eruption in the next 50 years is about 2.0% (based on the last 130 000 years), hence this would be classed as a rare event. The consequence of one of these large, but rare volcanic eruptions would be catastrophic only on the island, being much less on the North Island (BOP region). The societal impact would be minor as few people would be affected, with next to no people being displacement or killed. Damage to infrastructure and properties would be low, and caused by distal ashfall, the local through to national economy would be impacted lightly, along with some clean up and recovery costs. There could also be serious environmental impacts in the marine environment. Only small areas would be impacted on-shore.

Mt Edgecumbe (Putauaki) is a young volcano and has a very poorly understood eruptive history. The volcano is considered to be less than 5000 years old, with no eruptions in the last 1850 years. The young age and poorly known eruptive history make it difficult to predict or assess future eruptions. These are expected and the probability of an eruption in the next 50 years is assessed at about 2-5%. The consequence of one of these very local, but rare volcanic eruptions would be major to catastrophic for the local Kawerau community. The societal impact would be minor to moderate as large numbers of people would be effected, by displacement and no fatalities should occur. There would be significant damage to local infrastructure and properties and the local through to national economy would be impacted. Significantly high clean up and recovery costs could be expected. There would also be serious environmental impacts with small to moderate areas impacted.

White Island (Whaakari) is currently in a frequent state of eruption. Based on recorded history the return period is less than 10 years, while the geological record (sea bed cores) for the last 15000 years records seven eruptive episodes (all are larger than the current activity). This is a significant miss match. The probability of an explosive eruption in the next 50 years that would impact the Main Crater floor (most accessible portion of the island) is greater than 95%. The consequence of one of these larger eruptions could be moderate to major on the island if visitors are present. The social, built, economic and environmental impacts are only present if visitors are on the island are impacted. Very light ashfall could occur on the mainland. The impact on the North Island is negligible.

9.3 Manageability Statement

Caldera forming or post caldera eruptions of the size that have typically occurred at OVC in the last 22 000 years are almost impossible to manage in terms of reduction and readiness, except for land use planning and volcano monitoring. The near vent areas (within 10-15 km) which will be totally destroyed should be kept free of significant infrastructure, as should major catchments as post eruption sedimentation and flooding will be a significant issue. In terms of response, these low probability but high consequence events needs to acknowledged in hazard and response planning, but are difficult to plan for specifically. Volcano monitoring will reduce the impact as some form of useful warning will be possible. Recovery is very difficult to plan for as the outcome of an eruption will be varied and are difficult to predict in detail.

As Mayor Island (Tuhua) is offshore and has a very small resident population (that would be evacuated during unrest before an eruption) there is little that can be added in terms of reduction and readiness beyond planning for evacuation, keeping infrastructure to a low level and continued volcano monitoring. Impacts on the coast will be restricted to ashfall and treated as any distal eruption. Recovery will be dependant on the effects of the eruption.

Mt Edgecumbe (Putauaki) will have a significant impact on the local near vent area and areas within 1-5 km of the volcanic cone, and some distal ashfall will also occur. Recognition of the volcanic hazards in local and regional planning can be achieved as a part of reduction, readiness and response planning and will help mitigate some issues should an eruption occur. Volcano monitoring will help recognise reawakening of this volcano. Recovery will be dependant on the effects of the eruption.

White Island (Whakaari) is an active volcano, but is offshore and has little impact on shore beyond minor ashfall and acid rain. Visitors to the island are exposed to significant risk during eruptive activity and this needs to be identified for in terms of reduction, readiness and response planning. Currently little effort is made in this area due to the difficulty in identifying responsibilities.

9.4 Growth Statement

The likelihood and style of hazards from OVC are unlikely to change with time. However the consequence will continue to increase as growth continues in the region.

The likelihood and style of hazards from Mayor Island (Tuhua) are unlikely to change with time. The consequence is unlikely to increase unless growth of infrastructure occurs on the volcano or nearby in the sea.

The likelihood and style of hazards from Mt Edgecumbe (Putauaki) are unlikely to change with time. However the consequence will continue to increase as growth of infrastructure and population continues in the local area and region.

The likelihood and style of hazards from White Island (Whakaari) are unlikely to change with time. However the consequence will remain high as tourism growth continues on the island.

9.5 Level of Confidence

The above information was complied with current scientific knowledge obtained through published research documents, it is of a moderate to high level of confidence.

10 Volcanic – Distal

This Hazard assessment was prepared by GNS Science as part of the 2013 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

10.1 Hazard Description

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 it's an ashfall hazard. Ashafall 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.

10.2 Likelihood and Consequence Statements

10.2.1 Maximum Credible Event

The Taupo Volcanic Centre (TVC) is downwind of the Bay Of Plenty and is capable of eruptions that could generate ashfall greater than a few mm thick in the Bay of Plenty. TVC has produced eruptions that range in size from about 0.5 km3 to over 45 km3. The smaller events are more frequent. Maximum expected ashfall from an event less than about 1 km3 would be about 1-2 cm dependant on the height of the eruption column and the wind direction at the time of the eruption.
The other volcano systems are more distal and would typically have smaller eruptions, hence have less impact.

10.2.2 Likelihood and Consequence Assessment

The history of volcanic activity at the Taupo Volcanic Centre (the nearest large volcano to the BOP) indicates that future eruptions will occur. At least 28 eruptive episodes have occurred at TVC in the last 28000 years, suggesting an average frequency of about 1 per 1000 years. The probability of an eruption in the next 50 years is about 5% (based on the last 28 000 years).
Hence this would be classed as a unlikely event. The consequence of one of these large volcanic eruptions would be minor to moderate for the BOP. The societal impact would be moderate as large numbers of people would be effected, minor to moderate damage to infrastructure and properties, the local through to national economy would be impacted, along with high clean up and recovery costs. There would also be serious environmental impacts with large areas impacted.

10.3 Manageability Statement

Volcanic eruptions from sources outside of the BOP will typically only have a minor to moderate impact, however they are almost difficult to manage in terms of reduction and readiness, except for land use planning, adherence to building codes and volcano monitoring. In terms of response, these low probability but high consequence events needs to acknowledged in hazard and response planning, but are difficult to plan for specifically. Recovery is very difficult to plan for as the outcome of an eruption will be varied and are difficult to predict in detail.

10.4 Growth Statement

The likelihood and style of hazards from a volcanic eruption outside of the region are unlikely to change with time. However the consequence will continue to increase as growth continues in the region.

10.5 Level of Confidence

The above information was complied with current scientific knowledge obtained through published research documents, it is of a moderate to high level of confidence.

11 Volcanic – Caldera Unrest

This Hazard assessment was prepared by GNS Science as part of the 2013 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

11.1 Hazard Description

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.

11.2 Likelihood and Consequence Statements

11.2.1 Maximum Credible Event

Periods of volcanic unrest for OVC and Mayor Island have not been assessed in detail. The potential scale of unrest is best assessed from other caldera systems that have been evaluated. For example unrest has been observed many times at Taupo Volcanic Centre, including periods of up to a year of frequent earthquakes, 3.7m of subsidence at the lake edge and self-evacuations, without a resulting eruption. Unrest has also been documented at Campi Flegrei in Italy, Rabaul in Papua New Guinea and Long Valley in USA, with only the Rabaul unrest eventually resulting in an eruption in 1994.

A period of volcanic unrest lasting weeks to years is possible, with damaging earthquakes, ground deformation and changes in hydrothermal systems. This is likely about once in 50-100 years from OVC. The consequences will be public and governance uncertainity and has the potential to affect the local and national economies, the tourism industry, infrastructure of national importance, the psychological and physical health of the nearby residents and the trust between the community, media, emergency management officials and scientists.

11.2.2 Likelihood and Consequence Assessments

The history of volcanic activity at the OVC indicates that future eruptions will occur and therefore will be preceded by caldera unrest that may or may not end in an eruption. The probability of an eruption in the next 50 years is about 2.4% (based on a return period of 2090 years during the last 22 000 years), but as caldera unrest could occur as often as once every 50-100 years its probability is higher, about 60%, therefore needs to be considered as *possible*. The societal impact would be moderate as large numbers of people would be affected, by displacement or self evacuation, damage to infrastructure and properties, the local through to national economy would be impacted, along with clean up and recovery costs. There could also be areas of environmental impacts.

11.3 Manageability Statement

Caldera unrest of an intensity that have typically occurred at Taupo in our recorded history are possible from the OVC. These can be managed to a degree in terms of reduction and readiness with recognition of the issues in planning and education, coupled with active support of the Caldera Advisory Group and volcano monitoring (allows a warning). Some aspects of the issues like seismic activity are covered by that topic. Considering factors relating to efficient evacuation may also reduce the risk. In terms of response, these low probability but moderate consequence events need to acknowledged in hazard and response planning, but are difficult to plan for specifically. Recovery is very difficult to plan for as the outcome of the unrest will be varied and is difficult to predict in detail. However it is likely to be similar to recovering from an on-going earthquake sequence, with the additional fear in the population (and in the media) of a large-scale eruption.

