Queenstown Lakes District Council

Hazards Register Part II Stage 2 Risk Management Study Report

Volume 1

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Contents

Volume 1

Figures

Volume 2

Appendices

Summary

Legislative Framework and Responsibilities

The legislative framework with respect to the management of hazards has been reviewed, together with appropriate case histories and related information. There is a significant responsibility on local authorities to identify, provide and manage the risk with respect to hazards, primarily under the RMA 1991 and the Building Act 1991. The Council would need to take due care to collate an appropriate amount and detail of hazard information, and make this available to the community.

There are provisions in the legislation to manage the risks from the hazards under the resource consent process (RMA) and the building consent process (Building Act).

The proposed Civil Defence Emergency Management Act, which is expected to become law in 2002, will require local authorities to individually and collectively (as part of regional Civil Defence Emergency Management Groups) take proactive measures to manage risks from hazards.

Review of Hazards

The Council provided information on areas of priority for review of the hazards, and the hazard information in these areas have been reviewed, and the risks from these hazards have been assessed.

Flooding & Erosion

The flood hazards have been reviewed and the latest information from Otago Regional Council has been incorporated in the hazards coverages in geographical information systems (GIS) database. These indicate the significant flood hazards in Queenstown, Wanaka, Frankton, Albert Town and Glenorchy. It would be prudent to refine the flood hazard areas in the important areas, such as Queenstown and Wanaka, and present a range of flood lines for different return periods.

Areas at risk from erosion have been identified for the priority areas.

The dam break flood has the potential to affect Albert Town and Wanaka, but has a much lower probability (less than 1 in 10,000 years) than the flood hazards from rainfall.

Landslides

The landslides mapped in the priority areas have been reviewed. While the landslide hazard map in the current hazards register indicates the distribution of hazards at a regional scale, there are a number of inaccuracies and errors in a number of places. Some of these have been corrected but a more detailed study is prudent given the risk from this hazard, and the current development in the district. The landslides have been characterised in the priority areas based on the type of landslide and their level of hazard to development.

The potential for new slope failures (first time slides) have not been mapped in the current hazards register. These have the potential to be much more damaging, and hence it would be prudent to map the potential for slope failures, both from rainfall and earthquakes.

Avalanches

The hazards register indicates the avalanche hazards to be concentrated at ski resorts and other rural mountainous areas outside the priority areas. Nevertheless, given that avalanche hazards can be catastrophic and can lead to large loss of life, particularly in areas of tourist activity (Coronet Peak, Remarkables and Routeburn Track), the risks are significant to the district. Other ski fields that have avalanche hazards, Treble Cone and Cardrona have been included in the GIS hazards coverages.

Earthquakes

Earthquakes have the potential to cause a range of hazards, such as active fault rupture, ground shaking, earthquake induced slope failures, liquefaction and possibly "tidal" waves or seiche. The recent studies into the activity of the Alpine Fault show that it is much more active than originally thought. The Alpine Fault is located a distance of about 80 km to 85 km from the important towns of the district, and it is assessed to be capable of producing Richter magnitude 8.1 earthquakes at a return period of about 300 years. Only some of the earthquake hazards (ground shaking, active faults) have been mapped in the current hazards register.

The active fault hazards have been reviewed, and the locations updated based on the latest information available from the compilation for the new QMAP for Wakatipu, at 1:250,000 scale. The active faults within the district have a relatively low return period, for example the Cardrona Fault is estimated to rupture at a frequency of about 1 in 7500 years.

The ground shaking hazards, shown in the current hazards register, are simply areas of quaternary deposits. This does not give any indication of the level of amplification and is inappropriate. It would be prudent to carry out a ground shaking hazard study for the district to understand the level of ground shaking possible in the urban areas.

Historical earthquakes throughout the world and the steep terrain in the district suggest that earthquake induced slope failures have the potential to be a significant hazard in the district. It would be prudent to assess the potential for earthquake induced slope failures and map the hazards, to assist with risk management.

A number of areas in the district are potentially exposed to the risk of earthquake induced liquefaction and consequent ground damage. It would be prudent to assess and map these hazards in the priority areas of the district.

Earthquake induced landslides have the potential to cause "tidal" waves, if large landslides displace water within the lakes in the district. The risk could be reviewed once the potential for earthquake induced landslides are mapped.

Landfills

The landfills in the hazards register have been reviewed and additional information collected from QLDC have been added to the hazards layer. The review suggested that the majority of the landfills had caused a low hazard to date. The location of Warren Park landfill in Queenstown is not known with certainty and it is prudent to investigate its location and possible risks (such as from subsidence, leachate or landfill gas) to the community. The Wanaka landfill may contain toxic chemicals and it would be prudent to investigate this.

Contaminated Sites

The contaminated sites have been reviewed and additional information collated from QLDC and ORC and added to the hazard theme in the GIS coverage.

Mine Workings

The presence of mine workings has been researched from information obtained from QLDC and a database has been compiled. The review of this information indicates that the risk from these known workings is low.

Risk Management

Approaches to manage the risks from hazards have been reviewed and the relative benefits and issues related to different approaches are presented. These approaches include :

- Land use and planning controls (hazard maps, district plan rules, resource consent process)
- Building controls (criteria, Section 36 entry, building consents)
- Hazard proofing buildings
- Voluntary actions
- Emergency management
- Structural measures

It would be prudent to agree and implement a process for risk management for the various hazards, which may include :

(a) Developing options for risk management

(b) Evaluation of options using social, economic, environmental, technical and political criteria.

(c) Consideration and selection of mitigation in consultation with the community

(d) Preparation of a plan / strategy for implementing the selected measures.

Risk management approaches for specific hazards are presented and discussed. These provide a framework for working through the risk management measures for each hazard. It is important that possible risk management options and the preferred options are explored through consultation with the community.

It would be prudent to prioritise the evaluation of risks and risk treatment, consistent with the level of risk posed to the community.

It is important to ensure that all the available hazard information is taken into consideration in the evaluation of applications for consents under the Resource Management Act and the Building Act, and the issue of consents.

A systematic and rational approach, such as that presented, would help manage the risk to the community and limit the liability to the Council.

1 Introduction

A Hazards Register was prepared for Queenstown-Lakes District Council (QLDC or the Council) as the Part I study in 1998. The Hazards Register (Woodward-Clyde, 1998) identified known hazards in the Queenstown-Lakes District. Geographical Information System (GIS) hazard maps from this study were compiled by Queenstown-Lakes District Council (1999). However, these did not provide information on the degree of hazard.

Opus International Consultants Limited was commissioned in September 2000 to carry out Part II of the Hazards Register. This study is being carried out in stages.

Stage 1 of the study commissioned in September 2000 included consideration of additional hazard information that had come to light, search of some of the records held by the Council, a brief review of statutory issues and a risk management workshop with Councillors, QLDC staff and representatives.

Queenstown-Lakes District Council subsequently engaged Opus International Consultants to proceed with Stage 2 of the Hazards Register Part II study. The study covers the Queenstown Lakes District, see Figure 1.

The Stage 2 study involves review of the Council's responsibilities under various legislation, review of the hazards and consequential risks to the community, and development of management options to manage the risk to the community and the liability to the Council.

2 Scope of Study

The objective of Stage 2 of the Hazards Register Part II study is to identify how the Hazards Register can be used to improve the management of risk to the community and reduce potential liability to the Council arising from the hazards.

The scope included :

(a) Review statutory responsibility and liability

(b) Review landslide, flooding, avalanche, seismic, erosion, mine workings, contaminated site and landfill hazards in the areas of priority, including :

- Information on the hazards
- Potential impact on development
- Areas where district plan provisions require amendment
- Options to limit liability for existing and new development
- Recommendation of actions to limit liability

(c) Preparation of Report presenting the findings of the study

The detailed scope of the study is included in Appendix A.

3 Review of Legislative Framework

A Hazards Register prepared for the Queenstown-Lakes District Council is being reviewed to include information on the degree of the hazard, and to identify how it can be used to improve the management of risk to the community and reduce the potential liability to the Council. For this purpose, it is necessary to consider the Council's responsibilities with respect to natural hazards under various legislation and any associated liabilities.

The Council's statutory responsibilities and potential liabilities associated with natural hazards under various legislation have been identified and are discussed in this report. The legislation considered in the study are :

- Resource Management Act 1991
- Building Act 1991
- Local Government and Official Information and Meetings Act 1987
- Local Government Act 1974
- Local Government Amendment Act No 3 1996
- Soil Conservation and Rivers Control Act 1941
- Land Drainage Act 1908
- Civil Defence Act 1983
- Civil Defence Emergency Management Act (proposed)
- Public Works Act 1981
- Lake Wanaka Preservation Act 1973

Relevant case law was also reviewed to assess the interpretation of the legislation in a number of cases that have arisen.

Based on the review of the legislation and case law, and other related publications, the Council's responsibilities with respect to natural hazard risk management were considered, and potential for liability was assessed.

A detailed discussion of the legislation analysis is presented in Appendix B.

4 Identification of Areas of Priority

It is prudent to focus the study on areas where the risks from the hazards would be significant. This was carried out by consideration of :

- The District Plan zoning
- Areas of current and likely future development
- Prioritisation of development areas.

The areas of development were identified by CivicCorp for QLDC and were provided by the QLDC to Opus, as priority areas.

The priority areas are shown as themes on the GIS data, which form part of the study. The priority areas have been classified by the Council as :

- Priority 1 areas, which comprise most areas of current development and some priority areas of potential development
- Priority 2 areas, which comprise lesser priority areas of future development.

The review of the hazards was focussed on the areas of priority.

5 Review of Hazards

5.1 Outline of Hazards Review

The hazards were reviewed for the priority areas of the district as identified by QLDC. The priority hazards identified by the Council for the review are :

- Flooding
- Erosion from Waterways
- Landslides
- Avalanche
- Seismic Hazards
- Landfills and Contaminated Sites
- Mine Workings

The hazards compiled in the hazards register as Part I of the study were reviewed together with any additional regional studies carried out since then. The spatial hazard information in the GIS themes were reviewed and amended as appropriate. The manner in which the hazards were reviewed varied for the different hazards as appropriate for those hazards.

The hazards review is summarised in the sub-sections that follow. A more detailed presentation of the review of the hazards associated with flood, erosion, contaminated sites, landfill and mine workings are presented in the appendices as follows :

- Flooding and Erosion from Waterways — Appendix C
- Landfill, Contaminated Sites and Mine Workings — Appendix D

The hazards review focused on the Priority 1 and Priority 2 areas indicated by the Council.

5.2 Flooding and Erosion from Waterways

5.2.1 Flooding from Rainfall

Flood hazards are a significant hazard in Central Otago. Several large floods have been recorded in the Queenstown Lakes District, particularly since 1994, and have heightened public concern. Several technical reports have been prepared to quantify the flood hazards. Otago Regional Council (ORC) prepared a report on flood management prior to the 1994 flood event (Otago Regional Council, 1993). This report presented identified flood issues, return probabilities and flood hazard zone maps for various locations in the region based on the information available at that time. The flood report for the December 1995 (Works Consultancy Services, 1996) and the November 1999 flood events (Opus International Consultants, 2000a) provide a comprehensive review of the rainfall, flood flows and levels around the catchments associated with those specific flood events. The flood events of 1994 and 1995 prompted ORC to review the flood hazard at Queenstown and Wanaka (Otago Regional Council, 1997). The hazards register prepared for the Queenstown Lakes District

Council (Woodward-Clyde, 1998) provided a summary of potential hazards in the District, and presents flood hazard zones for a number of locations.

Following the November 1999 flood (see Photographs 1 and 2), the Otago Regional Council updated the flood frequency analyses for Lakes Wakatipu and Wanaka, and for the Clutha River at Alexandra and Balclutha (ORC, 2000a). The Crown with support from local District and Regional Councils commissioned a project to investigate practicable solutions for the Clutha River flooding issues following the damage caused by the November 1999 flood. The report from this investigation (Clutha Solutions Co-ordinator, 2000) identified the issues associated with the 1999 flooding, and provided a range of recommendations. The *Flood History in the Clutha Catchment* by Opus (2000b) presents a comprehensive review of flooding in the catchment, covering the major flood events since the 1800's to 1999.

Flood frequency analysis is not covered in this present report.

The 50-year (2% annual probability) and 100-year (1% annual probability) return period flood estimates (ORC, 2000a) are presented in Table 1. The estimates are based on the annual recorded maximum lake level at each location and include the flood events of 1878 and 1919. These estimates are conservative, representing the higher end of the range of estimates.

However using this return period analysis, the magnitude of the November 1999 flood at Lake Wakatipu has a return period of over 150 years, and at Lake Wanaka of about 70 years. The return period of the 1878 flood on the other hand was estimated at about 100 years at Wakatipu and over 100 years at Lake Wanaka.

Table 1 - Flood return period estimates for Lakes Wakatipu and Wanaka

Site	50-year	100-year
Lake Wakatipu level	312.4 m	312.6 m
Lake Wanaka Level	281.1 m	281.7 m

Lake Wakatipu flooded (exceeded 311.25 m, the level at which flooding is noted to occur) six times in the last 20 years, whereas it flooded only five times during the 50 years prior to 1981. The duration of the flooding was also significant, with a total of nearly 21 days above the level of 311.25 m in the December 1995 event.

Lake Wanaka flooded (events which exceeded 280.20 m) four times since 1878, with three of those events being after 1984.

Further information on the flood hazard is provided in Appendix C.

Photograph 1: Flooding at Rees Street, Queenstown, 17 November 1999
Photo: Otago Daily Times

Photograph 2: Flooding at Helwick Street, Wanaka, November 1999
Photo: Otago Daily Times

The flood hazard maps were updated based on the study of the Albert Town area (Opus International Consultants, 2001), the area of flooding indicated by aerial photographs taken during the floods on 22 November 1999 and the most recent flood hazard information from an unpublished draft report from Otago Regional Council (2000b).

The flood hazard zones from Otago Regional Council are based on:

- The maximum known historical flood levels e.g. 1878 flood at Wanaka
- Information from maps, contour surveys, aerial photographs and on-site inspections
- Observations by local people, QLDC and ORC staff
- Overtopping or breaching of flood banks which may affect flooding in some areas
- Information from historical accounts of flooding.

The *Flood Hazard Zone (ORC)* shown on the accompanying maps are areas of land, which are known to be prone to flooding. They are NOT the flood zone for a 100-year flood, nor for a specific flood event such as the November 1999 flood. The *"flood hazard zones"* are indicative of areas likely to be affected by flooding.

Persons considering placing buildings or other structures within the defined flood hazard zones should check with QLDC / ORC to ascertain whether more precise flood level information is available for a particular location. This is particularly important near medium to small size rivers and streams, which are not monitored for water level and flow on a continuous basis like the large lakes and the Clutha River. These small rivers and streams (like Horne Creek in Queenstown) can however be subjected to intense rainstorms and flash flood carrying much debris, gravel and silt. Such an event was observed in Queenstown in November 1999.

In some urban areas such as Queenstown, Wanaka, Glenorchy, Kingston and Albert Town, flood inundation maps for the November 1999 flood are available (Otago Regional Council, 2000c). The known areas of inundation in the 1878 and 1999 floods are also included in the GIS hazards themes.

Sections of the flood hazard map in the townships of Queenstown / Frankton (Figure 2), Wanaka (Figure 3) and Albert Town (Figure 4) are presented in this report.

5.2.2 Erosion

The very nature of high rainfall and flow events increases the potential for erosion and deposition from the lakes and rivers within the Queenstown Lakes District. Intense rainfall will cause localised slipping and slumping as noted during the 1999 event (Opus, 2000a), and fresh and flood events will at times cause incising and bank erosion. Stream and river carried material have the potential of causing flow obstruction, and localised flooding. In the period of government subsidies up until the early 1980's, considerable time and money was devoted to flood protection in the region. The flood management report (ORC, 1993)

gives an account on the history of flood and erosion damage in the Lakes region. Some examples of erosion and flood protection are given below.

The Horne Creek flood protection scheme has been upgraded so as to pass the 1% flood event through Queenstown and into Lake Wakatipu. Improved bridges and culverts were constructed at many locations in the region. Flood banks and more recently catchment management strategies (such as for the Makarora catchment) have been used to limit the damage caused by floods.

Flooding of and damage to pastoral land has in the past been observed in the Lower Rees, Dart and Makarora catchments. Temporary flooding of road links and damage to bridges have been observed in these and the Matukituki catchments in the past, eg the October 1978 flood.

The Cardrona valley was affected by the November 1999 flood with bank erosion and extensive localised flooding and deposition of sediment from the Cardrona River.

There is a potential for shoreline erosion in Lakes Wakatipu, Wanaka, and Hawea during periods of high lake levels due to the wave action. In Lake Wakatipu, strong southerly or south-westerly winds combined with high lake levels have the potential to cause lakeshore erosion. These conditions can exacerbate flooding with wave surge in Queenstown bay.

At Lake Hawea, high lake levels and strong nor-westerly winds can lead to lakeshore erosion adjacent to the Hawea Township at the southern end of Lake Hawea (refer hazard maps). The maximum controlled Lake Hawea outflows are limited (to about 200 to 220 m^3/s) as the outflow channel is susceptible to erosion during high flows. Likewise the area in the vicinity of the Hawea River confluence with the Clutha River is prone to erosion.

River bank erosion has the potential to affect the northern margins of Arrowtown, along the Arrow River. This is an area historically affected by episodes of erosion and large scale sediment deposition during the gold mining period. The erosion hazard area has been identified as a theme in the GIS data.

5.2.3 Dam Break Flood

A flood caused by dam break has been identified separately in the hazards register. The dam break floods have a much lower likelihood of occurrence, as these flood events will occur only in the event of a dam break.

A dam break flood discharge would affect the area around Albert Town at the confluence of the Clutha and Hawea Rivers. The areas affected by a dam break flood are identified as a theme in the GIS hazards database and are presented in detail in the Albert Town Flood Hazard Study report (Opus, 2001), which also referenced the earlier dam break study by Works Consultancy Services (1990). The likelihood of the dam break flood is less than 1 in 10,000 years.

There is an area in the Hawea Flats where flood flows from the Gladstone Gap Emergency Spillway would discharge during an extreme flood event. This flood discharge spillway zone should be kept clear (or free) of buildings and has been identified in GIS hazards database.

The dam break flood in the Albert Town area is shown on Figure 4. Water also backflows into Lake Wanaka and inundates the low-lying land at Roys Bay (Wanaka township) as identified on the hazard themes, and the flood hazard map on Figure 3.

5.3 Landslides

5.3.1 Existing Hazards Register

Available information on existing landslides within the Queenstown-Lakes District was compiled by Woodward-Clyde (1998), and was included in the Hazards Register. The landslide hazard information was also captured in digital form and this information forms part of the current landslide hazard theme in the GIS hazards database held by the Council.

The hazards register also mentions the presence of rockfall hazards, particularly along river and road corridors, but none have been mapped.

The existing hazards register does not present any information on the potential for future slope failures (first time slides) in the district.

5.3.2 Review of Landslides

The existing landslides in the Priority 1 and 2 areas identified by the Council were reviewed as part of this study. The existing information was presented on 1:20,000 maps of the priority areas (with Queenstown and Frankton at 1:10,000) showing the existing landslide hazard zones, the topography (contours from the 1:50,000 LINZ maps) and the priority areas, and served as a basis for the study.

An engineering geological review of the landslides was carried out by Mr Graeme Halliday (Halliday Consulting). This comprised :

- a limited review of readily available literature and reports in the area
- viewing of aerial photographs and
- a limited site reconnaissance by drive over, including selected brief walkover surveys.

Some additional areas of existing landslides were identified and were mapped to an accuracy possible given the time limitations. Obvious errors in the existing landslide hazard zones were corrected.

5.3.3 Characterisation of Landslides

The landslides were characterised based on the limited field and aerial photographic review, and the knowledge of the area from past experience and literature. The characterisation of the landslides is summarised in Table 2, and the common types of landslides prevalent in the district are described in the following sections.