11.4 Growth Statement

The likelihood and style of hazards associated with caldera unrest from OVC are unlikely to change with time. However the consequence will continue to increase as growth continues in the region.

11.5 Level of Confidence

The above information was complied with current scientific knowledge obtained through published research documents, it is of a moderate to high level of confidence.

12 Earthquake

This Hazard assessment was prepared by GNS Science as part of the 2013 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

12.1 Hazard Description

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, hence damage for 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.

12.2 Likelihood and Consequence Statements

12.2.1 Maximum Credible Event

The National Seismic Hazard Model recognises the greater Taupo Rift Faults as the most likely source of significant accelerations, hence damage for 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.

The North Island dextral fault belt is expected to produce earthquakes in the M 7.4 to M 8.2 range. While the Taupo Rift faults and extensional western North Island faults are expected to produce M 6.2 to 6.5 events.

12.3 Likelihood and Consequence Assessments

The National Seismic Hazard Model is based on a return period of 475 years. The model is based on input of the likely maximum magnitude and recurrence interval for each known fault source in selected geographic areas of similar expected faulting. Due to the more frequent occurrence of faulting on the Taupo Rift Faults the model predicts stronger shaking over the return period in this area. If one of the much less frequent but larger faulting events, expected from the North Island dextral fault belt occurs the result will deviate from the model. The recurrence rate for the Taupo Rift Faults is of the order of centuries. Large damaging earthquakes would be classed as *unlikely-possible* events.

The consequence of one of these large unlikely but possible events would be *major-catastrophic* depending on where in the region it occurs. The societal impact would be severe as large numbers of people would be effected, by displacement or fatalities, significant damage to infrastructure and properties, the local through to national economy would be impacted, along with high clean up and recovery costs. There would also be serious environmental impacts with large areas impacted.

12.4 Manageability Statement

Large damaging earthquakes of the size expected are very difficult to manage in terms of reduction and readiness, except for land use planning and adherence to building codes. The near source areas (within 0-30 km) which will experience significant shaking from a large earthquake. This will affect many aspects of the society and infrastructure. In terms of response, these low probability but high consequence events need to be acknowledged in hazard and response planning, but are difficult to plan for specifically. Recovery is very difficult to plan for as the outcome of an earthquake will be varied and are difficult to predict in detail.

12.5 Growth Statement

The likelihood and style of hazards from a large damaging earthquake are unlikely to change with time. The likely source areas and parameters for large earthquakes are well known for the Bay of Plenty region. However the consequence will continue to increase as growth continues in the region.

12.6 Level of Confidence

The above information was complied with current scientific knowledge obtained through published research documents, it is of a moderate to high level of confidence.

13 Slope Instability (Landslide, Debris Flow, Slumping)

13.1 Ōpōtiki District Assessment

This Hazard assessment was prepared by Ōpōtiki District Council as part of the 2013/14 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

13.1.1 Hazard Description

The Ōpōtiki District is made up of mostly hilly and mountainous land covered in dense bush. There is a reasonably high risk of landslides occurring as a result of rainfall events due to the district receiving a relatively high annual rainfall. There is a lesser risk of these occurring as a result of earthquakes.
Previous rainfall events have resulted in a number of serious landslides occurring. In 2004 landslides occurred throughout the district, damaging properties and infrastructure and resulting in 1 death. In more recent times serious landslides have occurred on State Highway 2 in the Waioeka Gorge south of Ōpōtiki and on State Highway 5 to the east of Ōpōtiki. Both resulted in the closure of the road for prolonged periods and extensive repairs being required.

13.1.2 Likelihood and Consequence Statements

Maximum Credible Event
The likelihood of a significant landslide occurring as a result of a rainfall event in the Ōpōtiki district is high. Ōpōtiki is sparsely populated and only a small number of the district's residents live in areas prone to landslide. The major impact is likely to be upon transport networks, where previous events have caused prolonged road closure and limited access to the east (Gisborne and coastal settlements east of Opotiki). The risk to travellers using roads in areas prone to slips is very high during heavy rainfall.
Likelihood and Consequence Assessment
The table below represents the risk of a major landslide occurring with the potential to destroy buildings and infrastructure and potentially cause loss of life.

Table 13.1: Slope instability risk assessment for the Ōpōtiki District

Area	Trigger	Likelihood	Consequence	Risk Rating
SH2 Waioeka Gorge	Rainfall	Likely	Moderate / Major	Med / High
	Earthquake	Possible	Moderate / Major	Medium
SH 35 – Ōpōtiki to Waihau Bay	Rainfall	Likely	Moderate	Medium
	Earthquake	Possible	Moderate	Medium
Ōhiwa area	Rainfall	Possible	Moderate	Medium
	Earthquake	Possible	Moderate	Medium
SH2 - Waiotahi	Rainfall	Possible	Minor	Medium
	Earthquake	Possible	Minor	Medium

13.1.3 Manageability Statement

Works have been undertaken in areas that have suffered landslides to stabilise slips. Where slips have occurred in populated areas work has been undertaken to improve stormwater control above escarpments.
Work to understand and reduce the hazard in the district has mostly been undertaken in conjunction with the New Zealand Transport Agency. No projects have been undertaken to map or assess the risk of landslides across the entire district.
Response to these events can be difficult due to the terrain. Access to the east of Ōpōtiki and in the Waioeka Gorge can be difficult, meaning response to and recovery from these events can take a long time.

13.1.4 Growth Statement

The risk of landslides occurring in the district is likely to be higher with any increase in the frequency of severe weather events as a result of climate change. The consequences of major slips on key infrastructure routes may potentially increase with the development of the aquaculture industry in the Ōpōtiki District requiring reliable transportation networks.

13.1.5 Level of Confidence

The information above is based on knowledge of the area and the impacts of previous events. There is a medium level of confidence in the information contained within this document.

13.2 Tauranga City Assessment

This Hazard assessment was prepared by Tauranga City Council as part of the 2013/14 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

13.2.1 Hazard Description

Tauranga City is a landform that has been formed by 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 case 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 Tauranga City, along with many other 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.

Awareness of the risk of the issues and mechanisms associated with land slippage in the City has been reported on for over 4 decades.

Research undertaken by Tauranga City Council over many years has confirmed the areas that are most susceptible to land slippage. These areas have been mapped and published on our GIS systems and form part of business process when considering infrastructure development, LIMS, PIMS and building and resource consents.

The recognised as most susceptible to slippage are the zones known as 2:1 and 4:1 zones.

The 2:1 zone (up slope Failure) maps the area of land that is steeper than 26 degrees in slope starting at the toe of the slope and ending at the top of the slope. The 4:1 zone (down slope failure) maps the area of land below a slope that is steeper than 2:1 that if it fails the slip debris would travel within.

The City experiences slips of some form most years. Out most notable periods of extensive slippage are as follows:

1979, 1984, 1995, 2000, 2001, 2005, 2011 and 2012.

13.2.2 Likelihood and Consequence Statements

Maximum Credible Event

As such TCC has never modelled a maximum credible event. TCC have simply taken advice on the likely slope failure mechanics and linked that to development patterns, slope geometry and rainfall intensities, distribution and volumes to understand when a slope is at elevated risk of failure.

If a maximum credible event was required then modelling the rainfall intensities and distribution for the May 2005 event would be a good start point

Current work being undertaken by TCC is to analyse the rainfall intensities and distribution patterns preceding and on the day when known slip and flood events occurred. This will provide an understanding of vulnerability that can be used in long term and emergency management planning.

The worse slippage that has occurred in recent times is the 2005 extreme rainfall event when over 300 slips were recorded resulting in the loss of 42 homes. 2011 saw over 40 slips occur, most notable were the multiple slips that occurred on Mauao. No houses were threatened or lost.

Through its statutory processes TCC continues to update its knowledge of slippage and slumping and ensuring those documents obtained are available for public and organisational use.

Likelihood and Consequence Assessments
Input from a geo-professional is required for this section as hazard management of slippage to date has generally not considered return periods as such in determining maximum credible events. In some cases this may have occurred on specific large scale infrastructure projects or on large scale land developments where massive earth working of slopes has occurred and building setback lines have been required. But even in those instances a return period earthquake may have been applied to a slope that simply related to either a service limit state or was looking at sensitivity of factors of safety.
The research work mentioned in the first section will provide return periods for the rainfall that was present when the slippage occurred and also for any rainfall present in the 10 days leading up to a slip event. Experience says that land slippage in Tauranga is often preceded by a rainfall event that has the effect of filling the soil pores with water thus elevating the groundwater pore pressure before the subsequent rainfall increases the pressure still further leading to slippage.