Table 2 - Characterisation of Existing Landslides

Type of Landslide	Characteristics	Possible Effects
Active Pre-existing Schist Debris Landslides	Pre-existing slides in debris derived from Schist bedrock, with areas of known or apparent episodic activity in historical times (last 150 years). Possible activity inferred from geomorphology, literature or prior knowledge.	Possibly ongoing creep deformation with episodic accelerated movements with heavy rainfall. Possibly localised slumps in landslide debris. Movement unlikely to exceed a few metres.
Pre-existing Schist Debris Landslides (Activity Unknown)	Pre-existing slides in debris derived from Schist bedrock, with activity unknown due to lack of information.	Unknown.
Dormant Pre-existing Schist Debris Landslides	Pre-existing slides in Schist bedrock, with no known activity in historical times (last 150 years). No obvious geomorphological evidence of activity.	No ongoing effects, part from possibly extremely slow creep (few millimetres per year). Deformation possible in extreme events, but unlikely to exceed a few metres. Possibly localised slumps in landslide debris.
Slope Failure Hazard in Superficial Deposits	Steep slopes or banks with fine lake sediments, glacial till and colluvium, with areas of known or apparent slumps. Slumps inferred from geomorphology, literature or prior knowledge.	Episodic movements following heavy rainfall, raised groundwater and high flood levels. Movements could be a few to several metres.
Shallow Slips and Debris Flows in Colluvium	Steep hillsides with areas of known shallow slips, or small to moderate debris flows in historical times (last 150 years). Inferred from geomorphology or prior knowledge.	Shallow slips and small to moderate debris flows following periods of heavy rainfall, which can run downhill for 10s of metres.
Debris Flow Hazards	Rapid debris flow from long gullies and streams following heavy rainfall carrying significant debris.	Catastrophic damage to buildings and property in the path of flow and in deposition areas extending 10s of metres downhill.
Rockfall	Rolling or bouncing of rock from slopes following a trigger such as heavy rainfall or with weathering, which can travel up to 10s to 100s of metres downhill.	Damage to buildings downhill and possibly loss of life or injuries due to rockfall impact.

Pre-existing Schist Debris Slides

The existing large schist debris landslides are generally slowly creeping features (millimetres per year). The active landslides are subject to intermittent movement events, generally related to rainfall, and can move up to a few metres over a period of hours and possibly days. There is no evidence of rapid catastrophic movements of the existing schist debris slides in the Central Otago region. Such catastrophic movements are also considered to be unlikely in large earthquake events, based on the absence historical precedent (Gillon and Hancox, 1992). This is consistent with the observation by Keefer (1984) that earthquake induced landslides generally tend to be first-time failures rather than reactivation of pre-existing slides.

Some of the slides are classified as *active*, on the basis of evidence of fresh scarps or known recent movement (Frankton Slide), while others show no geomorphological evidence of movement in historical times and are considered to be *dormant*.

However, there exists the possibility of rock fall from the head scarps (generally over-steep, insitu ground above the top of the landslide mass), triggered by an earthquake. These rock falls may possibly run down the slope for 10s of metres and perhaps below the toe of the landslide. There is also the possibility that movement of the landslides could head load and trigger a lower slide with larger movements.

Slope Failure Hazard in Superficial Deposits

Slope failures can occur in superficial deposits such as along over-steep river banks or lake shores. These deposits are typically glacial lake sediments, comprising laminated silts. Some of the slides are active, while others show no evidence of movement and are considered to be dormant. Other superficial deposits prone to slope failures are steep slopes in glacial tills and colluvium (eg Hill End, Wanaka). While the movements associated with existing slides may be slow, there is the possibility of fresh and more rapid slumps triggered by rainfall, lake fluctuations, river erosion or earthquake liquefaction.

Shallow Slips and Debris Flows in Colluvium

Shallow slips and debris flows have been observed in a number of hillsides in the district (eg Quail Rise). These are generally on steep hillsides overlain by colluvium or within the landslide debris of larger schist landslides. Shallow slips and debris flows caused by heavy or persistent rainfall can move 10s of metres down the slopes to affect downhill areas.

Debris Flows

There is a potential for debris flows in steep gullies with relatively large catchments in the steep terrain in the district. These gullies or streams can accumulate and move a large debris load during or following heavy rainfall events over significant distances of 100s of metres down slope and deposit debris over a wide area. The potential for such events have been identified in Makarora, during this study. This needs to be verified by further investigation of the areas identified.

Rock fall

Rock fall hazard has been identified in a number of areas such as Nevis Bluff, where a large rock fall / rock slide recently affected the highway, see Photograph 3. However this is outside the priority areas identified by the Council. There are also large rocks on relatively steep hillsides which present a rock fall hazard, eg in Peninsula Hill. The rock falls may be triggered by rainfall or earthquakes. These have the potential to affect areas downhill of the hillsides.

Photograph 3 - Rock Slope Failure at Nevis Bluff, along State Highway 6

5.3.4 Accuracy of Landslide Maps

The existing landslide maps were compiled by Woodward-Clyde (1998) from a number of sources, including QMAP compilation sheets (1:50,000), previous studies and MSc theses. The maps provide a reasonable picture of the distribution of landslides in the district at a regional scale. From discussions, the Institute of Geological Sciences who compiled the QMAP sheets, indicated that these were based on aerial photographs and have not all been field checked. Such data may be subject to significant inaccuracies and errors.

The review of landslides in the priority areas as part of this study confirmed the presence of inaccuracies and errors in the current landslide hazard maps. The errors that were found were corrected, but given the limited review carried out as part of the study, it was not possible to accurately map all the landslide hazards. The landslide hazards in Queenstown/ Frankton are shown on Figure 5 and in Wanaka are shown on Figure 6.

It is recommended that specific studies be commissioned to address the inaccuracies in the hazard maps. This could be carried out by prioritising the areas based on the risk to current and future development, as discussed in Section 8.3.

Some of the areas of priority may be Arthurs Point, along Frankton Arm, Quail Rise, and areas of Albert Town and Hill End in Wanaka.

5.3.5 First-time Slope Failures

The slope failure hazards from new failures (compared to existing landslides) have not been considered for the district as part of previous studies for the Hazards Register. New failures or "first-time slides" could occur in a number of areas given the steep terrain in the district.

New slope failure hazards could originate from a number of triggers, such as :

- Intense rainfall
- Earthquakes
- River or lake erosion
- Human Activities (eg earthworks for development or roads)

While human activities can be potentially controlled by resource and building consent processes, the hazard from other triggers are difficult to control. Therefore, it is important that these slope failure hazards also be assessed for the priority areas of the district.

For example, the potential for failures of *dip slopes* (where the rock defects dip in a down slope direction making them vulnerable to sliding along the defect planes) in Schist terrain has been identified during the current study. A number of areas of such potential were identified along the hillside on the northern side of the Frankton Arm of Lake Wakatipu, where there are existing developments as well as the state highway road corridor.

Further studies should include consideration of new slope failure potential in addition to the existing landslides. Some areas of new slope failure hazard have been mapped as part of the current study, such as in the areas of lake sediment slumps.

5.3.6 Presentation of Hazard Information

While further studies will enable improvement of the accuracy of hazard zones and correction of errors, it is unlikely to be practical to accurately identify landslide boundaries throughout the area, the possible run-out distance downhill or the extent of potential regression uphill.

This uncertainty could be overcome by considering the form of presentation of the hazard information to the community, such as by incorporating buffer zones around the identified slope failure hazards or landslides, and presentation of this as an area that requires consideration of the landslide hazard. The basis and definition of such a zone could be varied depending on the type of landslide, the end use of the maps and the likelihood of any restrictions.

5.4 Avalanches

5.4.1 Existing Hazards Register

Available information on avalanche hazards in the Queenstown-Lakes District was compiled by Woodward-Clyde (1998), and was included in the Hazards Register. The avalanche information was sourced from Coronet Peak and Remarkables ski fields and the New Zealand Mountain Safety Council. However, they mention that any mountainous area of sufficient slope and height should be considered as having avalanche potential.

5.4.2 Review of Avalanche areas

None of the avalanche prone areas identified are located within the Priority 1 and 2 areas identified by the Council for this study.

The New Zealand Mountain Safety Council was requested to consider the potential for avalanche hazards in the priority areas in the district identified by QLDC. Hamish McCrostie of the NZ Mountain Safety Council (pers comm.) advised that there are no known avalanche hazards in the priority areas. However, the New Zealand Mountain Safety Council confirmed the presence of the avalanche hazards indicated in the hazards register, at the Coronet Peak and Remarkables ski areas and the Routeburn Track area. In addition, the potential for avalanche hazards exists in the Treble Cone and Cardrona ski areas, and these areas have been added to the avalanche theme in the GIS hazards database.

The avalanche hazard is the encounter probability of a walker or skier being hit by an avalanche, and is a function of :

- The size and type of avalanche
- The frequency of avalanche occurrence
- The number of avalanche paths
- The length of time walkers, skiers take to cross the avalanche paths (exposure time)
- The numbers of walkers or skiers who use the tracks or slopes.

The NZ Mountain Safety Council indicated a subjectively assessed hazard of moderately high for the Remarkables, Treble Cone and Routeburn Track areas, and low for Coronet Peak and Cardrona areas.

The avalanche hazards are located in tourist resort or areas of tourist activity. Avalanche hazards can be catastrophic. Any incident may cause significant loss of life and potentially affect the tourist industry for some time. It would be prudent to consider the avalanche hazards and associated risks to ensure that appropriate risk management measures are in place.

5.5 Seismic Hazards

5.5.1 Existing Hazards Register

Available information on seismic hazards within the Queenstown-Lakes District was compiled by Woodward-Clyde (1998), and was included in the Hazards Register. This included active faults and ground shaking. The ground shaking hazard area has been mapped as merely the areas underlain by Quaternary sediments, without consideration of earthquake sources and amplification likely. In the present form, the existing ground shaking hazard information in the Hazards Register is of limited use, without further study of the seismicity and ground shaking hazard.

5.5.2 Hazards from Earthquakes

Earthquakes originating from sources within and outside the Queenstown Lakes District could cause seismic hazards in the district. For example the Alpine Fault is located just to the northwest of the district, see Figure 7, but can cause significant seismic hazards within the Queenstown Lakes District.

Earthquakes can cause the following seismic hazards :

- Fault Rupture
- Ground Shaking
- Earthquake induced Slope Failures
- Liquefaction
- Tsunami and Seiche

All these effects pose hazards to development within the district to a greater or lesser extent. The hazards caused by earthquakes have each been reviewed for the district.

Fault Rupture

There are fault rupture hazards within the district. These have been updated using the most up to date information on the locations of the faults within the district obtained from the Institute of Geological and Nuclear Sciences, who have recently published the QMAP series 1:250,000 map for Wakatipu (Institute of Geological and Nuclear Sciences, 2000a), see Figure 7. This map covers most of the district, but excludes a small proportion of the district at the northern end where the Makarora township is located. No information is available for this area, as the existing hazards register also did not cover this area. However no significant faults are known in this area.

The new active fault hazard theme (Figure 7) shows differences from the existing hazards register information, and it is considered to be the result of more detailed mapping undertaken for the recent QMAP. The inactive faults are also shown on the map, and while these are not expected to rupture, they may represent areas of weaker rock and hence may be of use for consideration during land development.

The map shows that the active faults do not cross the majority of the priority areas identified by the Council except at Albert Town and Hawea, see Figure 7. In addition the recurrence interval of rupture of the Cardrona fault system that crosses Albert Town and Hawea is very long at 7500 years (Institute of Geological and Nuclear Sciences, 2000b). Therefore, active faults do not represent a significant risk to the priority areas of the district. Although it may be prudent to consider risk management measures given that fault rupture can cause severe damage, the poor accuracy of the location of the faults where they cross the priority areas (eg Albert Town), probably because of the deep sediments overlying these areas, would make the implementation of risk management difficult.

Ground Shaking

The ground shaking hazard in the existing hazards register has been based on areas of Quaternery sediments. This is unlikely to represent the earthquake ground shaking hazards in the district as it does not take into consideration the depth, nature or strength of the deposits, which influence the level of amplification of motions.

The recent studies of the Alpine Fault have led to a significant change in the hazard represented by this fault. The characteristic rupture of the Alpine Fault between Milford and Haupiri is now considered likely to give a very large earthquake of magnitude 8.1, with a recurrence interval of about 300 years. This section of the fault is located at a distance of about 80 km to 85 km from the major townships of the district (Queenstown, Wanaka, Albert Town and Hawea). Such an earthquake can cause significant ground shaking in these towns, particularly where the shaking is amplified by the lake sediments or alluvium. The shaking will be pronounced where deep or soft lake sediments are present. Other faults in the region can also lead to amplified ground shaking.

It is important to better understand the effects of the sediments on the ground shaking, and therefore it is recommended that a seismicity study be carried out to assess the ground shaking intensities and ground accelerations that could be encountered during various earthquake events including the Alpine Fault event.

The national seismicity study carried out by the Institute of Geological and Nuclear Sciences (2000b) indicates the peak ground accelerations shown in Table 3 for different return periods, for intermediate (firm) soil sites.

Table 3 - Peak Ground Accelerations for Intermediate Sites in Queenstown District

Probability (Return Period)	Peak Ground Acceleration	
	Queenstown, Frankton, Arrowtown	Wanaka, Albert Town, Hawea
10 % in 50 years (475 years)	0.4g - 0.5g	0.3g - 0.4g
10 % in 105 years (1000 years)	0.5g - 0.6g	0.4g - 0.5g

The accelerations in areas underlain by sediments may be higher than those in Table 3.

The New Zealand Loadings Code provides information for design of buildings for ground shaking based on zone factors. Given the increased seismicity assessed for the district and the potential for amplification of ground shaking by lake sediments, the designs based on the current loadings code may be inadequate for design of important buildings in the district. The loadings code is currently being revised, and this may better represent the seismic ground shaking levels specified for design, and in particular for locations like Queenstown, which are located within the influence of the Alpine Fault. An appropriate seismicity would need to be assumed particularly for important buildings and facilities.

Earthquake Induced Slope Failures

Earthquake induced slope failure hazard is not identified in the current hazards register.

However, the district has a high potential seismicity and characteristic rupture of the Alpine Fault can give rise to a large Richter magnitude 8.1 earthquake at a return period of about 300 years.

Keefer (1984) who collated and reviewed landslides triggered by various earthquakes indicated that a magnitude 8.1 earthquake could cause coherent and disrupted slides up to 200 km away from the fault rupture. The main towns of the district are only about 80 km to 85 km from the Alpine Fault, and the region has steep mountain slopes that are susceptible to slope failure. Therefore there is a potential for significant earthquake induced slope failure hazards in the district.

An earthquake induced slope failure hazard study is recommended for the district. The study could be similar to that carried out for the Wellington Region (Brabhaharan, 2000).

Liquefaction

Liquefaction commonly occurs in loose sands and silts that are saturated, when they are exposed to severe ground shaking. The lake sediments in the district are potentially susceptible to earthquake induced liquefaction. Given the significant ground shaking likely in the district as discussed above, these sediments could potentially liquefy in a large earthquake event. This is particularly likely in an Alpine Fault event, which is expected to be associated with a Richter magnitude 8.1 event, with a large duration of shaking.

However, the distribution of sediments that are susceptible to liquefaction is not known. An initial attempt has been made to assess the distribution of soils with a susceptibility to liquefaction by considering the geology of the district. The recent deposits identified in the QMAP 1:250,000 geological map (Institute of Geological and Nuclear Sciences, 2000a), which are considered to contain fine grained soils, have been categorised as provisionally susceptible to liquefaction. A section of this provisional liquefaction map is shown on Figure 8. This has been prepared to consider the possible distribution and hence importance of liquefaction hazards in the district only and should not be used for hazard identification purposes for development.

The provisional liquefaction susceptibility map indicates that significant priority areas may be susceptible to liquefaction, and therefore a liquefaction susceptibility study is recommended for the important areas of the district.

Tidal Waves (Tsunami) and Sieche

Tsunami is generally caused by a large sudden displacement of deep water bodies such as oceans leading to tsunami waves. In the Queenstown Lakes District, the lakes are potentially vulnerable to tidal waves from fault rupture or large catastrophic landslides, which are most likely to be associated with earthquakes. It is recommended that this be reviewed after assessment of the earthquake induced slope failure hazards, which are possibly the major source of tsunami wave generation. The only active fault that crosses the lakes is the Cardrona Fault at Lake Hawea, but this fault has a return period of 7500 years making it a low frequency hazard.

Seiche is oscillation of water bodies due to say earthquake shaking. The possibility of seiche in an Alpine Fault event is not certain and requires further research. This could also be considered at the same time as tsunami.

5.6 Landfills and Contaminated Sites

5.6.1 Existing Hazards Register

The existing hazard register provides locations of the landfills and potentially contaminated sites, from the proposed district plan and from Otago Regional Council resource consent documentation.

5.6.2 Review of Landfills and Contaminated Sites

Information in the current database was reviewed and additional information was collated from Otago Regional Council and QLDC. This information was reviewed to assess the risk posed by these sites to development. This review is presented in Appendix D.

The list collated is not comprehensive and it is important to update the register as information becomes available. It would be prudent to check with the ORC register as well at regular intervals as they also maintain a list of potentially contaminated sites.

The available sites have been included as a theme in the GIS hazards database. However, the locations of some of the sites are not known and need to be identified and included in spatial database. The mapped hazards in the Queenstown-Frankton area are presented on Figure 9.

Similarly available information on landfills was reviewed, and has been mapped. The location of Warren Park landfill is not accurately known, and given that this is located in an urban area of Queenstown, it is suggested that this be investigated so that any risks to the community can be identified.

5.7 Mineworkings

5.7.1 Existing Hazards Register

The existing hazards register provides locations of mine workings from the NZMS 260 topographic maps. It provides no information on the mine workings or the hazards posed.

5.7.2 Review of Mine Workings

Information on mine workings through licences and other sources were obtained from QLDC and from the Department of Mines through the Council. This information has been reviewed to assess the hazards and the risks posed to the community. This review is presented in Appendix D.

However, the locations of some of the sites are not known and need to be verified and included in the spatial GIS database. The list collated is not comprehensive and it is important to update the register as information become available.

The available information suggests the risk from mine workings to be generally low.

6 Provision of Hazard Information

6.1 Identify Natural Hazards

The Council must gather information necessary to enable it to effectively carry out its functions under the RMA (s. 35). The information must be "reasonably available" to the public (s. 35(3)). Natural hazards information is to be included where the Council considers it appropriate.

While there is no specific obligation to keep records of natural hazards, the Council will need to act "reasonably" when deciding whether to keep records on particular natural hazards and the level of detail required. The Council will need to properly consider whether to gather certain information or records, while not imposing an unreasonable burden upon ratepayers to fund these activities.

The level of detail in the records will depend to a large extent upon the degree of risk associated with the natural hazard and the purposes for which the information may be required. It may also depend on when and how the Council will use the records. For example, a local authority will need to have available detailed records and information relating to an area where the risk from a natural hazard is high, and the information is relied upon when processing resource consent applications.

The records appropriate for the district may depend, amongst other things, on:

- The physical geography of the district;
- Present land use activities;
- Potential development;
- Practicalities in obtaining information;
- Frequency and severity of a natural hazard occurrence;
- Funding and costs of obtaining information; and
- Policy matters.

It is current practice amongst a number of local authorities to have available GIS information and historical records. The source, reliability and accuracy of old records will be relevant.

The Otago Regional Council has a management function under the Soil Conservation and Rivers Control Act 1941 and will generally be the most appropriate source of flood hazard information and advice. This information is likely to include technical investigations, river monitoring data gathered and flood information for the major floodplains.

6.2 Providing Information

Certain information must be included in Land Information Memorandum ("LIMs") and Project Information Memorandum ("PIMs") issued by the Council.

LIMs and PIMs must include information identifying special features or characteristics of land, including natural hazards such as potential erosion, falling debris, subsidence, slippage and inundation. The feature or characteristic is to be known to the Council and not apparent from a district plan [1].

Information will be "known" if it is actually recorded somewhere in the Council's records, and due care will need to be taken when this information is provided.

It is likely that "known" information will extend to information that ought to be known by a diligent territorial authority. This could involve a territorial authority undertaking research and investigations into particular aspects of land in their district, although not necessarily as a direct result of a request for a LIM or PIM.