13.2.3 Manageability Statement

From a reduction perspective the hazard is generally easily managed and is either mitigated or avoided for new development. Longer term geological processes such as inner harbour erosion and peninsula regression make reduction of somewhat more complex and difficult to engage the community over. Also funding solutions in that realm is poorly defined and not well supported by communities unaffected by the issue.
From a readiness and response perspective the hazard is generally easy to manage.
From a recovery perspective the hazard can be complex and time consuming to deal with. Any slip hazard that occurs that is proximal to homes or outbuildings or loses part of the amenity of a section can take a long time to reinstate and involve tense conversation around funding etc.

13.2.4 Growth Statement

For urban / commercial areas that were established pre-1996 the impact of the hazard may increase as additional development of structures occurs which require limited consenting for the activity. For those areas where additional development occurs and that requires a more robust resource and / or building consent process then the impact will either diminish or at the least remain the same.
For new areas the hazard risk will reduce as the hazard is actively avoided, mitigated or removed.

13.2.5 Level of Confidence

The above information is supported by good quality information obtained over many years and has been actively managed for a similar period of time.
Confidence - High

13.3 Whakatāne District Assessment

This Hazard assessment was prepared by Whakatāne District Council as part of the 2013/14 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

13.3.1 Hazard Description

Whakatāne District Council (WDC) has undertaken quantitative landslide and debris flow risk assessments for parts of Whakatane, Ohope and Matata. This work was initiated following 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.

13.3.2 Likelihood and Consequence Statements

Whakatāne Likelihood and Consequence Assessment

Table 13.2: Slope instability risk assessment for the Whakatāne and Ohope

Sector	Susceptibility	Hazard	Loss of Life Risk
Whakatāne – Nth of Wairere Stream	High	High	Very High
Whakatāne – Sth of Wairere Stream	Moderate	Moderate	Very High
Ōhope – West End Road	High	High	Very High
Ōhope – Pohutukawa Avenue	High	Moderate	Very High

Matatā Likelihood and Consequence Assessment

Table 13.3: Probability of occurrence in 50 years and debris flow hazard rating for Matata

Event Relative Magnitude	Return Period (years)	Probability of occurrence in 50 years (%)	Description of Likelihood in 50 years	Hazard Rating
Half 2005	<200	>25	Likely	High
2005	200-500	10-25	Possible	Moderate
Twice 2005	>>500	<<25	Unlikely	Low

NOTES: The design return period of the 2005 event has been estimated as being somewhere in the order of 200-500 years. For the purpose of this assessment, it has been assumed that an event that has half the volume of the 2005 event would have a return period less than this (say less than 200 years) but no value has been assumed. It has been assumed that given the very large size of the 2005 event, a future event that is twice this size would be a very rare event, if indeed it is even possible. The return period is unspecified but assumed to be much greater than 500 years.

13.3.3 Manageability Statement

Structural measures
These physical measures eliminate or mitigate a hazard, or reduce the risk from a hazard.

Hazard Elimination
Potential measures include:

- Re-profiling of slopes
- Reducing the height of slopes and/or removing potential landslide material
- Construction of earthwork buttresses to support slopes
- Construction of retaining walls
- Reinforcement of slopes by the installation of rock anchors, etc.
- Prevention of material falling from slopes through the placement of shotcrete, wire netting etc.

The cost of these solutions means they are unlikely to be practicable at an area wide scale. These solutions may be applicable at an individual site scale.

Hazard Reduction
Potential measures include:

- Stormwater and Ground water control through:
  - diverting water flows away from landslide-prone land
  - lowering groundwater levels through subsurface drains
- Vegetation Control through:
  - removal or reduction of dangerous overhanging trees
  - planting of appropriate species at crest, face and base of slopes

Some stormwater diversion works have been undertaken in Otarawairere and above West End Road to reduce the severity and frequency of landslide hazards. These measures may also have application in other parts of the hazard areas.

Vegetation control is particularly applicable as vegetation has been identified as a major component of destructive debris that reached the residential areas in Ohope as a consequence of landslides occurring high in the escarpment. The most recent landslide fatality at West End in 2011 occurred as a consequence of vegetation debris impacting an occupied dwelling. The implementation of vegetation control measures will be affected by land ownership, land status and zoning. For example, some of the vegetated escarpments are in reserves or identified as Outstanding Natural Features and Landscapes or as having ecological significance. Priority should be considered for vegetation works that reduce loss of life risk. All of these measures could be applicable to the study areas.

<u>Risk Reduction</u>
Potential measures include:

- Debris flow control structures
  - Debris dams
  - Debris nets
- Debris barriers
  - Earth bunds
  - Steel posts
  - Flexible ring net barriers
  - Impact walls

Debris flow control structures have been installed at the Waitepuru stream to reduce debris flow risk, designed to contain a repeat of the May 2005 debris flow event (200-500 annual exceedance probability for rainfall). Proposals for debris flow control structures at the Awatarariki stream for a 2005 equivalent event have been abandoned due to the high cost and engineering feasibility. The cost and feasibility of these solutions at an area-wide scale means they are not currently practicable as options. Some solutions may be applicable at site-level for those sites situated in a low hazard zone. Risk reduction works become a permanent commitment if development is allowed to proceed on the basis of the risk reduction that is provided. This includes long term maintenance and ensuring that granted resource consents are kept current and conditions are met.

Non-structural measures
Non-structural measures are risk reduction measures. They do not alter the likelihood of hazards occurring, but contribute towards addressing some, or all, of the consequences.

<u>Information</u>
Potential measures include:

- Research, scoping studies, hazard vulnerability studies, risk assessments to inform decision making
- Monitoring of existing landslides by technical specialists
- Lifeline engineering projects to assess vulnerability of lifelines and develop contingency and response plans
- Education programmes to improve knowledge and promote awareness
- Advice and advocacy e.g. keeping up to date best practice guidelines on mitigation measures and contact information for qualified experts
- LIMs to provide information on location and/or characteristics of known hazards
- PIMs to provide information on location and/or characteristics of known hazards

All of these measures could be applicable to the study areas.
<u>Warning systems</u>
Potential measures include:

- Landowner education on natural warning signs and self-evacuation
- Low level early warning systems

  * Regular monitoring and assessment of risk areas by qualified staff
  * Active monitoring of rainfall forecasts and radar during events to detect any potential issues
- High level early warning systems - Low level early warning systems plus
  * Forwarding of all severe weather warnings to residents in risk areas (email and text alert)
  * Deployment of mobile radar to monitor areas of concern during major events
  * Installation of wire sensors to measure land movement in all areas of high risk
  * Rainfall sensors in all catchments
- Low level event system
  * Visual observation by residents in risk areas
- High level event system
  * Sensors connected to alarms placed in all areas with a high risk of potential landslide/debris flow
  * Staff deployed to monitor specific sites during heavy rainfall events and warn residents if movement in slope detected
- Evacuation procedures, including both formal and self-evacuation.

<u>Development control</u>
Enabling District and Regional Plan rules to manage development in hazard areas, such as:
- Allowing existing activities to continue but only within the existing building envelope
- Allowing alterations or re-development where risk is reduced
- Allowing properly designed protection works to be undertaken without resource consent or streamlined consent procedures
- Providing best practice guidelines to assist landowners with risk mitigation
- Allowing vulnerable uses to be replaced with less vulnerable uses (e.g. residential use replaced by non-habitable use).

Restrictive District Plan zoning and rules to manage development in hazard areas, such as:
- Requiring resource consent for extensions and relocations, and any works on sites within hazard zones
- Continuation of existing uses meeting the legal requirements of the RMA (Section 10)
- Not allowing intensification by further subdivision within hazard zones
- Not allowing new vulnerable land uses to establish within hazard zones.

Restrictive Regional Plan rules to manage development in hazard areas, such as:
- Requiring existing activities to cease by a specified date unless resource consent is obtained, which would require risk to be reduced to an acceptable level
- Not allowing reoccupation of sites that have been rendered uninhabitable by a hazard event unless resource consent to re-establish is granted, which would require risk to be reduced to an acceptable level
- Allowing life-time occupation of a site by current occupants and requiring resource consent for reoccupation by others, which would require risk to be reduced to an acceptable level.

<u>Development retreat</u>
A potential measure is for Council to purchase properties that have unacceptably high risk and enable relocation to sites with acceptable risk. The cost of this solution means that it is not practicable on an area wide scale. Councils do not have legal powers to compulsorily acquire land that is affected by hazards; nor can they be compelled to acquire such land.

13.3.4 Level of Confidence

Please refer to quantitative landslide risk assessments.

14 Geothermal

This Hazard assessment was prepared by GNS Science as part of the 2013 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

14.1 Hazard Description

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.

14.2 Likelihood and Consequence Statements

14.2.1 Maximum credible event

The largest known geothermal explosion deposits in the BOP region occur at Kawerau and Waimangu and appear to be related to large scale 'post caldera' eruptions occurring nearby. The probability of one of these volcanic eruptions is about 2.4% within 50 years. Everything nearby to one of these will be significantly impacted or destroyed.