It is recommended that QLDC continues to record existing information on hazards. Where necessary, QLDC should qualify information if it is outdated or potentially inaccurate.

6.3 Potential Liability

Common law principles are relevant to the Council's responsibilities in relation to natural hazards. This mostly relates to the responsibility of the Council not to be negligent when undertaking its functions, duties or powers, and not to cause a nuisance to others. Negligence involves falling below the reasonable standard of care that can be expected in the circumstances[2].

A local authority could be liable for negligent acts or omissions, or a positive act carried out negligently. This could involve:

- Negligent advice or omission such as providing inaccurate information and failing to advise on a hazard;
- The negligent administration of plan rules when issuing a resource consent;
- Negligence during the processing of resource and building consents;
- Negligently issuing a PIM or LIM, or building consent which contains inaccurate information or which fails to identify a natural hazard.

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[1] LIMs – Local Government and Official Information and Meetings Act 1987 (s.44A)
PIMs – Building Act 1991 (s. 31). The information must be likely to be relevant to the design and construction or alteration of the building or proposed building.

[2] For the elements of a negligence action see Appendix B.

The Council must exercise reasonable care to ensure that adequate and properly notated records are kept[3]. Financial or staffing constraints because of economic resources at the time, or any alternative demands on its resources, are no excuse for not keeping proper records [4]. Failing to exercise reasonable care to ensure that adequate and properly annotated records are kept, has the potential for claims in negligence against the Council.

The Council will owe a duty of care to a third party where it holds or provides information about a natural hazard and that person relies on the information or advice to their detriment [5]. The Council should draw attention to any natural hazard risk or put the third party on notice of such a risk. Whether the Council is approached formally or informally, as a public body it has an obligation to act with due care. It will also owe a duty of care when supplying information or comments to other statutory bodies [6]

Protection against civil proceedings is provided under the Building Act for certain people including members and employees of territorial authorities if acts under that legislation are done in good faith (s. 89)[7]. Territorial authorities and building certifiers are exempt from liability in civil proceedings in certain circumstances.

6.4 Recommendations

It is recommended that the Council :

(a) Gather information, appropriate to the significance and degree of the hazard.

(b) Discuss hazard information with the Otago Regional Council and seek a consistent approach to presenting and selecting mitigation measures.

[3] Bronlund v Thames Coromandel District Council (CP 48/94)

[4] Op cit p. 11

[5] Brown v Heathcote City Council [1986] 1 NZLR 76, Court v Dunedin City Council (CP51/97)

[6] McTavish v Morgan A145/97

[7] A ten-year limitation period is imposed under section 91, with the ten years running from the date a building consent or building certificate is issued rather than the discovery of the damage.

7 Generic Measures to Manage Risk

7.1 Introduction

The Council together with its community is responsible for decisions concerning land use, development and the development of hazard areas. This section identifies the legal framework for this decision-making process and looks at different measures available to the Council to manage the risk associated with hazards.

7.2 Legal Framework

A variety of legislation places responsibilities upon the Council with respect to natural hazards and their management. A more detailed analysis of the legislative framework is included in Appendix B.

The Resource Management Act 1991

The primary piece of legislation is the Resource Management Act 1991 (the "RMA"), which governs the use of natural and physical resources, including water and land. Local authorities play a significant role in this process because of the plans they are required to prepare. These plans ultimately provide the policy framework for the decisions to be made about managing risks associated with natural hazards.

The Council's functions include controlling the actual or potential effects of the use, development or protection of land to avoid or mitigate natural hazards (s. 31(b)). The Otago Regional Council also has a role, which is to control land use for the purpose of avoiding or mitigating natural hazards (s. 30(1)(c)(iv)). In practice there may be little difference in these functions.

When preparing or changing its district plan, the Council must make provision for any matter relating to the use, development or protection of land and any associated natural and physical resources, including controlling any actual or potential effects of and use to avoid or mitigate natural hazards[8]. The Council must also have regard to the Regional Policy Statement for Otago, and all the relevant regional and proposed regional plans which include the Otago Regional Council's Proposed Regional Plan: Water and Regional Plan: Waste. Other relevant documents that the Council will need to consider are the Otago Conservation Management Strategy, Kai Tahu ki Otago - Natural Resource Management Plan and the Water Conservation (Kawerau) Order 1997. The Lake Wanaka Preservation Act 1973 could also be relevant depending on what measures are adopted by the Council.

Other legislation

Other legislation which may affect how the Council can manage natural hazards, or which may influence the implementation of such measures, include the Building Act 1991, the

[8] RMA Second Schedule Part II Clause 1(a))

Local Government and Official Information and Meetings Act 1987, the Local Government Act 1974, the Soil Conservation and Rivers Control Act 1941, the Land Drainage Act 1908, the Civil Defence Act 1983[9].

Civil Defence and Emergency Management Bill

The Civil Defence Emergency Management Bill will repeal and replace the Civil Defence Act 1983, when enacted. The Bill (which is expected to become law in 2002), proposes developing a national strategy and regional civil defence emergency management plans. The focus of the new legislation is on promoting the four Rs – managing risk through to reduction, readiness, then response and recovery.

The bill places a responsibility on the civil defence and emergency management groups and their members (including local authorities) to :

- Identify, assess and manage hazards and risks
- Consult and communicate about risks
- Identify and implement cost-effective risk reduction.

This will generally require a more proactive strategy on managing risks from hazards.

7.3 Selecting Appropriate Measures

Prior to agreeing to a package of risk management measures the Council should identify a process to:

(a) Develop options [combination of measures to provide an agreed level of protection]

(b) Evaluate options [criteria - social; environmental; economic; technical; political acceptability]

(c) Consider and select mitigation measures - consultation with affected individuals, organisations, Iwi and the public is essential in formulating, accepting and implementing outcomes.

(d) Prepare a plan/ strategy for implementing the selected measures.

This approach will help reduce the impact on a community by creating an agreed set of measures and actions that improves the community's ability to manage the hazard. This approach enables a set of measures to be devised that would otherwise be managed in an ad hoc fashion. Such an approach should gain greater acceptance of the community and also help in limiting the liability of the Council.

[9] For information on these Acts see Appendix B.

7.4 Measures to Manage Risk

Developing measures to manage the risk from natural hazards is important for the Council to fulfil its obligations under the legislation and common law. Legislation, particularly the RMA and the Building Act, and the proposed Civil Defence Emergency Management legislation may influence the measures to be developed and how they are implemented.

There are many ways of mitigating the risk from hazards. Some measures are more viable than others depending on the community's vulnerability, extent of existing development, and available funding.

Generic risk management measures as summarised in the Australia / New Zealand Standard on Risk Management AS/NZS 4360:1999 (Standards Australia, 1999) include:

- *Avoiding risk* (e.g. the adoption of land use planning controls to control high vulnerability activities in hazardous areas);
- *Reducing the frequency of occurrence* (e.g. by providing stop banks or other structural protection measures);
- *Reducing the consequences* (e.g. flood proofing buildings, allowing for relocatable buildings, removing expensive or essential equipment from high hazard areas etc);
- *Transferring risk* (e.g. through insurance);
- *Financing risk* (e.g. through the EQC and disaster relief funds);
- *Accepting risk* (e.g. recognising and addressing residual risk via emergency management measures)

While not all of the above measures will be available to the Council, for example it may be difficult to transfer the risk, we suggest that the Council consider adopting a range of management measures to address the hazards affecting the district.

Assessing *environmental effects* of the selected mitigation measures is an important step in determining what mix of measures to select for an area. Structural measures, such as stopbanks and channel management to reduce flood hazards, will have significant effects on the environment. The opportunity for and benefits from environmental enhancement as part of the development and implementation of mitigation measures selected can if relevant also be considered.

Economic analysis[10] provides a common framework for assessing the effects of mitigation measures, positive or negative, social, environmental or financial. Proposed measures

[10] Wellington Regional Council, Flood Protection Group has used economic analysis to determine:
- the design standard
- structural measures affecting local areas
- non-structural measures guiding possible floor level restrictions

should be analysed to ensure that "costs" are justified by associated "benefits". The economic analysis usually follows conventional cost-benefit procedures.

7.5 Risk Mitigation Measures

Mitigation measures may help reduce the risk from hazards and improve community resilience to hazards. These measures include land use planning methods, voluntary actions and steps that residents, groups, businesses and utility and emergency services can take to prepare for hazards. These measures aim to keep people, possessions and development away from hazard prone areas. They also improve the community's ability to respond to and recover from a hazard event and enable a community to be more resilient to a potential hazard now and in the future through being aware, prepared and encouraging sensible land use.

In some circumstances it may be appropriate only to keep records and provide information as required on particular hazards. This will tend to be hazards with low risks and low probability. In other circumstances, where there are higher risks associated with a hazard, this approach may not be sufficient to discharge the Council's duty under the RMA, other legislation and common law. In such circumstances other mitigation measures need to be considered.

7.5.1 Land Use and Planning Controls

Controlling the use of land within hazardous areas can be used to keep inappropriate future development away from high-risk areas, and remove existing high hazard developments.[11] Land use controls should be formulated and resolved within the context of the political, social, economic and environmental priorities for the district.

Hazard Maps

Hazard maps can be useful for both local authorities and emergency services agencies. Hazard maps can be used to manage risk by :

Methods involving calculating tangible and intangible damages have been used to measure the effectiveness of a proposed design standard or individual measures. For example, a significant reduction in annualised damages encouraged the selection of a reasonably high design standard for the Hutt River. Measuring saved damages is a tool used more recently to establish the viability of minimum floor level restrictions. The approach used compares the costs of raised floor levels with the saved damages, based on a method developed by Canterbury Regional Council.
Benefit/cost analysis has also been used more widely for floodplain management planning decisions. The Hutt, Otaki and Waikanae FMP processes have incorporated social and environmental benefit/cost into decisions on the priority for timing upgrade works along the rivers.

[11] Kapiti Coast District Council controls development in some river corridors to avoid worsening the effects of flooding. The relocation of Milford Huts, Blandord, Canterbury is an example of where relocation has been successfully used.

(a) Providing information to developers and the community so that they can take self action to consider and mitigate hazards.

(b) Use of hazard maps in *"zoning"* land use to minimise the risk to the community from hazards.

(c) Use of hazard maps in the district plan as a means of influencing the mitigation of risk in development, through rules.

Hazard maps have been successfully incorporated into district plans, or can sit outside the district plan[12].

District Plan Rules

The district plan is a useful tool to identify some hazard information and, where appropriate, control the location and standards of development in hazard areas. Our experience is that district plans are the most appropriate place for rules in relation to hazards. However, if the regional plans specify rules, then the district plan should be consistent with those rules.

Rules may be included in district and regional plans to protect "other property" from the effects of surface water. These rules may require building work to achieve performance criteria additional to, or more restrictive than, those in the building code (s. 68(2A) and 76(2A) RMA). The term "other property" includes land or building not held under the same ownership and any road (s.2 Building Act).

Resource Consent Process

When acting as a consent authority, the Council can use the resource consent process to manage land uses so that natural hazards can be avoided or mitigated[13]. This may be done through:

(a) Requiring information such as a site-specific technical report on the effect of a hazard(s) on the proposed development, to be included in applications for resource consents.

(b) Including the risk from hazards in the consideration of resource consent applications including the Assessment of Effects on the Environment.

(c) Inclusion of conditions relating to reduction of risk from hazards, as part of the conditions imposed on resource consents.

[12] For example Kapiti Coast District Plan where hazard maps have been incorporated into the district plan. Canterbury and Bay of Plenty regions have developed hazard maps that sit outside district plans. In the Waikato region a region-wide Flood Hazard Mapping Project is currently underway and the Council intends to make these maps available to the general public via the Environment Waikato website.

[13] See Appendix B for more details.

The granting of a subdivision application is specifically restricted where land is, or is likely to be subject to material damage by specified natural hazards, or where subsequent use of the land is likely to accelerate, worsen or result in material damage to the land, other land or a structure. The natural hazards identified are - erosion, falling debris, subsidence, slippage, or inundation from any source[14]. A subdivision consent must be refused unless the consent authority is satisfied that steps can be taken to ensure the land is suitable by avoiding, remedying or mitigating the effects of the natural hazards (s. 106 RMA). Provisions that may be made are rules in a district plan, conditions on a resource consent or other methods which may include physical works.

7.5.2 Building Controls

Building controls refer to the conditions that can be attached to building within hazard areas. Such controls are aimed at reducing the risk to the building and its occupants from hazards. For example, in relation to flood hazards, this could be the floor level of buildings.

Minimum floor levels are currently defined by the Building Act 1991. However, the Resource Management Act can be used to set higher standards. Local authorities have used this approach for new development located in flood hazard areas. A number of local authorities have set minimum floor levels above the 1 in 100 year flood level rather than the 1 in 50 year standard set by the Building Act. Minimum floor levels tend to be applied to residential rather than commercial and industrial uses. Decisions on whether commercial floor levels are raised will also be affected by economics and commercial risk-taking considerations. For industries using hazardous chemicals, the risk of escape of hazardous materials may need to be considered.

Section 36 Entry on a Certificate of Title may be made where a consent authority considers building work will not exacerbate or result in a specified hazard, but land is subject to, or is likely to be subject to the hazards and other requirements are met[15]. A building consent may be granted in these circumstances and the entry on the certificate of title will provide the territorial authority with immunity from any civil liability in relation to the building works.

There is no requirement to identify the particular hazard in the entry on the certificate of title. The entry serves as a warning to potential purchasers of risks associated with the land but in essence becomes a blot on the title and may have significant insurance implications[16].

The application of Section 36 entries by some local authorities has been a subject of some controversy. As part of the recent review of the Building Act, some professional groups (eg New Zealand Geotechnical Society) have suggested modification of this clause. The general view is that while it may be prudent to put an entry to protect future owners in

[14] Section 106 (1) The wording of s. 106 means that a territorial authority is not constrained by the section if a natural hazard exists that is not specifically listed.

[15] Section 36(2) Building Act 1991

[16] Logan v Auckland City Council CA 243/99. For more details see Appendix B.

some circumstances, it would be desirable to specify what hazard led to the entry and make reference to the information or report used as a basis for the entry.

Building Consents

Building consents must be obtained from the Council for certain "building work" which includes site work. There are restrictions on granting building consents for work on land subject to, or likely to be subject to a number of specific hazards, or where building work is likely to "accelerate, worsen, or result in" those specific hazards on the land or any other property[17]. The hazards specified are erosion, avulsion, alluvion, falling debris, subsidence, inundation, or slippage[18] and there are some notable exclusions from the list of specified natural hazards in the Building Act.

A consent may only be issued if the territorial authority is satisfied that adequate provision will be made to protect, or restore any damage, to the land, the building work or other property (s. 36(1)).

As a general matter, a territorial authority must have "due regard" to natural hazards when exercising specific powers under the Building Act, including issuing PIMs, granting building consents, and dealing with dangerous and unsanitary buildings[19].

7.5.3 Hazard Proofing Buildings

Hazard proofing refers to the design and construction of buildings with appropriate details or materials such that damage to the structure of the building itself (structural damage) is minimised when the building is exposed to the hazard. For example, a building may be designed to resist a higher level of earthquake hazard than provided for in the codes of practice. While hazard proofing can minimise structural damage to potentially affected buildings, the residents and their possessions may still be adversely affected.

7.5.4 Voluntary Actions

In some hazard areas it may be impractical or uneconomic to mitigate the hazard. In these cases voluntary actions either by private or public individuals/organisations may be appropriate for protecting existing at-risk properties or reducing the residual risk in areas to be protected by physical measures (e.g. stopbanks, drainage works). Examples of voluntary actions include providing technical information and advice to the community about flooding effects, and ways to reduce impacts. In some cases voluntary property purchase may be an option.

[17] Section 36 Building Act 1991

[18] Not all natural hazards are listed - notably nothing associated with earthquakes, volcanic eruption, or windstorms.

[19] Section 47 Building Act

7.5.5 Emergency Management

Emergency management has typically been a service provided to at-risk communities during hazard events. Recent reform is aiming more at building an environment of self-help and mutual support within communities so they are better able to manage their own emergency response. Emergency management programmes and procedures are part of the four Rs of comprehensive risk management, which are :

- **Reduction** : reducing the likelihood of a hazard or the consequences if it does happen.
- **Readiness**: strategies that prepare for emergency response.
- **Response**: counteracting the emergency when it occurs.
- **Recovery**: returning the community back to how it was prior to the emergency.

7.5.6 Structural Measures

Structural measures involve constructing physical works designed to contain the hazard. They are the more traditional tools for reducing risks associated with hazards. These measures are physical structures or works (eg a flood stop bank) designed to protect people and assets from hazards often up to a specific standard or return period. This measure is more appropriate for existing development.

If the Council does construct physical works it may run the risk of an action in nuisance. The legal principle derived from the early case of Rylands v Fletcher (1868) L.R. 3 H.L. 330 may apply where a local authority has constructed some drainage works or undertook work in a watercourse, and the amount of water collected is likely "to do mischief" if it escapes. The local authority will be liable if the water escapes and causes damage. There is no need to establish fault on the part of the local authority that did the work - liability exists because the work may be a potentially dangerous thing[20].

[20] See Appendix B for more details on actions for creating a nuisance.

8 Risk Management Measures for Specific Hazards

8.1 Introduction

Measures to manage the risk associated with specific hazards in the Queenstown-Lakes District are discussed in the following sections. For each hazard, relevant generic measures have been evaluated against the following criteria:

- Effectiveness
- Costs of implementation
- Benefits derived
- Constraints

The suitability of measures to specific areas is also suggested. Some general comments about the effectiveness of these measures in terms of the Council's legal liabilities are also presented.

8.2 Flooding and Erosion

8.2.1 Consequences of Flood Hazard

It is important to consider the consequences of the flood hazard. This helps assess the risk from the hazards and consider measures that may reduce the consequences of the hazard. The consequences of the flood hazards in various locations are summarised in Table 4.

Table 4 - Consequences of Flood Hazard

Location in District	Impacts of Flooding	Consequences	Effects
Queenstown Wanaka	Inundation – ponding River bank flooding (Horne Creek)	Structural damage Farm use affected Sewage overflows	Loss of livelihood Tourism affected Damage reinstatement Business interruption Loss of stock Social impacts
Kinloch Glenorchy Makarora Kingston Hawea	Overflow path Inundation – ponding River bank flooding Inundation – ponding Overflow path (Gladstone Gap)	Erosion Sedimentation Damage to land	Loss of stock Social impacts
Albertown Arrowtown	Inundation – ponding River bank flooding		Loss of life Lifelines Stock Business interruption Social impacts Tourism

8.2.2 Risk Treatment

The roles and responsibilities of the Otago Regional Council (ORC), particularly under the Soil Conservation and Rivers Control Act 1941 are critical. ORC's approach to flood hazard mitigation will have an influence on the package of measures that QLDC selects.

There are many ways of mitigating flood and erosion hazards. The viability and effectiveness of the measures depend upon the vulnerability of the respective communities to flooding, the extent of existing development and the available funding.

The range of potential flood and erosion mitigation measures can be used to help reduce risk, but would have different costs and benefits. A range of possible measures and their benefits and issues to consider are summarised in Table 5.

Table 5 - Benefits and Issues for Flood Hazard Treatment Measures

Criteria / Measure	Cost to Council	Benefits derived	Issues to Consider
Hazard Maps (flood extent & degree of hazard)	Low	Provides information helps informed future planning decisions. Information generally included in PIM/LIMs	Decisions under the RMA and Building Act on subdivision resource consents and plan provisions would need to consider this hazard information. The level of accuracy of maps is important.
Land use and planning controls (eg zoning hazard areas and rules in district plan)	Low	Reduces future and residual risk. Community wide benefit.	Difficult to influence existing pattern of development. Suggest different standards between existing and new development. In initial stages often community resistance.
Building Controls (eg minimum floor levels)	Low	Reduces risk of damage to future buildings. Individual rather than community benefit.	Difficult to influence existing pattern of development.
Voluntary Actions (eg encourage people to build on flood free sites)	Low	Could protect existing at risk properties. Can be used to reduce residual risk in areas protected by structural measures.	Measure relies on individuals/ organisation to act and undertake voluntary measures. Need to maintain on-going community education to keep people aware.