14.2.2 Likelihood and Consequence Assessment

Large scale geothermal eruptions appear to be directly related to large scale 'post caldera' eruptions occurring nearby. These large eruptions have a return period of about 2000 years and the impacts are significant nearby, with extensive damage occurring up to about 1 km from the source.
Smaller scale geothermal eruptions related to natural processes occur in all high temperature geothermal systems and appear more common in some exploited systems. These occur on about an annual basis and only significantly affect the near source areas (5-50 m). The Waimangu Geyser claimed 4 lives in 1903, while the Frying Pan Flat eruption in 1917 (Waimangu) claimed 2 lives.

14.3 Manageability Statement

Geothermal hazards are restricted to well known areas of high temperature geothermal systems. Restricting access to near the surface features significantly mitigates the known hazards hence there is achievable gains in terms of reduction and readiness. Response the recovery is directly related to the location and size of the eruptions and this can not be predicted in advance. Areas of geothermal features that are easily accessable to the public are usually well fenced and controlled.

14.4 Growth Statement

The likelihood and style of geothermal eruptions in the BOP region are unlikely to change significantly with time. Only the future development of currently undeveloped geothermal systems is likely to change this. However the consequence will continue to increase as growth continues in the region.

14.5 Level of Confidence

The above information was complied with current scientific knowledge obtained through published research documents, it is of a moderate to high level of confidence.

15 Rural Fire

This Hazard assessment was prepared by The Bay of Plenty Civil Defence Emergency Management Group with input from the Rural Fire Authorities within the Region as part of the 2013/14 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

15.1 Hazard Description

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.

Further indicators of fire risk are:

- Those areas where there are no water supplies for fire fighting.
- Area difficult to access by vehicle
- Steep, hilly slopes
- Area with flammable vegetation, particularly where it is close to buildings and plant.
- Coastal zone where there is ready public access and significant coastal inhabitants
- Lack of fire fighting resources in rural areas
- Reduction of fire fighting skills within the industry through down sizing.
- “Just enough” prevention measures during uncertainty in forestry.

15.2 Likelihood and Consequence Statements

15.2.1 Maximum Credible Event

A major fire in extreme drought conditions on the rural urban interface threating urban areas would be a typical worst case scenario for this hazard. This would require a commitment of all regional resources, widespread evacuations and destruction of property and vegetation. National and possible international assistance would be required. There would be the potential for fire fighter and residential casualties and fatalities as a result of an event of this size.

An extended, dry windy period over the summer with minimal rain (e.g. a series of high pressure systems over the North Island) would bring an increased fire risk, followed by a deep tropical low bringing strong to gale winds from the south. Should a fire start in the south of Kawerau, Whakatāne and Rotorua during these conditions any of the three towns could be threatened, creating a regional incident and substantial consequences.

On a smaller scale multiple fires occurring at the same time within the region would fully commit local and regional resources potentially requiring resources from outside the region. This would threaten rural properties, utilities and agriculture areas.

15.2.2 Likelihood and Consequence Assessment

Due to the high proportion of vegetation cover over the Region, fuel loadings are high and occurrence of hot and dry periods are relatively common. The likelihood of some fires occurring on an annual basis is almost certain. The likelihood of any of the three scenarios described above occurring would be significantly less and estimated to be in the possible (or likely) range. A worst case scenario where loss of life results is estimated to be in the unlikely range

Using the suggested assessment of consequence the worst case scenario would have catastrophic consequences. The destruction and damage implications for our region in which the world’s largest man-made forest is located cannot be taken likely. The impact of a large exotic forest fire would be devastating.

Human

- Deaths possible in particular on urban/rural interface and rural communities. Comparable overseas events indicate death rates to be low (worst cases measured in tens not 100's of people).
- Injuries including burns, smoke inhalation, breathing disorders likely
- Psychological trauma and fear of recurrent events
- Fire fighters and aircraft operators vulnerable to death or serious injury.

Economic

- Very large impact to the region through reduction of export opportunities through the port of Tauranga.
- Significant coast of the emergency response
- Loss of income to the forestry and rural sector
- Up to 30 years effect on the Forestry industry.

Social

- Intense media coverage
- Loss of vegetation, agricultural pastures and domestic animals
- Severe depletion of native fauna and flora
- Significant social disruption through smoke, noise, evacuations and road closures.
- Loss of homes through fire and consequential displacement.
- Loss of confidence in emergency services.
- Social impacts of deliberately lit fires may include outrage, vengeance, fear and uncertainty.

Infrastructure

- Disruption to energy supplies
- Possible disruption to radio communications systems due to smoke effects.
- Road closures and reductions to access due to smoke and access for emergency vehicles
- Significant requirement for water supplies from many sources.
- Loss of above ground infrastructure.
- Loss of rural fencing

Geographic

- Loss of conservation outcomes
- Long term scarring of habitat
- Increased erosion following destruction of vegetation
- Loss of native bush for recreation and tourism downturn.

15.3 Manageability Statement

Rural Fire Authorities have a statutory responsibility for fire management and put significant resource across the region to manage this risk. The individual Rural Fire Authorities have adopted a number of policies and tools to do this including:

- Assessing and managing the fire hazard-scape
- Undertaking wildfire threat analysis
- Promotion of fire risk mitigation measures including but not limited to roadside grass mowing, safe burning practises, maintaining volunteer fire forces and equipment, publicising levels of fire risk, fire permits, prohibited fire seasons.
- Assessing levels of risk within their specific fire districts.
- Promoting and developing fire prevention measures.
- Prescribed fires
- Burn Plans
- Education
- Enforcement
- Engineering
- Administrating
- Insurance
- Fire safety margins

- Resource consent requirements on Forestry planting and harvesting
- Rural fire research
- Training and exercising.

15.4 Growth Statement

Recent conversion of productive forestry land across the region has reduced the total regional fuel loading. However increasing population growth, populations living closer to scrublands, exotic and native forests, and the impacts of climate change are all likely to contribute to an increase in risk in the future.

15.5 Level of Confidence

The above assessment is largely based on the 2005 assessment report and was updated with a limited amount of input from the local rural fire authorities. This assessment carries a moderate to low level of confidence.

16 Drought

This Hazard assessment was prepared by The Bay of Plenty Civil Defence Emergency Management Group as part of the 2013/14 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

16.1 Hazard Description

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.

16.2 Likelihood and consequence statements

Droughts are relatively common in the Bay of Plenty but vary greatly in frequency and intensity.
The Ministry of Primary Industries states that the 2013 summer drought was one of the most extreme on record and the worst since 1945-46. It was also one of the most widespread droughts across the country. The Bay of Plenty region was one of the most affected by the 2013 drought. Droughts are usually caused by El Nino weather conditions, however the 2013 drought was caused by a series of slow moving or 'blocking' high pressure systems over the Tasman Sea and New Zealand.
The 2013 drought provides a good example of more severe end of the hazard experienced across the region to examine the consequences of an event.
Droughts often affect the rural sector, through crop failure, lack of stock feed and water. The economic impacts generally has a lag effect, as farmer have to restock, animals carried through the drought regain condition and reproductive performance. Estimates put the cost of the 2013 drought at around 0.7% of GDP or around $1.5 billion nationally. No estimates were available on the regional impacts of the drought.
Drought can also have significant psychological and social impacts on rural communities, when there is increased financial pressure on rural businesses. Droughts also caused water shortages, restrictions and irrigation supplies can be affected. During the 2013 Drought the Whakatāne town water supply was dangerously close to running dry.
Drought also has a cascading effect on other hazards such as increasing the risk of wildfire across the region.
Using the suggested assessment of likelihood and consequence the hazard of a significant drought would be described as likely, the consequences of these events on a regional scale would most likely be minor to insignificant, resulting in a low to moderate risk for the Bay of Plenty.

16.3 Manageability Statement

Reducing the risks from drought focusses on good farm management and irrigation where it is available. Where irrigation is not available drought resistant pasture species, preventing over-grazing, flexible stocking strategies, early lambing, small farm dams and buying in supplementary feed will all help reduce the risk of drought.
Droughts are not easily predicted but NIWA produces 3 montly climate outlooks which are available to assist in early decision making and preparedness for the possibility of the onset of drought.
The regional and local authorities monitor water levels which assist in identifying at-risk water resources and allocations.
Due to the prolonged onset of drought the response is different from many other hazards and develops over a long period of time. As the situation evolves response measures increase with time

including business decisions including reducing stock numbers, buying in supplementary feed, or drying off dairy herds.

Upon the Minister of Primary Industries declaring a drought for a region financial assistance and management measures are available for the community to assist them to traverse the event. Water restrictions, rationing and in extreme cases trucking in water are all measure available during a response.

Similarly the recovery from a drought is prolonged and dependant on the duration and intensity of the event.

16.4 Growth Statement

NIWI advise that the most likely future scenario sees the bay of Plenty spending 5-10% more of the year in drought by the middle of the century. This means that is we spend an average of 10% of the time in drought at the moment, by 2040, we can expect to spend as much as 20% - although this figure will vary from year to year. An increase of 10% corresponds to about 35 more days a in drought per year on average.

16.5 Level of Confidence

The information for this assessment was obtained from nationally available data and reports written at a national level, information was inferred at a regional level. This has a moderate level of confidence.

17 Regional Deformation

This Hazard assessment was prepared by GNS Science as part of the 2013 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

17.1 Hazard Description

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).

17.2 Likelihood and Consequence Statements

17.2.1 Maximum Credible Event

The maximum likely event is the deformation accompanying a moderate to large shallow local earthquake. Earthquake activity in the BOP region is of two styles; normal faulting in the Taupo Volcanic Zone and strike slip in the North Island Fault System. Earthquake hazards are outlined elsewhere in this report (see Section 6 Earthquake). Shallow large earthquakes result in fault rupture propagating to the surface, creating a fault scarp. This may result in cm's to metres of offset of the ground surface. The 1987 Edgecumbe earthquake resulted in about 1.2 m of extension between Matata and Whakatane and up to 3m of vertical height change near the town of Edgecumbe. The major consequences are the change in topography and the influence this may have on drainage and lakes.
The long period gradual ground deformation can accumulate to relative changes of about 1 m per century.

17.3 Likelihood and Consequence Assesment

Ground deformation is occurring at two scales the gradual accumulation over years to centuries and the catastrophic near instant during a large shallow earthquake or major caldera eruption. The probability of the gradual deformation occurring is high <50% in the known active areas. The catastrophic offsets is related to the large scale earthquake return periods.

17.4 Manageability Statement

Ground deformation will have a significant impact on the local area near the surface fault rupture and areas within 10-500 m. The surface fault rupture maybe 5-15 km long. Recognition of the ground deformation hazards in local and regional planning can be achieved as a part of reduction, readiness and response planning and will help mitigate some issues that will occur. Continued monitoring of ground deformation will help recognise the magnitude and possible effects of this hazard. Recovery will be dependent on the effects of the deformation.

17.5 Growth Statement

The likelihood and style of ground deformation hazards in the BOP region are unlikely to change significantly with time. However the consequence will continue to increase as growth continues in the region.

17.6 Level of Confidence

The above information was complied with current scientific knowledge obtained through published research documents, it is of a moderate to high level of confidence.

18 Lifeline Utility Failure

This Hazard assessment was prepared by The Bay of Plenty Lifelines Group as part of the 2013 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

18.1 Hazard Description

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.

18.2 Likelihood and Consequence Statements

18.2.1 Maximum Credible Event

The main towns and cities of the Bay of Plenty along with the rest of the settlements are heavily dependent on services provided by lifeline utilities. A scenario based on the 1998 Auckland Power Crisis, which lasted two months would have similar impact here causing a similar long-term economic impact. The consequences of lifeline utility failure are variable and dependant of which lifeline failed.

18.2.2 Likelihood and Consequence Assessment

Likelihood
There is little information available to determine the likelihood of these types of events so the following estimates have been provided as a starting point.

Table 18.1: Scenario Likelihood Assessments

Scenario	Likelihood Estimate
Telecommunications failure of a significant duration that affects the ability to dial '111'.	1 Rare
Cell phone outage	1 Rare
IT failure telco	1 Rare
Power	2 Unlikely

Consequences
Human
- Illness and disease with breakdown in water, waste or heating systems

- Fatalities possible due to inhalation of gas, or fires and explosions caused by failure of gas or fuel systems
- Electricity Critical customers

Economic
- Business and industry disruption – the utilities themselves and those that rely on the utilities
- Cost of containment in case of failure of sewerage or gas systems
- Tourism industry major losses through loss of appeal as tourist destination.
- Loss of employment for businesses forced to shut/close.
- Loss of income for industries dependent on transportation facilities (e.g. ports, airports) including export and import industries. Long term economic effects
- Large costs of repair of infrastructure that failed
- Forced vacation of business premises

Social
- Sanitation and biological effects
- Evacuations and inconvenience of loss of gas for cooking/water heating in gas system failure
- Evacuation of large areas if gas spreads through underground corridors
- Possible loss of communication to emergency service providers
- Loss of confidence in infrastructure
- Social disorder due to loss of petroleum run transport systems, panic buying and congestion at fuel service sites.
- Psychosocial normality ch ch

Infrastructure
- Overloading of parts of systems that remain operational (e.g. sewerage overflow, remaining telecommunications sites)
- Physical damage to infrastructure possible
- Long term lack of supply during recovery
- Lack of supplies and personnel (or access of these things to the region) for efficient repair
- One system failure may trigger cascading failure of other systems
- Fires and explosions possible if failure of fuel or gas systems

Geographic
- Urban, coastal or marine pollution with waste water or fuel system failures

18.3 Manageability Statement

This hazard is managed as part of the ongoing business operations of the utilities involved. There are many solutions and options for managing these risks.

Current Management Mechanisms in Use
- Utility asset management plans
- Business/corporate continuity plans
- Service continuity plans
- Redundancy in system design
- Operational emergency response plans
- LTP planning
- Vulnerability study v1
- Interdependancies
- Fuel Contingency Plan 2013
- Emergency Response Plans (multi agencies)
- Infrastructure Upgrade Programmes eg bridges
- Build Programmes

Possible Future Management Mechanisms
- Emphasis on risk management through asset management renewal plans
- Support of Lifelines Group activities
- Further development of Lifelines Co-ordination/Information Centre
- Further development of communications between Lifelines
- Mutual Aid Agreements
- Contractor arrangements
- Consistent risk level terminology
- Vulnerability Study v2
- Organisational Resilience 2014

18.4 Growth Statement

There is no documented evidence to suggest that these events will become more frequent over time. While utilities carry out ongoing maintenance and planning as part of their normal business, in some areas there has been inadequate asset renewal, which may lead to increased frequency of events as the systems age. There is also increased congestion in road corridors.

The vulnerability of the community to these events is likely to increase as people and businesses become more reliant on these services. There is also significant interdependence between utilities.

18.5 Level of Confidence

The above information was complied with current industry knowledge to the best of participants recollection and does not contain reference to any research information, it is of a low to moderate level of confidence.

19 Hazardous Substance Release

Awaiting info

20 Major Accident – Air Road Rail

This Hazard assessment was prepared by The Bay of Plenty Lifelines Group as part of the 2013 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

20.1 Hazard Description

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

A NAC Skyline DC3 crashed in the Kaimais killing all 23 on board in 1963.
(Large-scale transportation accidents in the Nation's history include the Tangiwai Disaster in 1953, Wahine disaster of 1968 and Erebus in 1979.
Christchurch earthquake posed significant short and long term disruptions to infrastructure

20.2 Likelihood and Consequence Statements

20.2.1 Maximum Credible Event

A fully laden 737 crashes into a residential area on approach to Rotorua Airport
Commercial flight crashes into a residential area on approach to Tauranga Airport.
Mid-Range Events
Tourist Bus crash between Tauranga and Rotorua with International passengers from visiting Cruise liner based at Port of Tauranga. International consequences and liaison with Interpol etc.

20.2.2 Likelihood and Consequence Assessment

Each day there are a large number of passenger/goods trips taken without incident. The occurrences of small-scale events and near misses indicate that there is the possibility of these larger scale events occurring.
There is little information available to determine the likelihood of these types of events so the following estimates have been provided as a starting point.

Table 20.1: Scenario Likelihood Assessments

Transportation mode	People or goods impact	Qualitative Description
Commuter bus	40	3 Possible
Tourist Bus	40	3 Possible
Small aircraft Cessna to Saab	2-20 people (generally100 % full)	2 Unlikely
Domestic aircraft	Rotorua Airport 737:120-140 (average 70 –80 % full)	1 Rare
	Tauranga Airport Q300: 50 Passengers (100%)	2 Unlikely
Dangerous goods tanker crash	Urban environment: Domestic	2 Unlikely
	Main arterial route: Domestic and Commercial impacts	3 Possible
Rail Derailment	Te Maunga Bay Park Totara Street derailment Major Route for goods Economic impacts Possible affects for domestic travel and commercial access	2 Unlikely
Kaimai Tunnel Fire	Port of Tauranga: Economic Impact. If Kiwirail re introduce a passenger service, domestic impact may occur	2 Unlikely

Consequences

Human

- Deaths
- Injuries (including possibly crush and burns cases)
- Psychological distress for responders and primary victims

Economic

- Loss of confidence in the transportation sector affected
- Business disruption and possible shut down
- Large costs of response and investigation (esp. if recovery of vessel, craft necessary)
- Loss of confidence tourist sector

Social

- Temporary and permanent family disruption
- Commuter and transportation systems disrupted
- International Component Bus crash

Infrastructure

- Damage to physical transportation mechanisms (e.g. roads/rail lines) or vehicles – e.g planes.
- Possible damage to infrastructure in the vicinity of the accident

Geographic

- Possible ground or marine contamination from fuel or chemicals

20.3 Manageability Statement

There are a considerable number of management mechanisms in place to address these hazards. Most of the management mechanisms are part of normal safe business operating procedures and therefore have a low level of difficulty to implement.