Criteria / Measure	Cost to Council	Benefits derived	Issues to Consider
Emergency Management	Low	Enables communities to be prepared for emergency response. Complements other measures.	Relies on individuals/organisation to act. Need to maintain on-going community education to keep them aware. Less effective as damage will still occur.
Flood Proofing /House Raising	Low	Reduces risk of damage to existing buildings. Individual rather than community benefit.	Depending on funding arrangements may not be as acceptable as other methods, because benefit is to private individuals.
Structural Measures eg Stop banks, channel improvements, detention dams	High	Reduces existing risk. Community wide benefit.	Potential for environmental effects. Even if designed for large events, stop banks can still fail and damage would then be high. On-going community education and emergency management strategies required to ensure people are aware of the residual risk. Costs of maintaining structures. Potential for stop banks to increase flood levels elsewhere. Flood detention dams often have limited capacity and spillways need to be provided. Detention dams have limited applications in the district.

From the range of potential mitigation measures identified in Table 5, we suggest three possible courses of action for the Council.

1) Provide Information

This approach would involve the Council preparing flood hazard maps, implementing emergency management strategies and undertaking public education and encouraging voluntary actions related to the flood hazard. This approach would be suitable for all areas of hazard identified in the district and would be a minimum level of information and advice to meet the Council obligations.

It is suggested that existing hazard information be refined in areas of high risk in Queenstown, Frankton, Wanaka and Glenorchy. This would involve specific

studies to obtain information on ground levels and using these to develop and present flood hazard zones for different return periods.

Presenting flood hazard maps with several return periods would facilitate better understanding of the flood hazard and its implications by the community. This will also give the correct impression that the flood hazard varies gradually across the area, rather than a single line which would appear to indicate that there is no hazard on one side and full hazard on the other, which would make such lines less palatable to the community and which could lead people to possibly challenge the appropriateness of a particular return period flood line.

While this is a very important measure, in the absence of complementary measures to encourage or require action, the effectiveness of this measure on its own is limited.

2) **Non Structural Measures in addition to Provision of Information**

In addition to the measures identified in (1) above, land use, planning and building controls should be considered for areas where the flood hazard is well documented and the risks associated with flooding are high, for example in Queenstown, Frankton and Wanaka. Planning controls in particular are generally easier to apply in areas of new or future development because there is more flexibility to incorporate them as part of the development. They may also be appropriate for restricting infill development such as in the lake front areas of Queenstown and Wanaka, where minimum floor levels are already required.

Placing land use and building controls on existing development is more difficult. However, flood proofing or raising existing important development may be appropriate. Such measures may also be considered for areas such as Glenorchy, where structural measures are unlikely to be economically justifiable given the limited number of properties affected. These are particularly useful where structural solutions are not feasible or cost effective.

3) **Structural Measures in addition to Provision of information and Non-structural Measures**

Structural measures should be considered for areas of existing development where there is a significant risk from flooding due to the intensity of existing development. This would still need to be supplemented by provision of information and the non-structural measures identified in (1) & (2) above.

Structural measures may be appropriate in highly developed areas of Queenstown affected by flooding from Lake Wakatipu, and possibly for parts of Wanaka and Albert Town.

In other areas where there is less development (eg Glenorchy) or in greenfield areas, structural measures may not be appropriate. It is also not prudent to be developing

new structural measures to protect areas with little or no development, for example: Hawea, Kinloch, Greenstone Station, Walter Peak and Cecil Peak lakeshore areas.

Any decision to select specific structural measures should be made as part of the Council's overall assessment of how to treat the flood hazard, as discussed in Section 7.3.

8.2.3 Summary of Possible Actions for Flood Hazard

The key actions that may be adopted for managing the flood hazard are summarised below.

(a) Prioritise risk mitigation actions for the different areas affected by flooding in the district based on the risk, that is the severity and frequency of the flood hazard and vulnerability of the affected areas and the community to those hazards.

(b) Make available flood hazard information, with refining the hazards in the urban areas of Queenstown, Frankton, Wanaka and Glenorchy. This will involve gathering new information and ensuring that existing information is kept up to date.

(c) Develop mitigation options (2) and (3) further based on the priority, so that the options may be analysed and compared. This would include updating minimum floor level information currently provided in the Proposed District Plan for subdivision and land use consents.

(d) Implement education and awareness programmes and consult with the affected communities to develop an agreed programme of risk treatment measures.

(e) Develop emergency management response measures, which are consistent with the level of hazard and make the community aware of the measures and responses that are planned.

It is considered that such a systematic and rational approach would help manage risk to the community and limit the liability for the Council.

8.3 Landslides and Avalanches

8.3.1 Consequences of Landslide Hazards

The risk to development and the community from landslides depends on the effects from landslide activity. This will depend on the type, size and location of the landslides, frequency and magnitude of potential movements, and the consequential effects on development and the community.

The types, likelihood of significant movement and effects of landslides that predominate the district are summarised in Table 6.

Table 6 - Consequences of Landslides

Type of Landslide	Effects	Consequences to Property and People
Active Pre-existing Schist Debris Slides	Ongoing creep deformation with episodic accelerated movements with heavy rainfall. Possibly localised slumps in landslide debris.	Deformation and limited damage to buildings built on landslides, except on margins and scarps. Unlikely to damage buildings downhill of the slide except in extreme events.
Dormant Pre-existing Schist Debris Slides	No ongoing effects apart from possibly extremely slow creep (few millimetres per year). Deformation in extreme events. Possibly localised slumps in landslide debris.	Buildings generally perform satisfactorily except in extreme events, provided development is sensible and with good groundwater control.
Slope Failure Hazard in Superficial Deposits	Episodic movements following heavy rainfall, raised groundwater and high flood levels.	Severe damage to buildings built on the vulnerable areas. Possibility of loss of life exists but low.
Shallow Slips and Debris Flows in Colluvium	Slips and small to moderate debris flows following periods of heavy rainfall, which can run downhill for 10s of metres.	Damage and disruption to buildings built on or immediately downhill of vulnerable slopes.
First-time slides in Schist dip slopes	Rapid movement of slopes when triggered by heavy rainfall, excavation or earthquakes.	Catastrophic damage to buildings and property on slope and 10s of metres downhill, with possibly loss of life.
Rockfall	Rolling or bouncing of rock from slopes following a trigger such as heavy rainfall or with weathering, which can travel up to 10s to 100s of metres downhill.	Damage to buildings downhill and possibly loss of life or injuries due to rockfall impact.

8.3.2 Risk Treatment

There are a limited number of ways in which a landslide hazard can be treated, particularly when the landslides and potential slope failures are large and extensive such as in the Queenstown Lakes district. The viability and effectiveness of the measures depends on the activity and deformation of the landslides, and the extent of existing development.

A range of possible measures and their benefits and issues are summarised in Table 7.

Table 7 - Benefits and Constraints of Landslide Treatment Measures

Criteria / Measure	Cost to Council	Benefits derived	Issues to Consider
Landslide / slope hazard Maps	Low	Community aware of risks. Enables planning measures eg zoning. Information included in PIM/LIMs. Provides basis for site specific investigations / risk treatment.	Decisions under the RMA and Building Act on subdivision resource consents and plan provisions would need to consider this hazard information. The level of accuracy of maps is important.
Land Use Zoning (eg zoning landslide areas as reserves)	Low	Very effective to reduce risk in areas with no current development but with potential for future development.	Not suitable for already developed areas. There may be resistance from developers who already own land in hazardous areas.
District Plan Hazard Rules (eg require geotechnical report for consents)	Low	Helps ensure that developers assess risks and develop appropriately. Can be applied to infill development to a limited extent to control measures that exacerbate risk.	Only limited application to areas of existing development. There may be resistance from developers who already own land in hazardous areas.
Voluntary Actions (eg encourage developers to stabilise landslide or avoid areas)	Low	Little resistance from community. Enables developers to develop land by undertaking risk mitigation.	Measure relies on individuals/ organisation to act and undertake voluntary measures. Little incentive to developers to undertake risk mitigation. Need to maintain on-going community education to keep them aware.
Emergency Management (eg preparation to evacuate)	Low	Enables communities to be prepared for emergency response. Complements other measures.	Effectiveness limited as damage will still occur.
Stabilisation measures (eg drainage measures to reduce landslide deformation)	High	Reduces risk of damage to existing buildings. Generally can be implemented by individual developers. Can be used for existing or new development.	Generally difficult and costly for the large schist landslides in the district.

Criteria / Measure	Cost to Council	Benefits derived	Issues to Consider
Protection Barriers (eg rockfall fences or debris flow bunds)	Medium	Reduces risk to existing development.	Generally cost is high. Only applicable for a limited range of landslide hazards.

From consideration of the range of potential mitigation measures identified in Table 7, we suggest the possible courses of action for the Council listed in Table 8.

Table 8 - Alternative Risk Management Approaches

Course of Action	Type	Descriptions	Effectiveness	Areas of Applicability
(1)	Provision of Hazard Information	Develop hazard maps and provide through PIMS and LIMs and through education. Requires further work to map and better define landslide hazards. Provide emergency preparedness backup when events happen.	Low – Moderate.	All.
(2)	Land Use Zoning	Use hazard maps to zone areas of high hazard so that they are not developed for high vulnerability uses (building and residential). Implement (1).	High.	Future development in high hazard areas. Eg. Makarora debris flow areas. Infill development.
(3)	District Plan Hazard Rules	Use hazard maps as basis to require : ▪ Geotechnical reports demonstrating acceptable level of risk. ▪ Appropriate measures in the development such as stormwater control and disposal. Implement (1).	Moderate.	Future development and infill development. Eg Frankton, Sunshine, Quail Rise

Course of Action	Type	Descriptions	Effectiveness	Areas of Applicability
(4)	Stabilisation Measures	Investigate and implement stabilisation measures, where cost effective. Implement (1) and (3).	Moderate to high.	Existing high vulnerability development. Generally of limited applicability.
(5)	Protective Barriers	Investigate and install protective barriers (rockfall fence or debris flow bund) where risk is high and cost effective.	Moderate to High	Existing high vulnerability development. Eg Quail Rise

8.3.3 Summary of Possible Actions for Landslide and Avalanche Hazards

The key actions that may be adopted for managing the landslide and avalanche hazards is summarised below.

(a) Prioritise risk mitigation actions for the different areas affected by landslides in the district, based on the risk, that is, the severity and frequency of the hazard and vulnerability of the affected areas and the community to those hazards.

(b) Refine the hazard maps in the priority areas, through systematic engineering geological mapping and geotechnical assessment.

(c) Carry out study of earthquake and rainfall induced slope failures in all areas of urban development and important lifelines.

(d) Make hazard information available to the community, comprising the refined landslide maps, earthquake induced and rainfall slope failure hazards and avalanche hazards.

(e) Review zoning based on the hazard information from (b) and (c) above, and give consideration to zoning low intensity land uses which are least vulnerable to the hazards for high hazardous areas.

(f) Develop district plan provisions and consider incorporation into district plan, and implement through resource and building consents.

(g) Consider need for stabilisation measures and protective barriers in areas on high hazard and existing development.

(h) Implement education and awareness programmes and consult with the affected communities to develop an agreed programme of risk treatment measures.

(i) Develop emergency management response measures, which are consistent with the level of hazard and make the community aware of the measures and responses that are planned.

(j) Require active avalanche control programmes and emergency response plans to be developed by resorts in areas of avalanche hazards, to manage the risks.

It is considered that such a systematic and rational approach would help manage risk to the community and limit the liability for the Council.

8.4 Seismic Hazards

8.4.1 Consequences of Seismic Hazards

The risk to development and the community from earthquakes is dependent on the different effects of earthquakes. Earthquakes can cause a number of different hazards as discussed in Section 5.5. These different hazards have different effects on the community and the potential risk mitigation strategies. The effects of different earthquake hazards on the community are summarised in Table 9.

Table 9 - Consequences of Earthquakes

Type of Hazard	Effects	Consequences to Property and People
Fault Rupture	Ground rupture displacement of metres along the fault. Severe ground deformation over a wider zone where the bedrock is overlain by sediments. Possibly enhanced ground shaking due to near fault effects.	Severe damage and possibly collapse of buildings along fault rupture (say within 50 m). Enhanced damage in the vicinity of the fault rupture.
Ground Shaking	Ground shaking due to earthquakes. Amplification of ground shaking, particularly long period motions, due to the presence of soft or deep soil deposits. .	Buildings may be damaged due to enhanced ground shaking, particularly where the shaking is over that allowed for by codes of practice.
Earthquake Induced Slope Failures	Failure and catastrophic or rapid movement of rock and soil slopes as first time slides. Large rock falls or soil falls.	Catastrophic damage to buildings and property on slope and 10s of metres downhill, with possibly loss of life.
Liquefaction	• Sand boils leading to local flooding. • Subsidence of ground (100s of millimetres). • Lateral spreading of ground near banks, lake shores or sloping ground, and embankments. • Floatation of buried tanks and manholes. • Loss of foundation capacity.	Severe damage to buildings and lifelines / services particularly where lateral spreading occurs and shallow foundations or embankments are located on liquefiable ground.

Type of Hazard	Effects	Consequences to Property and People
Tsunami (triggered by EQ induced landslides)	Waves caused by displacement of water in lakes by a large sudden failure of a landslide and leading to waves.	Severe damage to facilities at low lying areas of the lake shore, possibly leading to loss of life.
Seiche	Flooding caused by oscillation of water bodies in lakes due to severe ground shaking.	Flooding of low lying areas of lake shores and buildings within these areas.

8.4.2 Risk Treatment

There are only few effective approaches to mitigate earthquake hazards, given that the effects are likely to be widespread. The viability and effectiveness of the measures depends on the extent of existing development in the higher hazard areas.

The potential treatment measures can be used to help reduce risk, but would have different benefits. Possible measures, their benefits and issues are summarised in Table 10.

Table 10 - Benefits and Constraints of Earthquake Treatment Measures

Criteria / Measure	Cost to Council	Benefits derived	Issues to Consider
Hazard Maps (ground shaking, slope failure, liquefaction and tsunami)	Low	Enables planning measures eg zoning. Information included in PIM / LIMs. Provides basis for site specific investigations and risk treatment.	Decisions under the RMA and Building Act on subdivision resource consents and plan provisions would need to consider this hazard information. The level of accuracy of maps is important.
Land Use Zoning (eg rezoning high hazard areas for low intensity or low vulnerability land uses)	Low	Very effective to reduce areas with no current development but with potential for future development.	Difficult in areas already developed. There may be resistance from landowners and developers who already own land in high hazard areas.
District Plan Hazard Rules (eg require geotechnical report for consents)	Low	Helps ensure that developers assess risks and develop appropriately. Can be applied to infill development to a limited extent to require measures that reduce risk.	Only limited application to areas of existing development. There may be resistance from developers who already own land in hazardous areas.

Criteria / Measure	Cost to Council	Benefits derived	Issues to Consider
Voluntary Actions (eg encourage developers to avoid slope failure areas or mitigate liquefaction risk).	Low	Little resistance from community. Enables developers to develop land by undertaking risk mitigation.	Measure relies on individuals/ organisation to act and undertake voluntary measures. Little incentive to developers to undertake risk mitigation. Need to maintain on-going community education to keep them aware.
Emergency Management (eg preparation to evacuate)	Low	Enables communities to be prepared for emergency response. Complements other measures.	Effectiveness limited as damage will still occur.
Protection Barriers	High	If stop banks are built for flood control, they may also provide some protection against tsunami and seiche. Reduces risk to existing development.	Generally cost is high. Only applicable for a limited hazards.

From consideration of the range of potential mitigation measures identified in Table 10, we suggest the possible courses of action for the Council in Table 11.

Table 11 - Alternative Risk Management Approaches for Seismic Hazards

Course of Action	Type	Descriptions	Effectiveness	Areas of Applicability
(1)	Provision of Hazard Information	Develop hazard maps and provide through PIMS and LIMs and through education. Requires further work to assess and map hazards. Provide emergency preparedness backup when events happen.	Low - Moderate	All.
(2)	Land Use Zoning	Use hazard maps to zone areas of high hazard so that they are not developed for high vulnerability uses (building and residential). Implement (1).	High	Future development in high hazard areas.

Course of Action	Type	Descriptions	Effectiveness	Areas of Applicability
(3)	District Plan Hazard Rules	Use hazard maps as basis to require : ▪ Geotechnical /design reports demonstrating acceptable level of risk. ▪ Appropriate measures in the development such as liquefaction mitigation or appropriate structural design. Implement (1).	Moderate.	Future development and infill development.
(5)	Tsunami Protective Barriers	Investigate and install protective where risk is high and cost effective. May be combined benefit for a flood bund.	Moderate to High	Existing high vulnerability development.

8.4.3 Summary of Possible Actions for Seismic Hazards

The key actions that may be adopted for managing the seismic hazard are summarised below.

(a) Prioritise risk mitigation actions for the different areas affected by earthquakes in the district, based on the risk, that is, the severity and frequency of the hazard and the vulnerability of the affected areas and the community to those hazards.

(b) Prepare hazard maps in all areas of urban development and important lifelines, for ground shaking, earthquake induced slope failures and liquefaction through systematic hazard studies.

(c) Make available hazard information, comprising earthquake ground shaking, earthquake induced slope failure and liquefaction hazard maps and associated reports.

(d) Review zoning based on the hazard information from (b) above, and give consideration to zoning high hazardous areas (such as high earthquake induced slope failure hazards) for low intensity land use.

(e) Develop district plan provisions (such as requiring consideration of the effects of enhanced ground shaking, liquefaction and slope failure hazards and mitigation to reduce risk to an acceptable level) and consider incorporation into district plan, and implement through resource and building consents.

(f) Implement education and awareness programmes and consult with the affected communities to develop an agreed programme of risk treatment measures.

(g) Develop emergency management response measures, which are consistent with the level of hazard and make the community aware of the measures and responses that are planned.

It is considered that such a systematic and rational approach would help manage risk to the community and limit the liability for the Council.

8.5 Landfill, Contaminated Sites and Mine Workings

8.5.1 Consequences of Hazards from Landfill, Contaminated Sites and Mine Workings

The risk from the hazards of contaminated land, landfill and mine workings will depend on the specific hazard in particular areas. The landfills, contaminated sites and mine workings have different impacts on the community.

The effects of different hazards on the community are summarised in Table 12.

Table 12 - Consequences of Landfill, Contaminated Sites and Mine Workings

Type of Hazard	Effects	Consequences to Property and People
Landfills	Potential for explosion from landfill gas migrating into confined spaces. Contamination of groundwater and other watercourses. Subsidence / settlement of buildings built on landfills. Ingestion of contamination.	Explosion and damage to assets and loss of life. Contamination of water sources or ingestion of soil or plants leading to health hazards. Environmental impact. Damage to property built on landfill.
Contaminated Sites	Explosion or spill of dangerous goods stored at sites. Contamination of groundwater and other watercourses. Ingestion of contamination.	Explosion and damage to assets and loss of life Contamination of water sources or ingestion of soil or plants leading to health hazards. Environmental impact.
Mine Workings	Contamination of groundwater and other watercourses. Subsidence / settlement of buildings built on sites disturbed by mining. Ingestion of contamination.	Contamination of water sources or ingestion of soil or plants leading to health hazards. Environmental impact. Damage to property built on ground disturbed by mine workings.

The impact of landfills, contaminated sites and mine workings will depend on the age of these sites and their location with respect to watercourses and their proximity to areas inhabited by the community, or community assets.

8.5.2 Risk Treatment

There are only few effective approaches to mitigate the landfill, contaminated sites and mine workings hazards. The viability and effectiveness of the measures depends on the extent of existing development in the higher hazard areas.

For known information on mine workings in the priority areas of the district, the hazard is quite low and it would be appropriate to take minimal effort at risk treatment. But landfills require ongoing monitoring for many years and some contaminated sites may pose a significant health risk to the community.

It is also important to consider the hazards from active sites with dangerous goods which pose a different but perhaps more severe hazard to the community.

The potential treatment measures can be used to help reduce risk, but would have different benefits. Possible measures and their benefits and issues to consider are summarised in Table 13.

Table 13 - Landfill, Contaminated Site and Mine Workings Treatment Measures

Criteria / Measure	Cost to Council	Benefits Derived	Issues to Consider
Hazard Maps (landfill, contaminated sites and mine workings)	Low	Enables planning measures eg zoning. Information included in PIM / LIMs. Provides basis for site specific investigations and risk treatment.	Decisions under the RMA and Building Act on subdivision resource consents and plan provisions would need to consider this hazard information. The level of accuracy of maps is important.
Land use planning (eg zoning high hazard areas for land uses of low vulnerability)	Low	Very effective to reduce areas with no current development but with potential for future development.	Not suitable for already developed areas. There may be resistance from developers who already own land in high hazard areas.
District Plan Rules (eg require geotechnical / contamination report for consents)	Low	Helps ensure that developers assess risks and develop appropriately. Can be applied to infill development to a limited extent to require measures that reduce risk.	Only limited application to areas of existing development. There may be resistance from developers who already own land in hazardous areas.

Criteria Measure	Cost to Council	Benefits Derived	Issues to Consider
Voluntary Actions (eg encourage developers to avoid high hazard sites or clean up contaminated sites).	Low	Little resistance from community. Enables developers to develop land by undertaking risk mitigation. Potentially very high costs of mitigation to developers.	Measure relies on individuals/ organisation to act and undertake voluntary measures. Little incentive to developers to undertake risk mitigation. Need to maintain on-going community education to keep them aware.
Cleanup contaminated sites or relocate landfill to secure / remote site.	High	Reduces risk to existing development.	Generally cost is high. Only appropriate to consider for sites posing a high hazard to people.

From consideration of the range of potential mitigation measures identified in Table 13, we suggest possible courses of action for the Council in Table 14.

This table considers the different approaches that may be adopted by the Council to manage the risks from landfills, contaminated sites and mine workings that the present in the district.

Table 14 - Risk Management – Landfills, Contaminated Sites & Mine Workings

Course of Action	Type	Descriptions	Effectiveness	Areas of Applicability
(1)	Provision of Hazard Information	Develop hazard maps and provide through PIMS and LIMs and through education. Requires further work to assess and map hazards and keep up to date. Provide emergency preparedness backup when events happen.	Low - Moderate	All.
(2)	Land Use Zoning	Use hazard maps to zone areas on high hazard so that they are not developed for high vulnerability uses (building and residential). Implement (1).	High	Future development in high hazard areas.

Course of Action	Type	Descriptions	Effectiveness	Areas of Applicability
(3)	District Plan Hazard Rules	Use hazard maps as basis to require : ▪ Geotechnical /contamination reports demonstrating acceptable level of risk. ▪ Appropriate measures in the development such as clean up or isolation of contaminants. ▪ Require owners of contaminated or dangerous goods sites that pose a risk to undertake clean-up or risk management measures. Implement (1)	Moderate	Future development and infill development.
(4)	Relocation or Clean up	Investigate and clean up or relocate if the risk is unacceptable.	Moderate to High	Existing high vulnerability areas.

8.5.3 Summary of Possible Actions for Landfill, Contaminated Sites & Mineworkings

The key actions that may be adopted for managing the hazards from landfills, contaminated sites and mine workings are summarised below.

(a) Prioritise risk mitigation actions for the different areas affected in the district, based on the risk, that is, the vulnerability of the affected areas and community to those hazards.

(b) Prepare hazard maps showing areas of landfills, contaminated sites and mine workings and make reference to reports, which provide any relevant information.

(c) Keep the hazard maps up to date by incorporating new information as it becomes available. Contact Otago Regional Council regularly to obtain any additional information that they have in their contaminated sites database.

(d) Make available hazard information, ensuring that this presents the risk in its proper context, rather than raise unnecessary concerns.

(e) Review zoning based on the hazard information from (b) above, and give consideration to zoning high hazardous areas for low intensity land use.

(f) Develop district plan provisions and consider incorporation into district plan, and implement through resource and building consents.

(g) Implement education and awareness programmes and consult with the affected communities to develop an agreed programme of risk treatment measures.

(h) Investigate potentially high hazard sites to determine the risk to community, for example Warren Park Landfill (location) and Wanaka landfill (presence of toxic chemicals) to assess the risk to the community.

(i) Continue to monitor the landfills for leachate and water quality in surrounding areas. In particular Tucker Beach landfill needs to be carefully monitored, and consider mitigation measures if necessary.

It is considered that such a systematic and rational approach would help manage risk to the community and limit the liability for the Council.

9 Conclusions

1) The legislative framework with respect to the management of hazards has been reviewed, together with appropriate case histories and related information.

2) There is a significant responsibility on local authorities to identify, provide and manage the risk with respect to hazards, primarily under the RMA 1991 and the Building Act 1991.

3) The Council would need to take due care to collate an appropriate amount and detail of hazard information, and make this available to the community.

4) There are provisions in the legislation to manage the risks from the hazards under the resource consent process (RMA) and the building consent process (Building Act).

5) The proposed Civil Defence Emergency Management Act, which is expected to become law in 2002, will require local authorities to individually and collectively (as part of regional Civil Defence Emergency Management Groups) take proactive measures to manage risks from hazards.

6) The Council provided information on areas of priority for review of the hazards, and the hazard information in these areas have been reviewed, and the risks from these hazards have been assessed.

7) The flood hazards have been reviewed and the latest information has been incorporated in the hazards register. These indicate the significant flood hazards in Queenstown, Wanaka, Frankton, Albert Town and Glenorchy. It would be prudent to refine the flood hazard areas in the more populated and developed areas (higher risk), such as Queenstown, Frankton, Wanaka and Glenorchy, and present a range of flood lines for different return periods.

8) Areas at risk from erosion have been identified for the priority areas.

9) The dam break flood has the potential to affect Albert Town and Wanaka, but has a much lower probability (less than 1 in 10,000 years) than the flood hazards from rainfall.

10) The landslides mapped in the priority areas have been reviewed. While the landslide hazard map in the current hazards register indicates the distribution of hazards at a regional scale, there are a number of inaccuracies and errors in a number of places. Some of these have been corrected but a more detailed study is prudent given the risk from this hazard, and the current development in the district.

11) The landslides have been characterised in the priority areas based on the type of landslide and their level of hazard to development.

12) The potential for new slope failures (first time slides) has not been mapped in the current hazards register. Care should be taken in assessing consent applications, to ensure that developers have had the potential for first-time slides considered in geotechnical reports for the development and taken appropriate risk management measures.

13) The hazards register indicates the avalanche hazards to be concentrated at ski resorts and other rural mountainous areas outside the priority areas.

14) Nevertheless, given that avalanche hazards can be catastrophic and can lead to large loss of life, particularly in areas of tourist activity (Coronet Peak, Remarkables, Treble Cone, Cardrona and Routeburn Track), the risks are significant to the district.

15) Earthquakes have the potential to cause a range of hazards, such as active fault rupture, ground shaking, earthquake induced slope failures, liquefaction and possibly "tidal" waves or seiche.

16) The recent studies into the activity of the Alpine Fault show that it is much more active than originally thought. The Alpine Fault is located about 80 km to 85 m from the important towns of the district, and it is assessed to be capable of producing Richter magnitude 8.1 earthquakes at a return period of 300 years.

17) Only some of the earthquake hazards (ground shaking, active faults) have been mapped in the current hazards register.

18) The active fault hazards have been reviewed, and the locations updated based on the latest information available from the compilation for the new QMAP for Wakatipu, at 1:250,000 scale. The active faults within the district have a relatively low return period, for example the Cardrona Fault is estimated to rupture at a frequency of about 1 in 7500 years.

19) The ground shaking hazards, shown in the current hazards register, are simply areas of quaternary deposits. This does not give any indication of the level of amplification and is inappropriate. It would be prudent to carry out a ground shaking hazard study for the district to understand the level of ground shaking possible in the urban areas.

20) Historical earthquakes throughout the world and the steep terrain in the district suggest that earthquake induced slope failures have the potential to be a significant hazard in the district. It would be prudent to assess the potential for earthquake induced slope failures and map the hazards, to assist with risk management.

21) A number of areas in the district are potentially exposed to the risk of earthquake induced liquefaction and consequent ground damage. It would be prudent to assess and map these hazards in the priority areas of the district.

22) Earthquake induced landslides have the potential to cause "tidal" waves, if large landslides displace water within the lakes in the district. The risk could be reviewed once the earthquake induced landslides are mapped.

23) The landfills in the hazards register have been reviewed and additional information collected from QLDC have been added to the hazards layer. The review suggested that the majority of the landfills had caused a low hazard to date.

24) The location of Warren Park landfill in Queenstown is not located and it is prudent to investigate its location and possible risks to the community.

25) The Wanaka landfill may contain toxic chemicals and it would be prudent to investigate this.

26) The contaminated sites have been reviewed and additional information collated from QLDC and ORC and added to the hazard theme.

27) The presence of mine workings has been researched from information obtained from QLDC and a database has been compiled. The review of this information indicates that the risk from these known workings is low.

28) Approaches to manage the risks from hazards have been reviewed and the relative benefits and issues related to different approaches are presented. These approaches include :

- Land use and planning controls (hazard maps, district plan rules, resource consent process)
- Building controls (criteria, Section 36 entry, building consents)
- Hazard proofing buildings
- Voluntary actions
- Emergency management
- Structural measures

29) It would be prudent to agree and implement a process for risk management for the various hazards, which may include :

(a) Developing options for risk management

(b) Evaluation of options using social, economic, environmental, technical and political criteria.

(c) Consideration and selection of mitigation measures in consultation with the community

(d) Preparation of a plan/ strategy for implementing the selected measures.

30) Risk management approaches for specific hazards are presented and discussed. These provide a framework for working through the risk management measures for each hazard.

31) It would be prudent to prioritise the evaluation of risks and risk treatment, consistent with the level of risk posed to the community.

32) It is important to ensure that all the available hazard information is taken into consideration in the evaluation of applications for consents under the RMA and Building Act, and the issue of consents.

33) A systematic and rational approach, such as that presented, would help manage the risk to the community and limit the liability to the Council.

10 Recommendations

It is recommended that the Council gives consideration to :

10.1 Collection of Information

1) Gathering information appropriate to the significance and degree of the hazard.

2) Discussing the hazard information with Otago Regional Council to seek a consistent approach to presenting and selecting mitigation measures.

3) Refining and presenting a flood hazard lines for different return periods, in the more populated and developed areas (with a higher risk) affected by flooding, such as Queenstown, Frankton, Wanaka and Glenorchy.

4) Commissioning specific hazard studies to address the inaccuracies in the landslide hazard maps and characterising them.

5) Carrying out studies to assess and map the hazards from ground shaking, earthquake induced slope failures, liquefaction and tsunami / seiche.

6) Investigating landfills where there is uncertainty as to the risk posed to the community, such as at the Warren Park and Wanaka landfills.

7) Keeping a contaminated site database up to date to provide information on potential hazards from such sites. One action required is to keep in regular contact with the Otago Regional Council and obtain and incorporate any additional sites and associated information into QLDC's hazards database.

10.2 Provision of Information

8) Ensuring that the hazard information provided under PIMs and LIMs is the most up to date hazard data available or held by the Council.

9) Including a natural hazards section and relevant hazard information on district plan maps in the Proposed District Plan.

10.3 Risk Management Approach

10) Agreeing and implementing a process for risk management for the various hazards, which may include :

- Developing options for risk management
- Evaluation of options using social, economic, environmental, technical and political criteria.
- Consideration and selection of mitigation measures in consultation with the community
- Preparation of a plan / strategy for implementing the selected measures

11) Prioritising risk mitigation actions for the different hazards and areas affected, based on the severity and frequency of the hazard and the vulnerability of the areas affected.

10.4 Issue of Consents

12) Ensure that all the available hazard information is taken into consideration in the evaluation of applications for consents under the RMA and the Building Act, and the issue of consents.

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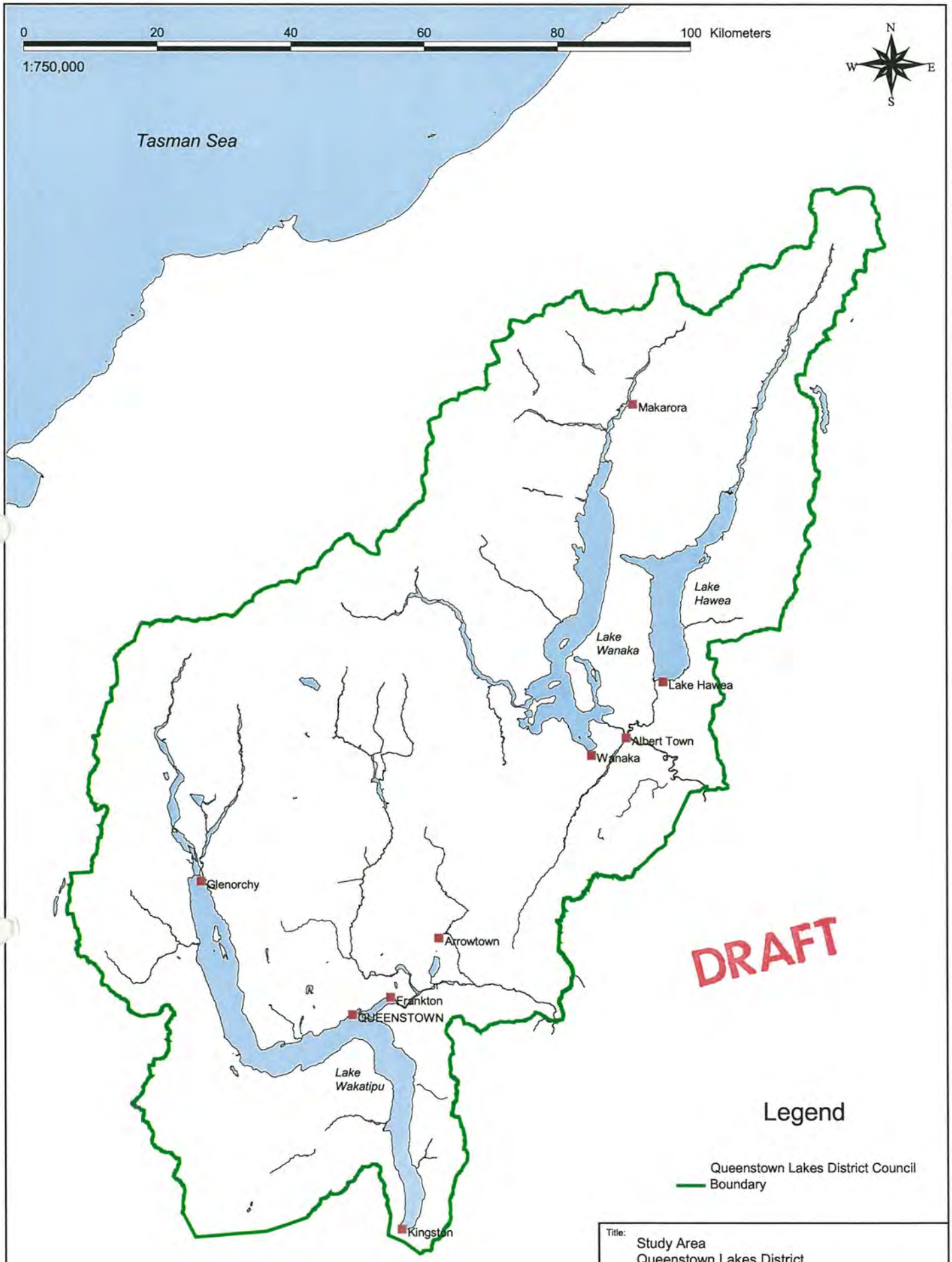

Title: Study Area Queenstown Lakes District		
Project: Hazards Register Part II Stage 2 Risk Management Study Report		
Client: Queenstown Lakes District Council		
Job No: 5C0185.00	Date: December 2001	Figure: Figure 1

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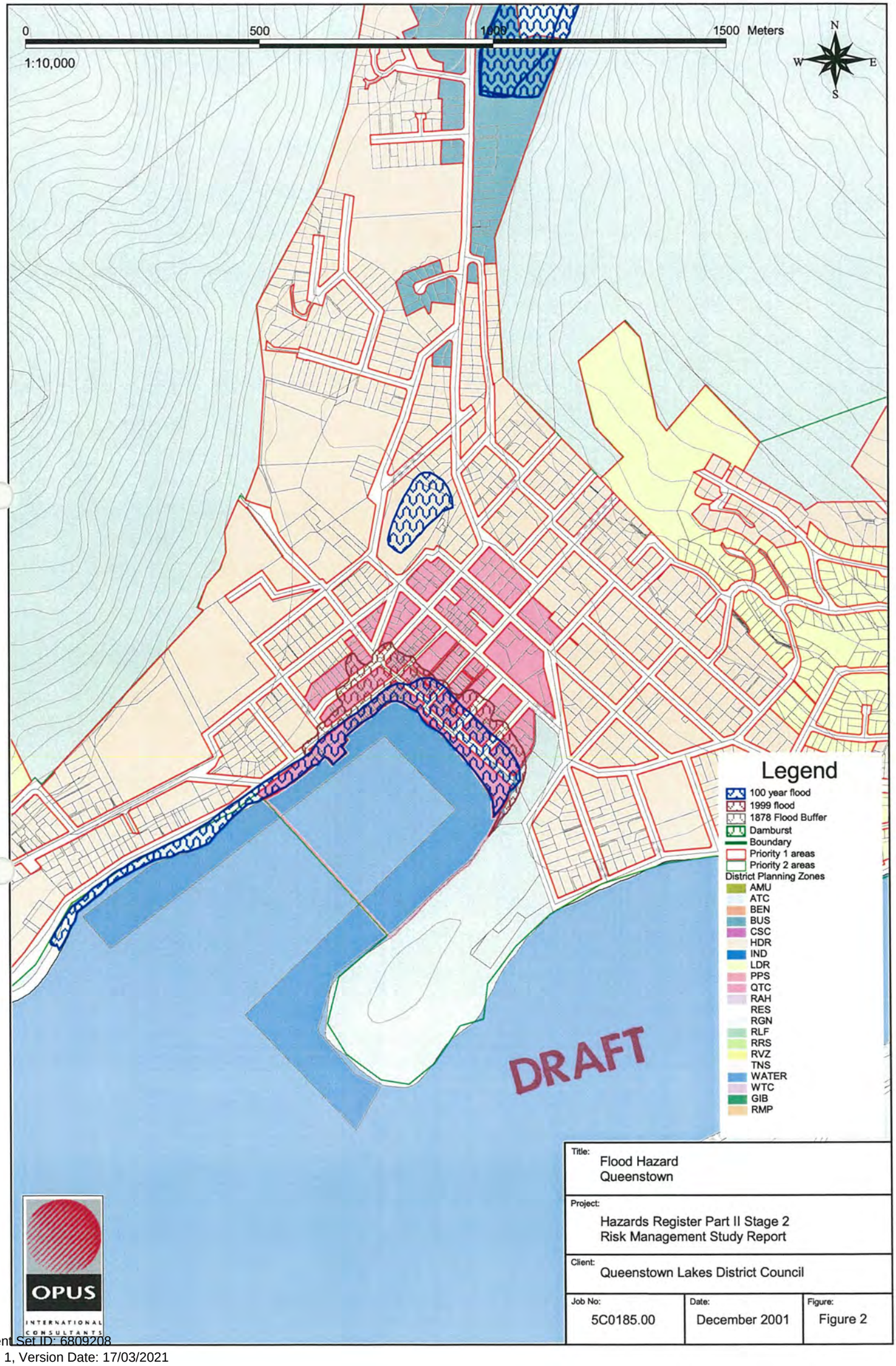