The Bay of Plenty will continue to be a tourist destination by land, sea and air or a combination of these.

Possible future management mechanisms

- Commuter management plans for delays and disruptions.
- Vulnerability study
- Org Resilience

- Fuel Contingency Plan

20.4 Growth Statement

The frequency of these events may increase as people become more mobile and therefore more trips are made. The safety mechanisms in place to prevent accidents are likely to continue and it is therefore unlikely that there will be any change to the vulnerability of the services themselves.

20.5 Level of Confidence

The above information was complied with current industry knowledge to the best of participants recollection and does not contain reference to any research information, it is of a low to moderate level of confidence.

21 Maritime Accident

This Hazard assessment was prepared by Bay of Plenty Regional Council as part of the 2013/14 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

21.1 Hazard Description

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:

Grounding
Collision
Contact berthing
Fire or Explosion
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.

21.2 Likelihood and Consequence Statements

For all of the accident categories above BOPRC have assessed the risk of several different scenarios and for each of these identified the most likely and worst credible assessments. This is reported more fully in the Tauranga Harbour Ranked Hazard List.

21.2.1 Maximum Credible Event

Grounding

Large tanker, passenger or freight vessel grounds in heavy swell at Mount Maunganui or Matakana Island resulting in serious hull damage and breaching of bunker tanks. This would result in a major pollution response but loss of life unlikely. It is also likely that the entrance will be impassable for an extended period of time.

Collision

Fishing vessel or pleasure craft impedes the safe passage of a large vessel transiting in bound or outbound and results in a collision sinking the smaller craft. Potential for fatalities and diesel spill.

Contact Berthing

Tanker in contact berthing situation at the Cement\Tanker berth. Sever damage to tanker hull and jetty structure in a heavy contact. Hull damaged and product split causing pollution incident. Port and Region affected by delay to tanker operations while survey and repairs to berth completed.

Fire or Explosion

Fire on a small passenger ship or charter vessel requires rapid evacuation of vessel for up to 60 pax resulting in people in the water and potential fatalities.

Pollution

Tanker discharging product, hose failure. Two tonnes spilt before pumps stopped, incoming tidal flow take spill into bridge marina and upper harbour, significant coastal clean up required.

21.2.2 Likelihood and Consequence Assessments

Maritime accidents are not uncommon in the Bay of Plenty and the Rena grounding in 2011 is the most significant to occur in recent times. It is estimated the likelihood of any of the maximum credible events described above is probably in the "Possible" range, however the likelihood of any of the events occurring above resulting in significant numbers of casualties is more unlikely.

Most of the maximum credible events above can be categorised as having moderate to major consequences. In modern day shipping a major vessel accident causing high numbers of fatalities is a rare occurrence worldwide. As Rena has demonstrated the environmental, economic and social costs of these types of incidents are not insignificant.

21.3 Manageability Statement

BOPRC and Port of Tauranga implement a range of measures to manage and mitigate the risks of a maritime accident. The Port of Tauranga provides a pilotage service for all vessels over 100 GRT unless the master holds a current pilot exemption certificate. Entry and exit to the Port is provided through an arrival and departure window. Harbour monitoring information provides current and regular information on the tide and weather conditions. Harbourmaster and pilot vessels patrol the harbour entrance and shipping lanes to clear the way for incoming or out going vessels. Ships that are difficult to manoeuvre are met by tugs outside the harbour entrance.

Maritime oil spill response equipment is stored at the port and ready for deployment at a moment's notice. BOPRC is responsible for staffing a Regional On Scene Commander and trained oil spill responders who will be deployed in the event of a tier two oil spill response. This is planed through the BOPRC Tier Two Oil Spill Response Plan.

Maritime activities are controlled and managed by the Maritime Transport Safety Act 1994, the Port and Harbour Safety Code, the Navigation Safety Bylaw and the Tauranga Harbour Safety Management System developed in conjunction with BOPRC and the Port Operators.

BOPRC and Port of Tauranga work closely together to ensure the risks associated with the harbour and its extensive use are managed carefully.

21.4 Growth Statement

Port of Tauranga is continuing to grow and has recently gained consent to widen and deepen the shipping channel allowing larger ships to enter the port. This means that more and larger ships are likely to visit Tauranga in the future.

21.5 Level of Confidence

The information provided in this report was obtained from the BOPRC Tauranga Harbour Ranked Hazard List and is of a moderate to high level of confidence.

22 Dam Failure

This Hazard assessment was prepared by Bay of Plenty Regional Council as part of the 2013/14 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

22.1 Hazard Description

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.

In 2003 Riley Consultants Report "*Lake Rotomahana Outlet Study*" identified a small residual risk that the natural barrier damming Lake Rotomahana could be overtopped under excessively high lake level conditions. This could potentially lead to the erosion of a breach in the barrier with the resulting dam breach flood spilling into Lake Tarawera and then flowing downstream through the Tarawera Valley. The communities primarily at risk of being impacted by such an event are the settlement at Spencer Road on Lake Tarawera, the township of Kawerau in the Tarawera Valley, and the expansive floodplain downstream of Kawerau. A subsequent report was written by Opus International Consultants *"Lake Rotomahana Dam Break Flood Hazard Assessment and Emergency Action Plan"*.

22.2 Likelihood and Consequence Statements

22.2.1 Maximum Credible Event

A failure of the Matahina Dam would be the maximum credible event. This 86m high earth dam is the largest dam in the Bay of Plenty and is located on the Rangitāiki River. The consequence of a total failure of the Matahina Dam would be catastrophic. Downstream of the dam are the village of Te Mahoe, the settlements of Edgecumbe and Te Teko on the Rangitāiki Plains.

The likelihood of failure is rare and there are significant risk mitigation measures put in place by the dam owner. The dam is designed for the maximum probable flood event and the owner of the dam, Trust Power Ltd, has systems in place to manage risk.

22.2.2 Likelihood and Consequence Assessments

There are two general categories of dams:

- **Large dams** (more than 4m high or more than 20,000 cubic meters volume) are those identified as classifiable or referable dams by the Building Act and are subject to the requirements of the Dam Safety Scheme.
- **Small dams** A classifiable dam (Building (Dam Safety) Regulations 2008) in accordance with the Building Amendment Bill No. 4.

a. four or more metres in height; and holds 100,000 or more cubic metres volume (water or fluid) ; or
b. Is eight or more meters in height; and holds 20,000 or more cubic meters volume (water or fluid)

A referable dam is a large dam that is not classifiable but may be forwarded for classification by the dam safety scheme if the potential impact of the dam is considered great enough.

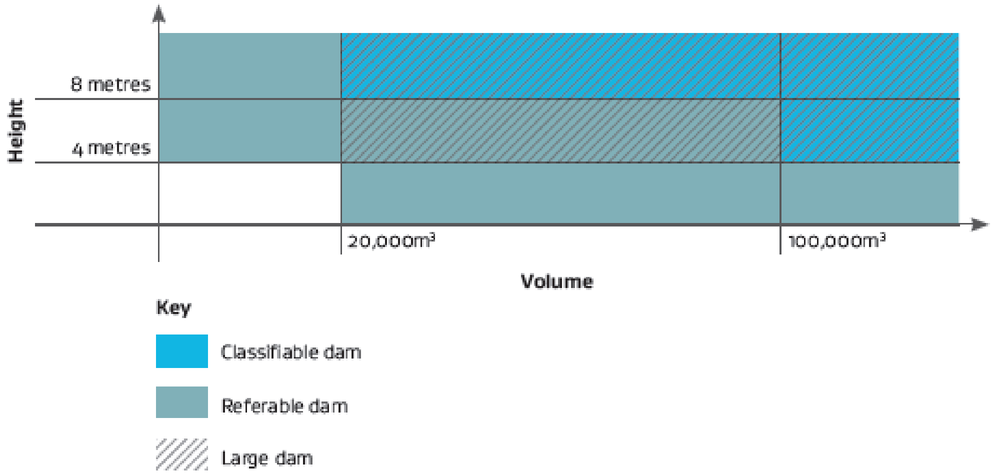

Figure 22.1: Thresholds for Classifiable, Referable and Large Dams

The hazards associated with these large and small dams are assessed separately below:

Large dam

A 1 in 100 year return period flood the consequence of failure of a large dam is potentially catastrophic, although the likelihood of failure is rare.

A 1 in 500 year return period flood or earthquake the consequence of failure of a large dam is potentially catastrophic, although the likelihood of failure is unlikely to rare.

Small Dam

A small dam is defined as such as the impact of failure is minor to moderate.

The likelihood of a single small dam failure in a 1 in 100 year flood event or earthquake is likely and it is possible in a less frequent event.

22.3 Manageability Statement

The management of dam safety is established in legislation (Dam Safety Scheme in the Building Amendment Bill no. 4) due to come into effect on 1 July 2014.

After 1 July 2014 the BOPRC will have a responsibility to maintain a register of dams. A draft of this register has been prepared and it contains 19 dams that are identified as classifiable dams. An assessment of referable dams has not yet been made. The location of the dams on this register is plotted in GIS and this forms a tool for readiness and response.

The requirements to maintain and manage the safety of a dam rest with the dam owner. The documents required to be prepared and submitted to the Regional Council under the Dam Safety Scheme depend on the risk posed by the dam.

A dam break analysis for Matahina Dam has been prepared by TrustPower Ltd as part of their Emergency Action Plan. A copy of the plan has been provided to the Bay of Plenty Regional Council.

22.4 Growth Statement

The potential risk from dam failure in the Bay of Plenty is expected to increase through the creation of more dams. It is likely more irrigation dams, stormwater detention dams and sediment dam will be constructed over time.

The consequences of the hazard are likely to increase as the population and distribution of built up areas grows. More intensive land use and the associated value of assets will make the damage more expensive to repair. Greater disruption to communities and utilities is possible.

22.5 Level of Confidence

The information provided is based on the best information available and there is a medium degree of confidence in the assessment provided.

23 Urban Fire

Awaiting info

24 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.

25 Plant and Animal Pests and Diseases

This Hazard assessment was prepared by Bay of Plenty Regional Council as part of the 2013 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

25.1 Hazard Description

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.

Some recent high profile incursions of pests or diseases are outlined below:

Table 25.1: Recent high profile pest incursions

Name of pest or disease	Risk to	Summary
Bovine tuberculosis (TB)	- Social - Economy	<u>Background:</u> TB probably arrived in New Zealand in the middle of the 19th Century with live deer or cattle. By 1970 all cattle herds were under regular TB testing, any found with the disease were immediately slaughtered. In the 1970's the inability to eradicate the disease in some regions was linked to localised infection of the brushtail possum. TB can be transmitted to humans via infected milk and aerosol droplets. Human cases are rare in developed countries due to pasteurisation and testing programmes, though the risk remains if low. Wild populations of possums, deer, pigs appear to the primary spread of TB in the wild. <u>Impact:</u> Estimated to cost in excess of $1billion dollars once eradicated. Costs currently largely due to sustained pest control and testing of herds and wild ungulate populations. If TB prevalence rates were to increase, the economic costs would be significant, damaging the export trade in beef, dairy, and venison.
Psa-V (*Pseudomonas syringae pv. Actinidiae*)	- Economic	<u>Background:</u> Psa was first detected in Te Puke in late 2010, since the disease has spread throughout the Bay of Plenty, and into surrounding regions. As of December 2013, 78% of New Zealand's kiwifruit hectares are on orchards identified to have Psa-V present.

		Impact: Significant economic cost to the industry, an industry driven organisation (Kiwifruit Vine Health) has been established specifically to manage Psa-V through a National Pest Management Plan. Cost to individual growers also significant with some abandoning orchards as no longer viable, and many other having to re-graft with less susceptible varieties. There is a significant loss of production for the landowner until the plants mature and produce.

25.2 Likelihood and Consequence Statements

Below are examples of pests or diseases that have or could potentially threaten our region, this is by no means an exhaustive list of the threats, simply a cross-section of some of the more likely threats. While most are not currently in the Bay of Plenty, if they became established social, economic, or the environmental values could be significantly impacted.

Table 25.2: Potential plant and animal pest and disease risks

Name of pest or disease	Risk to	Summary
Bird Flu (Avian Influenza)	Social Economic Environmental	Background: Avian influenza is a disease of birds, there are many strains if the virus which naturally occur in many species of wild birds, particularly water fowl. Most are considered harmless and do not cause disease, highly pathogenic avian influenza (HPAI) is a severe form of the disease that spreads quickly, causing sudden death in poultry. Potential impact: Potential cross-over into the human population creating potential epidemic, production impacts on commercial poultry industry, other captive birds (zoo's, avaries), and impacts on wild bird populations including indigenous birds.
Asian tiger mosquito (*Aedes albopictus*)	Social Economic Environmental	Background: Not currently established in New Zealand though an incursion has been identified in the past at the Ports of Auckland. It is an aggressive biter who frequently attacks during the day. Potential impact: Potential to spread diseases including Dengue fever, yellow fever and several types of encephalitis. Potential to be a vector for several serious human illnesses and also in other animals, both farmed and indigenous.
Foot and Mouth disease	Economic	Background: Foot and Mouth Disease (FMD) is a highly contagious viral disease which affects cloven-hoofed animals such as sheep, cattle, pigs, goats, llamas and deer. It can be spread by saliva, mucous, milk, faeces and can be carried on wool, hair, grass, footwear, clothing, livestock equipment and vehicle tyres. It can also spread quickly over long distances by wind. It has never been confirmed to be present in New Zealand. Potential impact: Foot and Mouth disease is extremely rare in humans, with only one confirmed case in Great Britain in 1966, due to this it is not considered a human health risk. It is however a significant threat to the Agriculture sector, if it was to reach New Zealand virtually all exports of meat, animal by-products and dairy products would stop. Exports would not resume until at least three months after the slaughter of the last infected animal. The cost to the New Zealand economy would be huge.

Gum leaf skeletoniser (*Uraba lugens*)	- Social - Economic - Environmental	Background: The gum leaf skeletoniser is an Australian moth first discovered in Mount Maunganui in 1992, and again in Auckland in 2001. It is now widespread through Auckland, and has been recorded in the Waikato, Bay of Plenty, Coromandel, Napier and Nelson regions. The caterpillar is covered with protective spines that sting and cause irritation, some contain venom which can injected into human skin upon contact. The result of this is local, sometimes severe, pain and welts that can last for many days. While they primarily feed on eucalypt trees, they will potential feed on other Australian varieties. Potential impact: As well as being a public health nuisance and potential hazard, they potential affect the viability of production forestry, both present species and the potential introduction of other commercially viable forestry species.
Red fire ant (*Solenopsis Invicta*)	Social Economy Environmental	Background: There have been three incursions of this ant since 2001, one at Auckland and two in or around Napier. While two of the incursions where at airport or port facilities, one nest was discovered north of Napier in a town called Whirinaki in 2006. This incursion was declared eradicated in 2009 The Red fire ant is a native to South America capable of spreading across wide areas and posing a significant threat if they became established. Potential impact: Fire ants pose a risk to human health and lifestyle. They are extremely aggressive and if disturbed they will sting and defend their nests, their sting can be painful to both humans and animals. They are also a threat to production, both as a nuisance factor to stock and their ability to cause damage to agricultural equipment, roads, and electrical equipment due to the size and location on nest mounds. Their impact on the environment is also likely to be significant through direct predation, annoyance of native species, and competition for resources.

25.2.1 Maximum Credible Event

The introduction of a disease, such as avian influenza, or a disease spreading organism could potential create an epidemic in the human population with devastating consequences. It is hard to predict the probability of such an event but the threat is real.

Beyond that, as has been evident through the introduction of Psa-V and TB, the introduction of a disease affecting one of New Zealand's key primary production species would severely impact the country's economy.

25.2.2 Likelihood and Consequence Assessment

The difficulty with measuring this using the suggested categories is the hazard could take any number of forms, with each of them posing a different type of threat. We are not dealing with a single type of event of a different magnitude (such as a tsunami), each has its own unique variables.

For plant and animal pests and diseases in general, the measure of likelihood is very high (5. Almost certain). The reality with Biosecurity, regardless of the effectiveness of border systems and processes, organisms will make it to New Zealand from elsewhere. Numerous cases can be noted of this occurring, and in many cases the impact socially, economically, or environmentally will be negligible (1. Insignificant) in the Measure of Consequence.

Some events, including diseases such as foot and mouth disease, would have a lower measure of likelihood (2. Unlikely), but the measure of consequence would be much higher due to the financial loss of exports for some of our key primary products (4. Major).

Worst case scenario, an epidemic caused by a disease or animal incursion, such as avian bird flu, would be even less likely (1. Rare), but could have more serious consequences (5. Catastrophic).

25.3 Manageability Statement

How difficult would it be to manage an event? Very difficult as there are a number of pests or diseases that could become the next big 'new incursion' and you cannot develop a response plan for all of them. Some new incursions may not have been identified as a pest elsewhere, but may become one in the Bay of Plenty environment.

In terms of managing the hazard in terms of reduction, readiness, response and recovery this is largely managed by the Ministry of Primary Industries who manage pests and diseases on national interest. Bay of Plenty Regional Council, through its biosecurity programme, provide advice and support on an 'as-need' basis but have no legislative authority for organisms outside of our Regional Pest Management Plan.