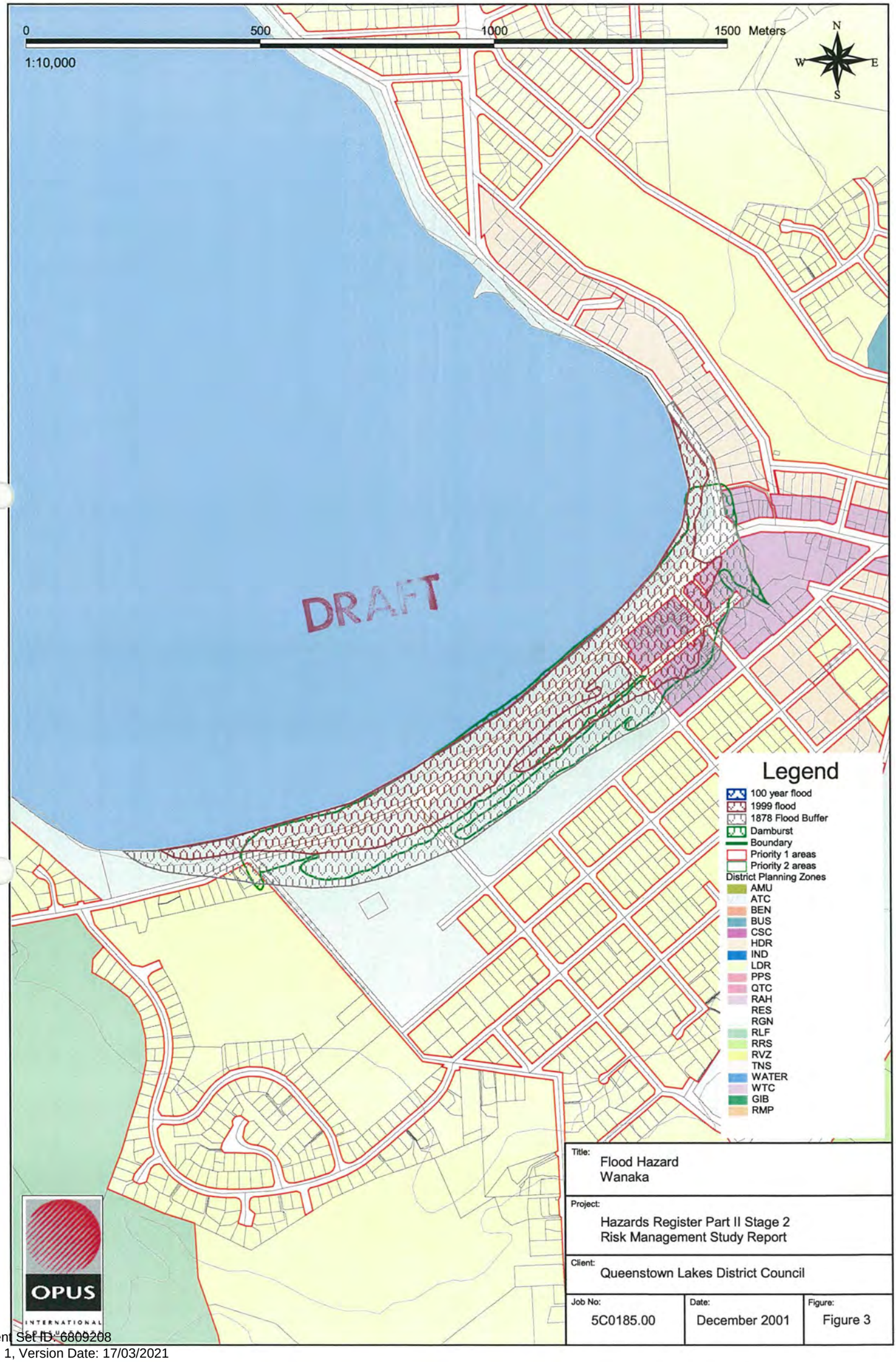

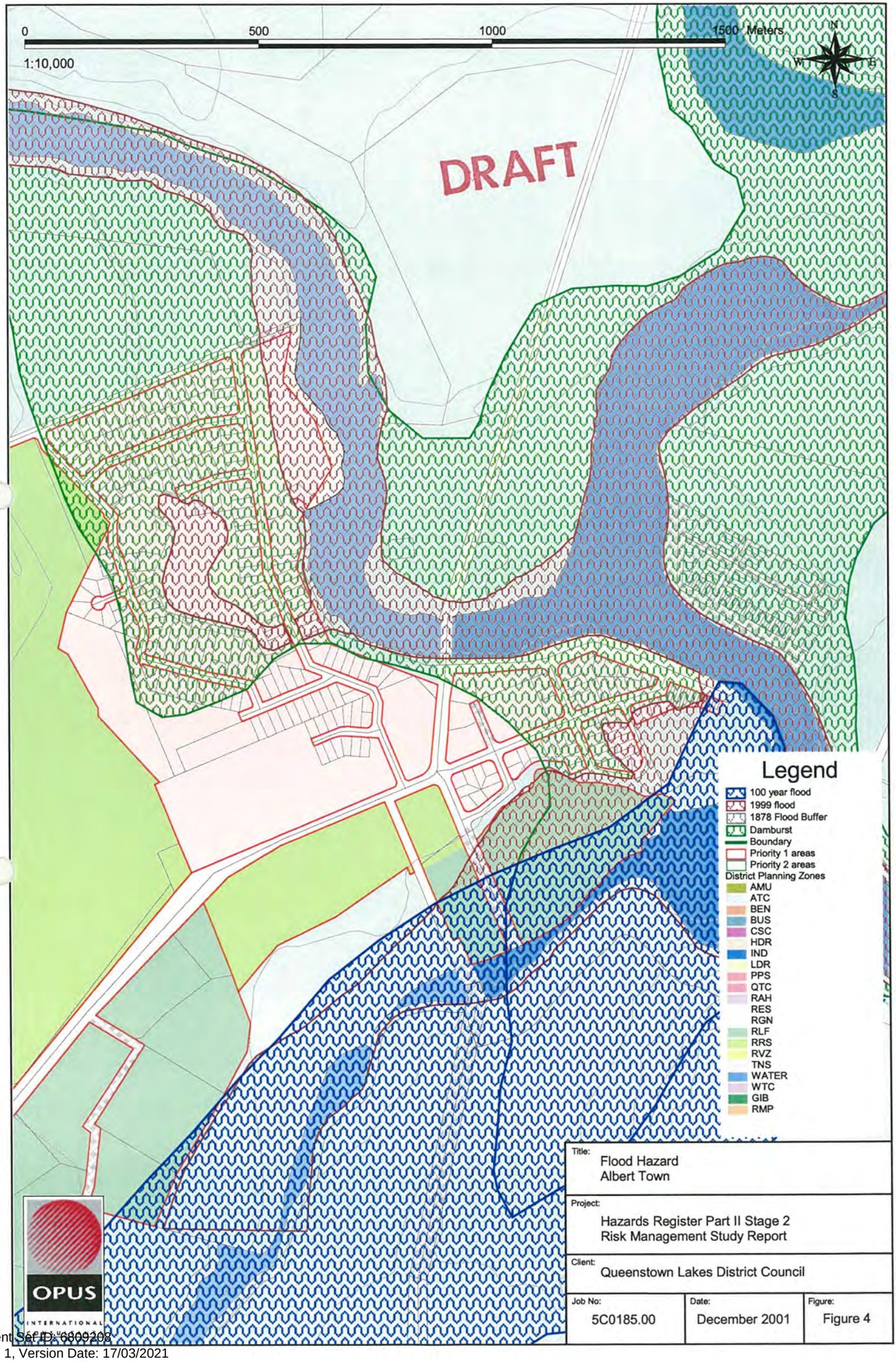

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Legend

- Boundary
- Priority 1 areas
- Priority 2 areas

Landslide

- Active pre-existing landslides
- Pre-existing landslides of unknown activity
- Dormant pre-existing landslides
- Shallow slumps and mudflows
- Debris flow hazard
- Erosion

Title: Landslide Hazard Queenstown - Frankton		
Project: Hazards Register Part II Stage 2 Risk Management Study Report		
Client: Queenstown Lakes District Council		
Job No: 5C0185.00	Date: December 2001	Figure: Figure 5

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OPUS INTERNATIONAL CONSULTANTS

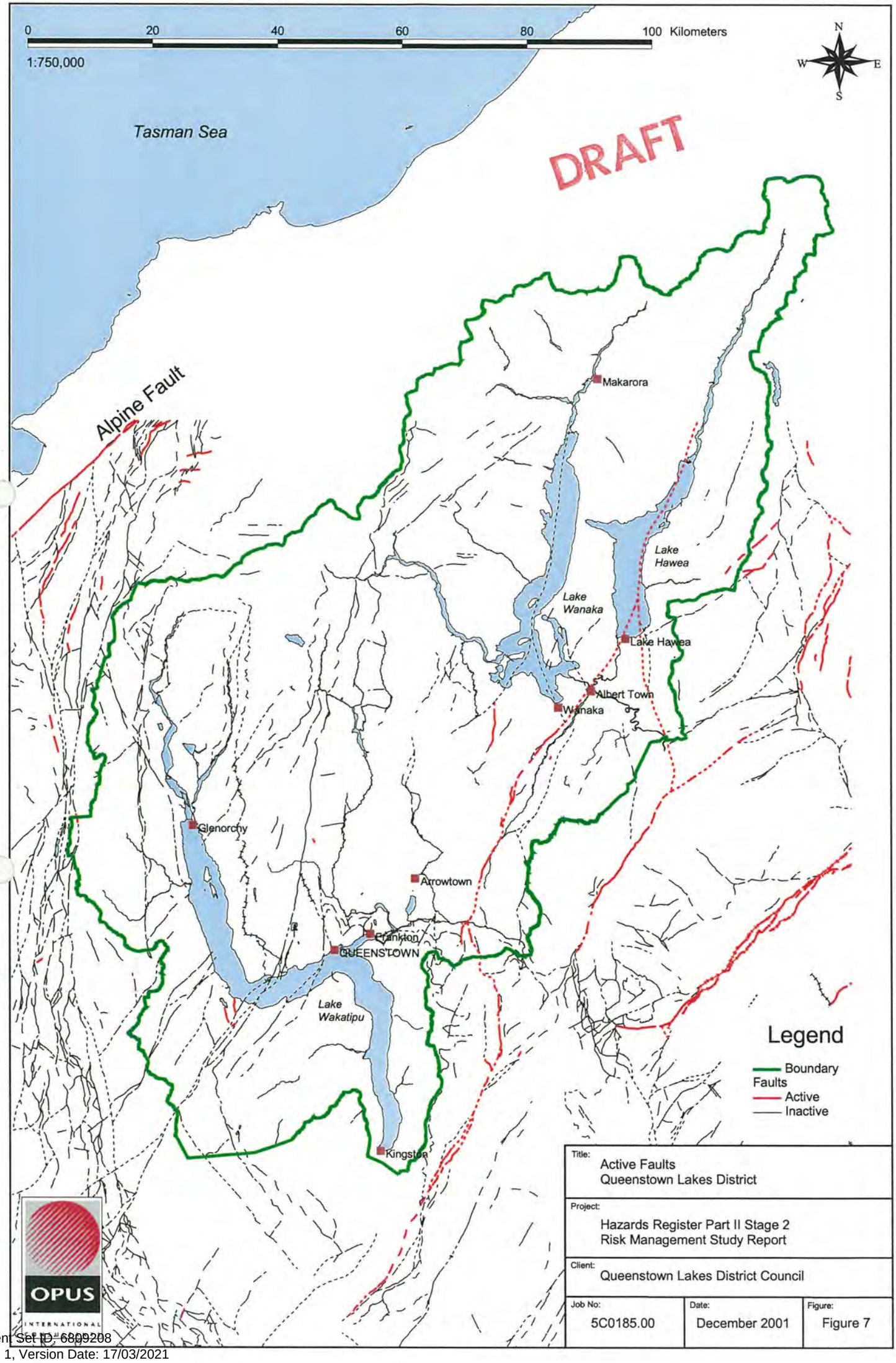
Legend

- Boundary
- Priority 1 areas
- Priority 2 areas

Landslide

- Active pre-existing landslides
- Pre-existing landslides of unknown activity
- Dormant pre-existing landslides
- Shallow slumps and mudflows
- Debris flow hazard
- Erosion

Title: Landslide Hazard Wanaka - Albert Town		
Project: Hazards Register Part II Stage 2 Risk Management Study Report		
Client: Queenstown Lakes District Council		
Job No: 5C0185.00	Date: December 2001	Figure: Figure 6



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OPUS INTERNATIONAL CONSULTANTS

Legend

- Boundary
- Priority 1 areas
- Priority 2 areas

Liquefaction

- Susceptible
- Possibly susceptible

Title: Provisional Liquefaction Susceptibility Queenstown - Frankton		
Project: Hazards Register Part II Stage 2 Risk Management Study Report		
Client: Queenstown Lakes District Council		
Job No: 5C0185.00	Date: December 2001	Figure: Figure 8

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Legend

- Boundary
- Priority 1 areas
- Priority 2 areas

Contamination

- Potentially Contaminated Sites
- Contaminated Sites
- Dangerous Goods Licence
- Landfill

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Title: Landfill and Contaminated Sites Queenstown		
Project: Hazards Register Part II Stage 2 Risk Management Study Report		
Client: Queenstown Lakes District Council		
Job No: 5C0185.00	Date: December 2001	Figure: Figure 9

Queenstown Lakes District Council

Hazards Register Part II Stage 2 Risk Management Study Report

Volume 2 : Appendices

Queenstown Lakes District Council

Hazards Register Part II Stage 2 Risk Management Study Report

Volume 2 : Appendices

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R J Mc Kelvey

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Contents

Volume 2

1 Appendix A : Scope of Study

Review Statutory Responsibility and Liability

Carry out a detailed review of statutory responsibility and liability associated with the Building Act 1991, the Resource Management Act 1991 and the Local Government Act 1974 and subsequent amendments.

- Review responsibilities under RMA 1991, Building Act 1991, Local Government Act 1974 and amendments
- Search and review case law and legal opinions including building authority rulings
- Search and review literature on actions to limit liability, including work for the floodplain management planning study
- Develop advice on Council liability issues

Landslides

Identify what action if any is required to limit the Council's liability in areas downhill of known unstable ground hazards.

- Review landslide information on areas of interest (this is to include but is not exclusive of the following areas: Frankton Road, Fernhill, Sunshine Bay, Arthurs Point, The Commonage, Quail Rise and Quail Point).
- Site reconnaissance of areas of priority identified by QLDC
- Identify potential impact on areas downhill of landslides
- Identify any areas where the District Planning provisions require amendment to manage the landslide hazards identified in the register, and if found, recommend the provisions which are required and where they are required
- Develop actions that may be considered to limit liability for a)Existing development b)New development.
- Recommendations for actions to limit liability (physical, planning and public awareness actions).

Flooding

Identify what action if any is required to limit the Council's liability in townships adjacent to waterways that were inundated during the November 1999 flood event.

- Review flood information in areas of interest
- Identify potential impact from flooding
- Identify any areas where the District Planning provisions require amendment to manage the flooding hazards identified in the register, and if found, recommend the provisions which are required and where they are required
- Develop actions that may be considered to limit liability for a)Existing development b)New development
- Recommendations for actions to limit liability from flooding (physical, planning and public awareness actions)

Avalanche

Identify what action if any is required to limit the Council's liability in areas downhill of known avalanche hazards.

- Review avalanche information
- Identify potential impact on areas downhill of avalanches
- Identify any areas where the District Planning provisions require amendment to manage the avalanche hazards identified in the register, and if found, recommend the provisions which are required and where they are required
- Develop actions that may be considered to limit liability for a)Existing development b)New development.
- Recommendations for actions to limit liability (physical, planning and public awareness actions).

Seismic Hazards

Identify what action if any is required to limit the Council's liability in areas of known seismic hazards.

- Review seismic information on areas of interest
- Identify potential impact from seismic events

- Identify any areas where the District Planning provisions require amendment to manage the seismic hazards identified in the register, and if found, recommend the provisions which are required and where they are required
- Develop actions that may be considered to limit liability for a)Existing development b)New development.
- Recommendations for actions to limit liability (physical, planning and public awareness actions).

Erosion

Identify what action if any is required to limit the Council's liability in areas adjacent to waterways open to erosion hazards.

- Review erosion information on townships adjacent to waterways
- Identify potential impact on areas effected by erosion
- Identify any areas where the District Planning provisions require amendment to manage the erosion hazards identified in the register, and if found, recommend the provisions which are required and where they are required
- Develop actions that may be considered to limit liability for a)Existing development b)New development.
- Recommendations for actions to limit liability (physical, planning and public awareness actions).

Mine Workings

Identify what action if any is required to limit the Council's liability in areas of identified Mine Workings

- Review mine workings information
- Identify potential impact from mine workings
- Identify any areas where the District Planning provisions require amendment to manage the mine working hazards identified in the register, and if found, recommend the provisions which are required and where they are required
- Develop actions that may be considered to limit liability for a)Existing development b)New development.
- Recommendations for actions to limit liability (physical, planning and public awareness actions).

Contaminated Sites and Landfills

Identify what action if any is required to limit the Council's liability in areas known to be a potential contaminated site or landfill.

- Review potential contaminated site and landfill information
- Identify potential impact from potential contaminated sites and landfills
- Identify any areas where the District Planning provisions require amendment to manage the potential contaminated sites and landfill hazards identified in the register, and if found, recommend the provisions which are required and where they are required

  Develop actions that may be considered to limit liability for a)Existing development b)New development.
- Recommendations for actions to limit liability (physical, planning and public awareness actions).

Summary Briefing Presentation and Report

At the conclusion of this stage of the study a presentation will be required to be made to Council and a summary report will be prepared.

- Report provided in hardcopy and digital copy
- Updated Shapefiles for use in the Natural Hazard Register on Council's GIS

2 Appendix B : Review of Legislative Framework

Local authorities have statutory responsibilities in relation to natural hazards and their management. The responsibilities and requirements of the main parties involved in the statutory processes, and in undertaking activities for managing natural hazards are summarised below.

Some of the powers and duties are mandatory for the body concerned and must be done to comply with the legislation. Other powers are discretionary with an underlying assumption that an authority will act reasonably in exercising its discretion.

A body exercising a discretionary power must have regard to matters that the statute conferring the discretion identifies, either expressly or by implication. The authority will need to ensure that it thoroughly considers the relevant issues and associated information before making a decision as to whether or not it will exercise a discretionary power.

Common law is also relevant to managing natural hazards.

2.1 The Resource Management Act 1991

2.1.1 Definition

Under the RMA 'natural hazard' is defined as:

"…any atmospheric or earth or water related occurrence (including earthquake, tsunami, erosion, volcanic, and geothermal activity, landslip, subsidence, sedimentation, wind, drought, fire, or flooding) the action of which adversely affects or may adversely affect human life, property, or other aspects of the environment."

This definition is similar to the ordinary meaning of the term. The "environment" is defined to include all natural and physical resources as well as people and communities (s.2).

2.1.2 Functions of Territorial Authorities

Territorial authorities' functions include:

'…[t]he control of any actual or potential effects of the use, development, or protection of land, including the implementation, of rules for the avoidance or mitigation of natural hazards and the prevention and mitigation of any adverse effects of the storage, use, disposal, or transportation of hazardous substances' (s. 31(b)).

There is some overlap of these functions of territorial authorities and regional councils. A regional council's function is to control the use of the land to avoid or mitigate natural hazards (s. 30), whereas a territorial authority is to control the effects of land use, development and protection to avoid or mitigate natural hazards (s. 31). In practice there may be little difference between a territorial authority controlling land use to avoid or mitigate natural hazards, and a regional council controlling actual or potential effects of the

use, development or protection of land for the same purpose. The Court of Appeal has stated that the control of effects of land use "must involve some degree of control of the use itself" (Application by Canterbury Regional Council [1995] NZRMA 452, 460).

A Regional Policy Statement may clarify the specific responsibilities between local authorities for managing natural hazards, to resolve the duplication or overlap of hazard management functions under the RMA. There may be a transfer of responsibilities via the regional policy statement (s. 62(1)(ha)). It may state which local authority within its area is to be responsible for developing objectives, policies and rules to control land use for avoiding or mitigating natural hazards, and it may state which particular hazards are involved. If no responsibility is identified then a regional council retains primary responsibility for the natural hazard (s. 62(ha)).

Alternatively a regional council may transfer some functions to another local or other public authority (s. 33(1)). However even if it does transfer one of its functions it will still remain responsible for the exercise of the function (s. 33(3)). The transfer requires the special consultative procedure in the Local Government Act 1974 to be used and the Minister for the Environment must be notified. Both authorities must agree that the transfer is desirable because of the community of interest, efficiency, technical or special capability or expertise (s. 33(4)(c)).

Otago Regional Council's - Regional Policy Statement for Otago (Operative 14th September 1998)

The Regional Policy Statement provides that within the Otago Region the territorial local authorities are to "prepare information on site specific and localised natural hazards that may affect any component of Otago's built environment under the Building Act" (Chapter 11.2.1). Local territorial authorities are also to be responsible for developing objectives, policies and rules relating to the use of land:

- "that is affected by a natural hazard in its district, and
- where the effect of development could be to exacerbate a natural hazard situation" (Chapter 11.2.2).

The Regional Policy Statement identifies methods that may be used by territorial local authorities which include: "identify and analyse natural hazard threats related to particular sites or developments and make that information publicly available through the use of hazard registers. Compile this information from existing sources or where such information is unavailable for specific sites or developments, the territorial local authority may require developers to supply this information." (Chapter 11.6.20).

2.1.3 Preparing District Plans

District and regional plans assist the local authorities in carrying out their functions. The territorial authority must prepare a district plan and it needs to have regard to any, or any proposed relevant regional policy statement or regional plan. The district plan must not be

inconsistent with a regional policy statement or regional plan on any regionally significant matter (s. 75).

When preparing or changing its district plan the territorial authority must also have regard to any management plans and strategies prepared under any other Acts and relevant planning documents recognised by an iwi authority affected by the district plan (s. 74(2)(b)).

A territorial authority must make provision in its district plan for:

'…any matter relating to the management of the use, development, or protection of land and any associated natural and physical resources for which the territorial authority has responsibility for under this Act, including the control of…any actual or potential effects of any use of land … including…for the purposes of the avoidance or mitigation of natural hazards' (Second Schedule Part II Clause 1(a)).

Land use may be controlled in a district plan to avoid or mitigate natural hazards by:

- Controlling the inappropriate use of hazard prone land; and/or
- Controlling activities that cause or accelerate natural hazards.

A district plan may "zone" certain areas prone to natural hazards as a "Hazard Area" for the purpose of controlling land use effects. Policies, objectives and rules may then be developed which prohibit, regulate or allow activities in a "Hazard Area".

A territorial authority must consider a wide range of matters before adopting objectives, policies, rules or methods in plans (s. 32). It must be satisfied that all objectives, policies, rules or methods adopted to manage natural hazards are necessary, effective and efficient. It needs to:

- "have regard to" specified matters which include the extent to which any objective, policy, rule or method is necessary to achieve the purpose of the RMA; and
- carry out a cost-benefit evaluation, appropriate to the circumstances and which assesses principal alternatives; and
- be satisfied that the provision or method is "necessary" in achieving the purpose of the RMA and it is the "most appropriate" means (s. 32(1)).

Otago Regional Council's - Proposed Regional Plan: Water ("Proposed Water Plan")

QLDC must have regard to the Proposed Water Plan when preparing its district plan. There are references to natural hazards throughout the Proposed Water Plan, in particular to giving priority to managing activities to avoiding adverse effects on identified values. The flood hazard is identified as being significant during periods of very high flow in many of Otago's lakes and rivers. It is noted that land use activities undertaken in close proximity to defences against water have the potential to adversely affect the way these

defences are designed to function and may increase the flooding risk (Chapter 8.2.5). Rules in the Proposed Water Plan have been introduced to address this issue.

The Proposed Water Plan identifies a number of methods other than rules, which are to be used to achieve the Plan's objectives. It is proposed that the Otago Regional Council will provide advice about the likely susceptibility of the location of a proposed structure to flooding. This advice is to be given when requested by a resource consent applicant or other individual, or when a district or city council requires the information when preparing district plans (Chapter 15.3.3.1). It is also proposed that the Council will provide information to each district and city council concerning the location, extent and likely characteristics of floodplains, floodways, and ponding areas in its district (Chapter 15.3.3.2).

Otago Regional Council's - Proposed Regional Plan: Waste for Otago ("Proposed Waste Plan")

The Proposed Waste Plan provides that when assessing an application for the discharge of waste onto or into land, the Otago Regional Council is to have regard to "the location of the landfill relative to any water body, areas prone to erosion, inundation or subsidence, " (Chapter 7.6.1.2).

There are a number of other documents which QLDC may need to have regard to including the:

- Otago Conservation Management Strategy;
- Kai Tahu ki Otago – Natural Resource Management Plan;
- Water Conservation (Kawerau) Order 1997.

2.1.4 Resource Consents

A territorial authority, when acting as a consent authority, can use the resource consent process to manage land uses so that natural hazards can be avoided or mitigated. This may be done in the following ways:

(1) Requiring Information to be included in a resource consent application – an application for resource consent must include any information required by a plan or regulations (s. 88(4)). A district plan could require a technical report on a particular natural hazard to be included in an application for a resource consent.

(2) Assessment of Effects on the Environment ("AEE") – matters that should be considered when preparing an AEE include any risk to the neighbourhood, the wider community or the environment through natural hazards (Fourth Schedule Clause 2(f)).

(3) Considering resource consent applications – a consent authority must consider the information included in a resource consent application. Further information may be sought from an applicant to enable a consent authority to better understand the nature

of the activity, the effect it will have on the environment or ways in which any adverse effects may be mitigated (s. 92).

(4) Imposing Conditions – a consent authority may grant a consent on any condition that it considers appropriate including any condition specified in section 108(2). Accordingly it has wide powers to impose conditions that will control the effects of land use activities, although these powers are limited by common law principles. The common law principles are, that the conditions must:

- Be for a resource management purpose; and
- Fairly and reasonably relate to the activity authorised by the consent; and
- Not be so unreasonable that a reasonable planning authority could not have approved it (Newbury DC v Secretary of State for the Environment [1980] 2 WLR 379).

2.1.5 Subdivision consents

The granting of a subdivision application is specifically restricted where:

- land is, or is likely to be subject to material damage by specified natural hazards, or
- subsequent use of the land is likely to accelerate, worsen or result in material damage to the land, other land or a structure (s. 106(1)).

The natural hazards identified are – erosion, falling debris, subsidence, slippage, or inundation from any source. The wording of section 106 means that a territorial authority is not constrained by the section if a natural hazard exists that is not specifically listed.

A subdivision consent must be refused unless the consent authority is satisfied that steps can be taken to ensure the land is suitable by avoiding, remedying or mitigating the effects of the natural hazards (s. 106). The Court has held that it is up to an applicant for resource consent to propose measures to satisfy a consent authority rather than for the consent authority to propose methods (Foreworld Developments Limited v Napier City Council (W89/98)). It is not expected that building work be designed for extreme rare major events which could cause extensive inundation or erosion (Kotuku Parks Ltd v Kapiti District Council (A73/2000)). In that case it was acceptable to use standard engineering practice to determine a minimum building platform level.

The effects of the natural hazards are to be avoided, remedied or mitigated by rules in a district plan, conditions of a resource consent or other matters that may include physical works. In some cases conditions on subdivision consents require extensive planting in areas subject to erosion and subsidence, and controls on stormwater and sewage discharge. The Court has held that the test in section 106 is not what is the best means of protecting the land and structures but an "assessment of the proposed measures to determine if these may be sufficient to avoid, remedy or mitigate any potential effects of erosion and/or inundation of the land in question "(Foreworld case p. 21).

The RMA does not provide any guidance on the degree of mitigation required. However a consent authority would be prudent to ensure proposed measures are sufficient to 'avoid' a potential effect as the standard in most cases. 'Remedy' or 'mitigate' may be appropriate where there is a low probability of the natural hazard occurring and any adverse effects will be minor.

2.2 Building Act 1991

Under section 36 of the Building Act there are restrictions on granting building consents for work on land subject to, or likely to be subject to a number of specific hazards, or where building work is likely to "accelerate, worsen, or result in" those specific hazards on the land or any other property. The hazards specified in section 36 are:

- Erosion,
- Avulsion,
- Alluvion,
- Falling debris,
- Subsidence,
- Inundation, or
- Slippage.

Not all natural hazards are listed, notably windstorms and earthquakes are missing.

A consent may only be issued if the territorial authority is satisfied that adequate provision will be made to protect, or restore any damage, to the land, the building work or other property (s. 36(1)).

Section 36 Entry on Certificate of Title

Where building work will not exacerbate or result in the specified hazards, but land is subject to, or is likely to be subject to the hazards and the requirements of section 34 are met (which deals with processing building consents), a building consent may be granted, and an entry must be put on the certificate of title for the land (s. 36(2)).

Therefore, a building consent cannot be granted where building work is likely to accelerate or worsen the condition of the land unless protection or restoration work can be done. Where building work will not accelerate or worsen the condition of the land, and the requirements of section 34 are met, a building consent may be granted but an entry put on the certificate of title. There is no requirement to identify the particular hazard or hazards concerned in the entry. The entry need only state that "a building consent has been issued in respect of a building on land that is described in section 36(1)(a) of the Building Act: (s. 36(2)(c)).

The territorial authority must "forthwith upon the issue of that consent" notify the District Land Registrar, who must make an entry on the certificate of title. The entry on the

certificate of title will provide the territorial authority with immunity from any civil liability in relation to the building works (s. 36(4)).

There is no requirement to identify the particular hazard in the entry on the certificate of title. The entry only has to state that "a building consent has been issued in respect of a building on land that is described in section 36(1)(a) of the Building Act" (s. 36(2)(c)).

Building work is defined in the Building Act to include work for or in connection with, the construction, alteration, demolition or removal of a building and includes sitework (s. 2).

Provisions to Protect At-Risk Land

When a building consent for hazard prone land is issued, the territorial authority will need to take great care and be satisfied on reasonable grounds that adequate provision can be made to protect the land or restore any damage to the land or property. Exactly what is meant by "adequate provision" is not defined or clarified in either the Building Act or the Building Code. However the Court of Appeal has indicated that adequate provision for protection does not mean eliminating "any possibility in all conceivable circumstances" of flooding or other relevant hazards (Logan v Auckland C.C. CA 243/99). The territorial authority will need to take a common sense approach and make a sensible assessment involving considerations of fact and degree. The level and frequency of the risk will need to be balanced against the expense of provisions required to protect the land.

The entry on the certificate of title serves as a warning to potential purchasers of risks associated with the land and will exempt the territorial authority from legal liability provided all the statutory requirements are met. In essence it becomes a blot on the title and may have significant insurance implications (Logan case). The Earthquake Commission may decline, or meet only part of a claim involving a property on land with an entry under section 36(2) on the certificate of title (Schedule 3 Earthquake Commission Act 1993).

PIMs

An owner contemplating building work that requires a building consent can apply to a territorial authority for a Project Information Memoranda ("PIM"). A PIM is to include information on special features of the land including potential erosion, avulsion, falling debris, subsidence, slippage, alluvion or inundation that:

- Is likely to be relevant to the design and construction or alteration of the building or proposed building; and
- Is known to the territorial authority; but
- Is not apparent from the district plan (s. 31).

One of the main problems for a territorial authority will be to ascertain what information is "known" to them and not apparent from the district plan. This issue is discussed below.

2.3 Local Government and Official Information and Meetings Act 1987

The principle of "availability" of information underpins this Act. Official information must be made available unless there is good reason for withholding it.

LIMs

A land information memorandum ("LIM") may be applied for from a territorial authority in relation to matters affecting land in a district. Information identifying special features or characteristics of land, including natural hazards such as inundation, is to be included in the memorandum. As with PIMs, the feature or characteristic is to be known to the territorial authority and not apparent from a district plan (s. 44A).

Information will be "known" if it is actually recorded somewhere in a territorial authority's records. Therefore a territorial authority will need to ascertain whether there are any special features or characteristics within its knowledge. Due care will need to be taken when providing this information.

It is likely that "known" information will extend to include information which ought to be known by a diligent territorial authority. This could involve a territorial authority undertaking research and investigations into particular aspects of land in their district, although not necessarily as a direct result of a request for a LIM or PIM.

2.4 Local Government Act 1974

This Act establishes the organisations and functions of local government. Territorial authorities have the function of providing for the efficient drainage of their districts (ss. 442,445 and 446). They may also construct protection works to prevent damage to any property within a district from floods (s.469).

Regional councils are given the duties and powers of catchment boards under the Soil Conservation and Rivers Control Act 1941, and specific functions, duties and powers in relation to water within regions (s. 37S). They may also have land drainage functions (s. 37SA).

The interrelationship between regional councils and territorial authorities in this respect was discussed in a recent High Court case. The Court stated that "as a matter of general operational practice" a regional council (as a catchment board) is primarily concerned with rivers, and that issues associated with drainage, including the disposal of surface water are dealt with by a territorial authority (West Coast Regional Council v Stepkowski AP 33/01, p. 8). However the statutory distinction between dealing with surface/stormwater, by one authority and river water, by another, is not that clear.

2.5 Soil Conservation and Rivers Control Act 1941

This Act sets out the operational responsibilities of a catchment board including catchment control functions and river control works. In particular, catchment boards have the

function of minimising and preventing damage by floods and erosion within its district (s. 126). Regional councils will generally have the functions, duties and powers of catchment boards.

A catchment board will need to consider what flood control measures it should take when exercising these discretionary functions and powers. Factors which should be considered include the degree of risk, the costs to be incurred for the benefits gained, the funds available and other demands. The provisions of the RMA will apply to any physical work carried out.

2.6 Land Drainage Act 1908

Under this legislation a Board of Trustees constituted for a district may undertake a number of activities in relation to drains and watercourses within their districts, including:

- cleansing, repairing or otherwise maintaining in a "due state of efficiency" an existing watercourse, or existing bank or defence against water;
- deepening, widening, straightening, diverting or otherwise improving existing watercourse or outfall for water;
- making new watercourses or outfalls for water; and
- constructing drains (s. 17).

These powers are subject to the RMA (s. 2A). A watercourse is defined to include all rivers, streams and channels through which water flows. Watercourses and drains, vested in a Board, are not to become nuisances or injurious to health, and are to be properly cleared and cleansed and maintained in proper order (s. 25).

Activities undertaken by a Board in reliance on this Act may influence how mitigation measures chosen by QLDC are implemented.

2.7 Civil Defence Act 1983

A territorial authority is required under the Civil Defence Act to plan for the adverse effects of all hazards. There are two forms of emergency defined in the Act: civil defence emergency and national emergency. The duties on a territorial authority are principally aimed at civil defence emergencies. A regional council prepares a regional civil defence plan which should be consistent with the National Plan. A territorial authority then prepares a local civil defence plan which is to be consistent with the regional plan.

During emergencies a territorial authority has extensive powers to take appropriate action to implement civil defence measures and to carry out works, rescue persons, and provide relief and aid services.

2.8 Civil Defence Emergency Bill

This Bill will repeal and replace the Civil Defence Act 1983. It redefines central and local government roles in relation to civil defence emergency management.

Regional councils are to unite with the territorial authorities within its region to establish a civil defence emergency management groups. This group must identify, assess and manage hazards and risks, consult and communicate about the risks and identify and implement cost-effective risk reduction. A "hazard" is defined as something that may cause or contribute substantially to the cause of an emergency. An "emergency" includes situations resulting from natural or otherwise events.

The civil defence emergency management group must prepare a plan that includes the hazards and risks to be managed by the group, and state what is necessary to manage the hazards and risks. Before making a plan the group must publicly notify its proposal and written submissions may be made on the plan.

The new legislation promotes the four Rs – from initial risk reduction through to readiness, response and recovery.

2.9 Public Works Act 1981

A territorial authority may acquire land for a local work (s. 16). This could involve acquiring land to use to meet the requirements of the RMA in terms of natural hazards.

2.10 Lake Wanaka Preservation Act 1973

The Lake Wanaka Preservation Act 1973 prohibits damming of Lake Wanaka and the Upper Clutha River. This Act preserves the normal water levels and shoreline of Lake Wanaka, and provides for the maintenance and improvement of its water quality.

2.11 Common Law – Potential Civil Liability

Common law principles are relevant to QLDC's responsibilities in relation to natural hazard. This mostly relates to the responsibility of a local authority not to be negligent when undertaking its functions, duties or powers, and not to cause a nuisance to others. The relevant aspects of common law are explained below.

2.11.1 Negligence

Negligence involves falling below the reasonable standard of care that can be expected in the circumstances. Before a claim in negligence is successful it will need to be established that:

1. The defendant owed a legal duty of care to the person who suffered the damage; and
2. The defendant breached the duty of care by being careless; and
3. The breach caused the damage; and

4. The damage was not too remote from the consequences of the breach of duty.

A local authority will owe a duty of care to a third party where it holds or provides the information about a particular natural hazard, and a third party relies on the information or advice to their detriment (Brown v Heathcote City Council [1986] 1 NZLR 76). In such circumstances the local authority should draw attention to any natural hazard risk or put the third party on notice of such a risk.

A local authority will owe a duty of care where a council officer supplying the information to the third party:

- is a professionally qualified person holding a professional position;
- has special skill and knowledge beyond that of the person requesting the information; and
- knows that the information will be relied upon (Court v Dunedin City Council CP51/97).

The standard of care expected of a professional person may increase with the availability of knowledge and also current practice standards. The standard required will be that expected of a properly informed and qualified adviser, who is a technically competent and professional officer carrying out a particular function. Guidelines created by a professional body may be evidence of standards expected of professionals within that body. However merely complying with such standards may not necessarily mean that a person has acted in a correct legal manner.

Whether a local authority is approached formally or informally, as a public body it has an obligation to act with due care. A territorial authority will owe a duty of care when supplying information or comments to a regional council or another statutory body (McTavish v Morgan A145/97).

Negligent Acts and Omissions

A local authority could be held liable for a negligent act or omission, or a positive act carried out negligently. This could involve:

- negligent advice or omission such as providing inaccurate information and failing to advise on a hazard
- the negligent administration of plan rules when issuing a resource consent
- negligent during the processing of resource or building consents
- the negligent issue of a PIM or LIM, or building consent which contains inaccurate information or which fails to identify a natural hazard.

When considering the liability of territorial authorities for decision–making processes, the Courts have generally drawn a distinction between the quasi-judicial and policy function and the administrative and operational functions of an authority.

As a general principle an operational or administrative function is more likely to carry civil liability for negligence rather than a quasi-judicial function such as considering a resource consent. For example, a territorial authority's decision in changing the land use zoning of an area was considered immune from challenge for negligence (Smaill v Buller District Council [1998] NZRMA 13,29). On the other hand approving a subdivisional scheme plan was regarded as a purely administrative function and could be challenged for negligence. However the distinction between a purely operational and a purely policy function is not clear.

Processing resource consents

Although a territorial authority has a broad discretion to consider what it thinks is necessary when processing resource consents, it may be negligent if it fails to consider such things as information on natural hazards contained in a hazard register. Under both the RMA and the Building Act, a territorial authority must be satisfied on reasonable grounds that certain circumstances exist. Failing to make the necessary inquiries and to use all the available information on the risks of a proposal may result in a territorial authority being held to be negligent.

In the Smaill case, the Buller District Council had received a sufficient assessment of risks associated with an area because of unstable adjacent bluffs. The Court held that the grant of a building permit for work in the area carried with it the implication that the area was safe and that it was an appropriate "incremental step to extend liability to the negligent grant of a building permit where risk to life and property from the failure of an external but nearby landform is established" (p. 37).

2.11.2 Creating a Nuisance

A local authority is not entitled to create a nuisance when undertaking public works or carrying out other duties (s. 247H Local Government Act 1974). This applies to a public nuisance, for example where a public right may be infringed such as the right to travel along a road, or a private nuisance, that relates to interfering with private rights.

Liability for creating a nuisance may arise if the nuisance complained of was a "necessary or inevitable consequence of the construction or maintenance of the authorised work" (Nobilo v Waitemata County [1961] NZLR 1064). Liability may also apply if a territorial authority:

- "Continues" a nuisance, for example ignoring a hazard after it has been noticed and failing to abate it within a reasonable time; or
- "Adopts" the nuisance by making use of it in a positive manner (Taupo Borough Council v Birnie [1978] 2 NZLR 397).