In saying that, we are currently developing a Regional Surveillance Plan to strategically and systematically undertake surveillance for new incursions targeting 'high risk vectors'. We are also developing procedures to minimise disease transmission from farm to farm. While this protocol is targeted at reducing the risk of transmitting diseases which are already established, if a new disease was to be identified, we will minimise the risk of transmitting it though our work activities.

25.4 Growth Statement

This is difficult to quantify and is reliant on the systems and controls preventing an incursion evolving as fast as, or faster than the risk. You would like to assume as we become more aware of the risk, we develop better screening and border control systems to minimise the probability of an incursion. The other side of the coin is other more serious and less manageable risks may become prevalent, and may be able to pass borders without human assistance (i.e. wind-blown pathogens).

The reality as the population increases, our reliance on trade will increase with it. This creates an increased risk of the introduction of foreign and potentially harmful organisms though imported goods. Unless the border control systems continue to improve at a sufficient level, the risk is likely to increase.

The consequence of an event is also dependant on advances in medicine, if a disease was to be introduced via a plant or animal, its severity is largely dependent on the development of a medicine or vaccine.

26 Human Pandemic

This Hazard assessment was prepared by Bay of Plenty District Health Board as part of the 2013/14 review of the Civil Defence Emergency Management Group Risk Profile. It is a high level summary of the hazard using the best current available knowledge at the time. The report is prepared for all 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 the report.

26.1 Hazard Description

A pandemic is an epidemic that becomes very widespread and affects a whole region, a continent or the world.

Influenza is a contagious viral disease of the respiratory tract.

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.

Characteristics of influenza

Influenza is a contagious viral disease of the respiratory tract. It is a major threat to public health worldwide because of its ability to spread rapidly through populations and to cause complications. Relatively minor epidemics of influenza typically occur in New Zealand during winter, often affecting all age groups and causing many complications, including viral or bacterial pneumonia.

Influenza is a significant and under-recognised cause of mortality in the New Zealand population, including many cases where influenza contributes to an elderly or chronically ill person's death.

Influenza is characterised by rapid onset of respiratory and generalised signs and symptoms, including fever, chills, sore throat, headache, dry cough, fatigue and aching. Influenza is easily spread through droplets from an infected person (suspended in the air through coughing or sneezing) being inhaled by another person, or through contact with contaminated objects. The incubation period can range from one to seven days, but is commonly one to three days. There is limited evidence that adults are infectious for half a day to one day before most symptoms start, and until about day five of the illness. Children generally remain infectious for up to seven days after symptoms start, but may be infectious for up to 21 days.

Characteristics of pandemics

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.

The standard planning model assumes a total case fatality rate of 2 percent, within which about 33,000 deaths would occur over the eight-week period, peaking at about 10,000 in week four (compared with New Zealand's normal weekly death rate of around 550). It is important to note that this is not a prediction – it is not possible to make any such forecast before a pandemic develops. A 21st-century pandemic may not reflect the course, incidence or fatality rates of the 1918 pandemic.

A characteristic of influenza and the associated pandemics is that, compared to most other emergency events for which we plan, there are ongoing global and national surveillance systems which usually result in us having at least some advanced warning (hopefully weeks) of a likely pandemic. Related to this it is unlikely that a pandemic would commence in New Zealand.

26.2 Likelihood and Consequence Statements

26.2.1 Maximum credible event

During the 20th and 21st centuries to date, the emergence of several new influenza A virus subtypes has caused four pandemics, all of which spread around the world within a year of being clinically recognised. These were:

- 1918/19 pandemic influenza A (H1N1) "Spanish Flu" 20-100 million estimated deaths worldwide. Over 8,000 deaths in New Zealand (including over 2,160 Maori). More than 20% of the population died in Samoa and French Polynesia as a result of the pandemic.
- 1957/58 pandemic influenza A (H2N2) "Asian Flu" 1 million deaths world wide

- 1968/69 pandemic influenza A (H3N2) "Hong Kong Flu" 1-4 million deaths world wide
- 2009/10 pandemic influenza A (H1N1) 2009 (Swine Flu) (NZ over 3,280 notifications, 1,122 hospital, 119 cases admitted to intensive care, 35 -50 deaths

The 1918/19 pandemic caused the highest number of known influenza deaths. Many people died within the first few days after infection, and others died of secondary complications; nearly half of those who died were young, healthy adults.

New influenza viruses arise from recombination in humans, pigs and birds. People have little or no pre-existing immunity to these new viruses.

The 1918/19 pandemic had a profound effect on New Zealand, which took years to recover. Because it came at the end of the First World War, the trauma suffered is less clear than it would otherwise have been, but it is evident that in many ways the pandemic was more damaging than the war itself. Little was known about the cause of the disease or how it spread, and a variety of ineffective treatments such as throat-sprays that were available at public facilities might have been additional sources of infection. Public health knowledge was limited, and in each community doctors were overwhelmed, able to do little to halt the course of influenza in those infected. With no effective treatment, many people died from secondary infections. Communities formed groups and committees to look after those most in need with food or home help, and it seems that without this basic care even more could have died.

The 1918/19 pandemic had a severe impact on Maori, whose death rate of 4.2 percent was approximately five to seven times higher than the non-Maori death rate.

Maori and Pacific peoples in New Zealand had higher rates of morbidity for the influenza A (H1N1) 2009 pandemic than other ethnic groups.

History, therefore, suggests that Maori and Pacific peoples are more susceptible to pandemic influenza than other groups. The New Zealand standard planning model assumes a severe pandemic wave in which 40 percent of the New Zealand population (more than 1.6 million people) become ill over an eight-week period. The peak incidence in the model occurs in weeks three to five, when about 1.3 million people − a third of New Zealand's population − would be ill, convalescing or just recovered. The standard planning model adopted by New Zealand assumes a total case fatality rate of 2 percent, within which about 33,000 deaths would occur over the eight week period, peaking at about 10,000 in week four (compared to New Zealand's normal weekly rate of around 550). It is important to note that this is not a prediction – it is not possible to make any such forecast before a pandemic develops. A 21st century pandemic may not reflect the course, incidence or fatality rates of the 1918 pandemic.

26.2.2 Likelihood and Consequence Assessments

The World Health Organisation advises that the risk of pandemics has recently increased due to the increase in the human population, the closer proximity of humans and animals in rural and urban settings and the increased speed and frequency of travel.

Compared with other countries New Zealand has some advantages when planning for a pandemic because it has a modern health system, comparatively easily managed borders, a simple and effective government structure and , in general, a strong sense of community.

Epidemiological and clinical characteristics of any future influenza pandemic are unable to be predicted, therefore action plans must be flexible to ensure that actions are appropriate to the situation and can be adapted as needed. Area encompassed by the BOP and Lakes District Health Boards is home to a diverse population (318,080 people) including large Maori and rural communities, which influence the way health services are funded and delivered. Overall the DHB population is markedly over represented in high deprivation scores.

Pandemics are unpredictable, but there seem to be some every century. Using the suggested levels number four (likely) for likelihood and since there will be deaths level five, catastrophic for consequence.

26.3 Manageability Statement

Planning and preparedness for an event of the scale, scope, complexity and potential impact of a pandemic requires expertise from a range of fields. The Ministry of Health takes the lead role in planning for a health related emergency, but many aspects of the national response are beyond its scope. Pandemic planning is on-going, and although the Ministry of Health is lead agency, an all-of-government response is required.

Pandemics by their nature are unpredictable in terms of timing, severity and the population groups that are most affected.

The Government has taken a strategic approach to preparing for, reducing the impact of, responding to and recovering from a pandemic. Central to this approach are the three overarching goals and a six-phase planning strategy.

The three overarching goals are to protect New Zealand's people, society and the economy during and after a pandemic.
The New Zealand Influenza Pandemic Action Plan: A framework for action, outlines the phases of a potential pandemic wave in New Zealand (based on the WHO phases), and provides guidance on; actions that need to be considered for each phase, who is responsible for the actions and by what authority the actions can take.
New Zealand pandemic planning is based around a six phased strategy
1 Plan For it (planning and preparedness)
2 Keep it out (border management)
3 Stamp it out (cluster control)
4 Manage it (pandemic management)
5 Manage It: Post-Peak
6 Recover From it (recovery).
Each District Health Board has been required to develop and maintain a Pandemic Plan which is specific to the region they provide services for, based on the New Zealand Influenza Pandemic Action Plan. Plans are reviewed on a three yearly basis or earlier following a major event such as the A(H1N1) 2009 Pandemic influenza.

26.4 Growth Statement

The World health organisation advises that the risk of pandemics has recently increased due to the increase in the human population, the closer proximity of humans and animals in rural and urban settings and the increased speed and frequency of travel.

26.5 Level of confidence

The above information is taken from;

- The most recent version of the "New Zealand Influenza Pandemic Plan" A framework for action" published in April 2010 by the Ministry of Health
- The Bay of Plenty District Health Board website and
- The Lakes District Health Board website.
- The Influenza A(H1N1) Pandemic in New Zealand During 2000 by Michael G Baker et el University of Otago