Another action may be bought which is similar to a nuisance action. The legal principle derived from the early case of Rylands v Fletcher (1868) L.R. 3 H.L. 330 is relevant in relation to work which a local authority may undertake:

> *"We think that the true rule of law is that the person who is for his own purposes brings on his land and collects and keeps there anything likely to do mischief, must keep it in at his peril, and if he does not do so, is prima facie answerable for all the damage which is the natural consequence of its escape."*

This principle will apply where a local authority has constructed some drainage works or undertaken work in a watercourse, and the amount of water collected is likely "to do mischief" if it escapes. The local authority will be liable if the water escapes and causes damage. There is no need to establish fault on the part of the local authority that did the work – liability exists because the work may be a potentially dangerous thing.

However there are a number of limited exceptions to the Rylands v Fletcher principle where liability will not exist. These include situations where the damage is caused by an "Act of God" or damage is caused by the wrongful act of a third party.

3 Appendix C : Flood and Erosion

3.1 Introduction

The following report presents the flood information as collated for inclusion into the Queenstown-Lakes District Council Hazard Register. The update of this register was undertaken by Opus. This report was not issued to the client, but was produced solely for use by Opus for ease of future reference.

3.2 Review of Flood Information

Since 1994 several large floods have been recorded in the QLDC region, which have heightened public concern, and generated several technical reports. The flood management report by the Otago Regional Council prior to the 1994 event (Otago Regional Council, 1993), reviewed relevant reports, identified flood issues, return probabilities and presented flood hazard zone maps for various locations in the region from the then available information. Technical and anecdotal information is presented on past floods for the lakes and rivers in the region.

The flood report for the December 1995 (Works Consultancy Services, 1996) and the November 1999 Flood (Opus International Consultants, 2000a) events provide a very comprehensive review of the rainfall, flood flows and levels around the catchment associated with those specific flood events. Particular attention is paid to the flood event at Lake Dunstan, Alexandra, and Roxburgh. Frequency analysis is not performed on the level of Lakes Wakatipu or Wanaka, but is provided for the lake inflow, outflow and other flows around the catchment.

The flood events of 1994 and 1995 prompted the Otago Regional Council to review the flood hazard at Queenstown and Wanaka (Otago Regional Council, 1997). The 2% (50 year return period) and 1% (100 year return period) flood level was determined as 311.78 m and 312.00 m respectively for Queenstown, and 280.36 m and 280.65 m respectively for Wanaka. Flood hazard maps were presented for the 1% (100 year) flood level for the two townships.

A Hazard Register was prepared for the Queenstown Lakes District Council in 1998 (Woodward-Clyde, 1998). This document collates and information from many sources, and provides a summary of potential hazards in the District, and presents flood hazard lines for a number of locations. These Hazard Register flood maps have been updated and included in this current review.

Following the November 1999 flood, the Otago Regional Council updated the flood frequency analyses for Lakes Wakatipu and Wanaka, and for the Clutha River at Alexandra, and at Balclutha (Otago Regional Council, 2000a). Included in the analyses were the available daily or 'instantaneous' recorded annual peak flood levels including the 1999 event, and the historic flood information for the events in 1878 and 1919 (note that the levels presented for the 1919 and 1924 events differ to the values presented by Works Consultancy Services (1996) and Opus International Consultants (2000a). Estimates were

considered conservative, with a range of levels or flows provided which reflected the frequency distribution method used to determine the flood frequency. This information is presented below for Lakes Wakatipu and Wanaka.

The Crown with support from local District and Regional Councils commissioned a project to investigate practicable solutions for the Clutha River flooding system following the damage caused by the November 1999 flood. The report from this investigation (Clutha Solutions Co-ordinator, 2000) identified the issues associated with the 1999 flooding, and provided a range of recommendations. The flood level and frequency information presented for Lakes Wakatipu and Wanaka in this report is sourced from the Otago Regional Council (2000a) report.

The *Flood History in the Clutha Catchment* by Opus International Consultants (2000b) presents a very comprehensive review of flooding in the catchment, covering the major flood events since 1800's to 1999. Flood frequency analysis is not covered in this report.

3.3 Identify Potential Impact from Flooding

3.3.1 Return Period of Flood Events

The Otago Regional Council (ORC, 2000a) updated the flood frequency analyses for several locations following the November 1999 flood event in the Clutha Catchment. The 50-year (2% probability) and 100-year (1% probability) return period flood estimate, along with a range of values for each estimate obtained from using various flood frequency curves are presented in Table 1. The estimates are based on the annual recorded maximum lake level at each location and include the flood events of 1878 and 1919. These estimates are conservative, representing the higher end of the range of estimates. However using this return period analysis, the magnitude of the November 1999 flood at Lake Wakatipu has a return period of over 150 years, and at Lake Wanaka of around 70 years. The return period of the 1878 flood on the other hand was estimated at around 100 years at Wakatipu and over 100 years at Lake Wanaka. The peak level and rank of the 1878 and 1999 events are given in Table 2 for Lake Wakatipu, and Table 3 for Lake Wanaka.

Table 1. Flood return period estimates for Lakes Wakatipu and Wanaka level (Source: Otago Regional Council (2000a)).

Site	50-year	100-year
Lake Wakatipu level	312.4 m (range 312.1-312.4)	312.6 m (range 312.4 –312.6)
Lake Wanaka Level	281.1 m (range 280.7-281.1)	281.7 m (range 281.1-281.7)

3.3.2 Depth / Level and Duration of Flooding

Flooding of the Queenstown township by Lake Wakatipu was assumed to begin at R.L. 311.25 m and at Lake Wanaka at R.L. 280.20 m as taken from Clutha Solutions Co-ordinator (2000) report dated June 2000.

Table 2 identifies flood events which have exceeded 311.25 m at Lake Wakatipu, and the duration the lake stayed above certain levels during each flood. The peak level, and the rank of the event are also presented. The information for this table is sourced from the daily lake level information available from 1924 to 1962, with more regular recorded data available since then. Only the peak level of the 1878 and 1919 events are available.

Figure 1 graphs the Lake Wakatipu peak levels for flood events greater than 311.25 m since 1919, but including 1878, with the flood event duration analysis as given in Table 2 graphed in Figure 2. To note in Figure 1 is that in the last 20 years, six flood events exceeding 311.25 m have been recorded. In the 50 years prior to 1981 only five other such events have been observed.

To explain the duration analysis as given in Figure 2, we can observe that the December 1995 flood event spends just over a day above the level of 311.60 m, nearly 7 days above 311.50 m, and a total of nearly 21 days above the level of 311.25 m (the level at which flooding is noted to occur). Also observed is that the 1999 event spends more time in the higher flood range than the other flood events presented.

Table 2. Lake Wakatipu flood events over 311.25 m, including the peak level and rank of that event, and flood duration above certain lake levels.

Date	Days above given Levels					Peak Level (masl)	Rank of peak level
	311.25 m	311.50 m	311.60 m	312.00 m	312.60 m		
Sep 1878	?	?	?	?	?	312.63	2
Jan 1919	?	?				311.52	8
Jan 1924	?	?	?			311.82	3
Oct 1946	2.5					311.35	12
Nov 1948	3.2					311.33	11
Nov 1957	8.4	2.6				311.59	7
Feb 1958	5.1 3.9					311.42	9
Mar 1968	2.2					311.26	13=
Jan 1983	11.5	6	4.1			311.70	4
Dec 1984	0.4					311.26	13=
Oct 1988	9.0					311.38	10
Jan 1994	8 8.7	1.4 5.3	- 2.9			311.68	5
Dec 1995	20.7	6.9	1.2			311.62	6
Nov 1999	15.8	13.1	12	8.4	3.4	312.78	1

Similar information is presented in Table 3 for flood events at Lake Wanaka which have exceeded 280.20 m. The duration the lake stayed above certain levels during each flood, the peak level and rank of the event is also presented. This information is sourced from the daily lake level information available from 1929 to 1933, with more regular recorded data available since then. Only the peak level of the 1878 was available for inclusion into this report. Figure 3 graphs the Lake Wanaka peak levels for flood events greater than 280.20m since 1919, but including the 1878 flood, with the duration analysis as given in Table 3 graphed in Figure 4.

To note is that three of the four flood events over 280.20 m since 1878 have been recorded since 1984 (Figure 3). As for Lake Wakatipu, the 1999 event at Wanaka records more time at higher levels than the other floods.

Table 3. Lake Wanaka flood events over 280.20 m, including the peak level and rank of that event, and flood duration above certain lake levels.

Date	Days above given Level			Peak Level (masl)	Rank of peak level
	280.2 m	**280.30 m**	**281.00 m**		
Sep 1878	?	?	?	281.83	1
Dec 1984	4.3	2.0		280.35	3
Dec 1995	3.0	0.8		280.32	4
Nov 1999	6.9	5.5	2.3	281.32	2

Photos of the 1878 and November 1999 flood event as sourced from the Opus (2000) report are appended.

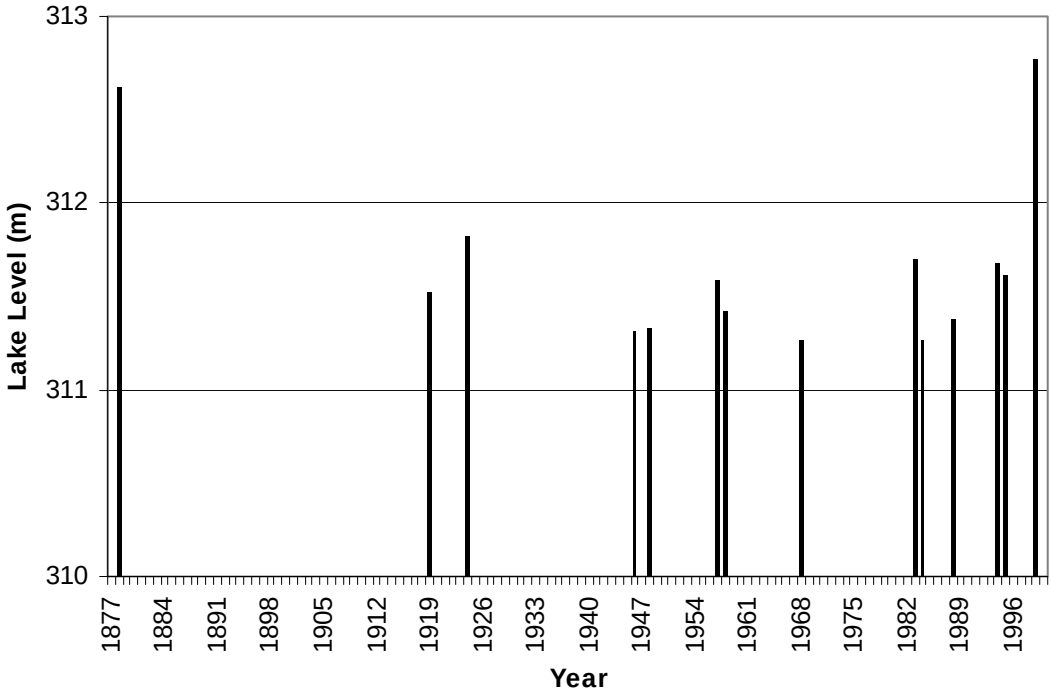

Figure 1. Lake Wakatipu peak levels over 311.25 m since 1878.

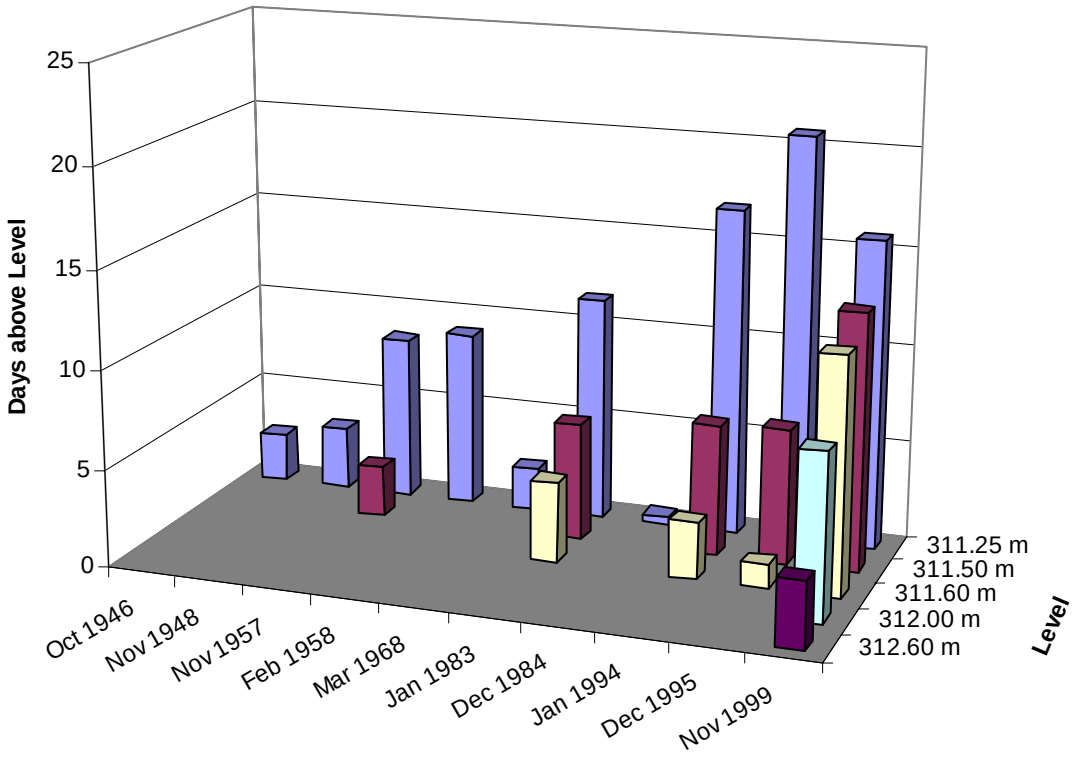

Figure 2. Lake Wakatipu flood durations above certain levels. The durations for the twin peak flood events of 1958 and 1994 have been combined.

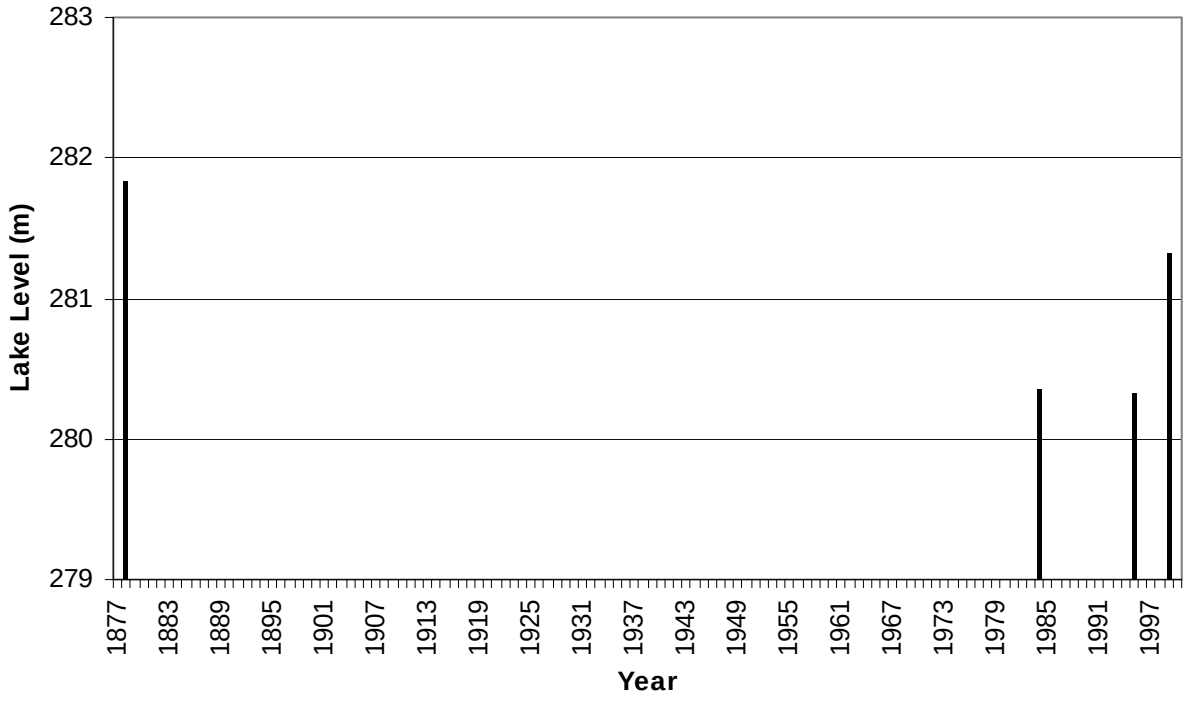

Figure 3. Lake Wanaka peak levels for flood events over 280.20 m, since 1878.

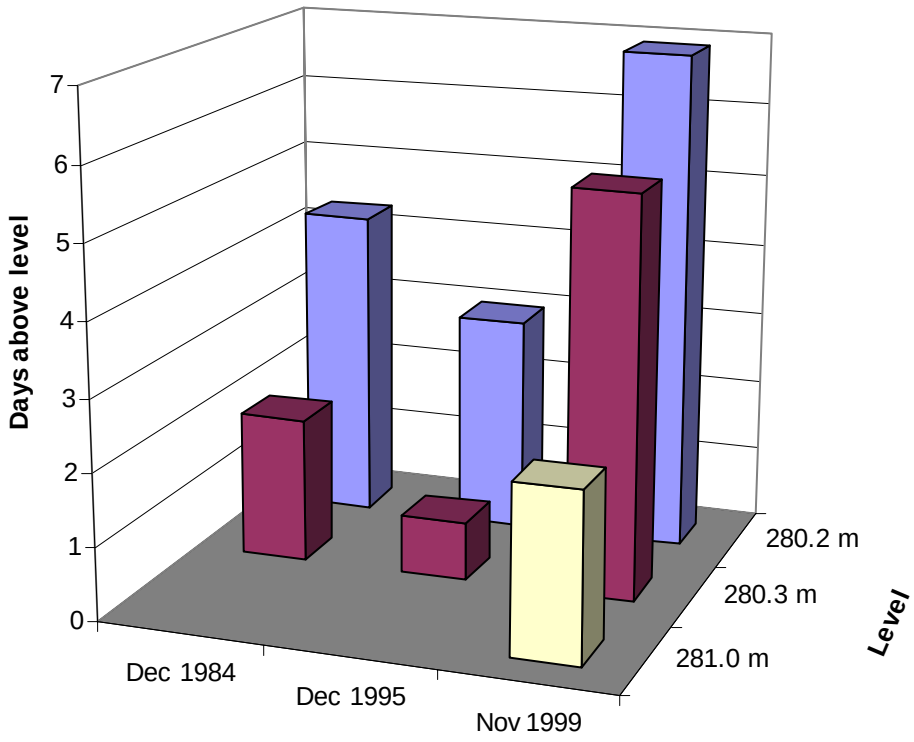

Figure 4. Lake Wanaka flood durations above certain levels.

3.4 Erosion

The very nature of high rainfall and flow events increases the potential for erosion and deposition from the lakes and rivers within the Queenstown Lakes District. Intense rainfall will cause localised slipping and slumping as noted during the 1999 event (Opus, 2000), and fresh and flood events will at times cause incising and bank erosion. Stream and river carried material have the potential of causing flow obstruction, and localised flooding. In the period of Government subsidies up until the early 1980's considerable time and money was devoted for flood protection in the region. The Flood Management report (ORC, 1993) gives some account on the history of flood and erosion damage in the Lakes region. Some examples of erosion and flood protection are given below.

The Horne Creek flood protection scheme has been upgraded so as to pass the 1% flood event through Queenstown and into lake Wakatipu. Improved bridges and culverts were constructed at many locations in the region. Flood banks and more recently catchment management strategies (such as for the Makarora catchment) have been used to limit the damage caused by floods.

Flooding of and damage to pastoral land has in the past been observed in the Lower Rees, Dart and Makarora catchments. Temporary flooding of road links and damage to bridges have been observed in these and the Matukituki catchments in the past.

The Cardrona valley was affected by the November 1999 flood with bank erosion and extensive localised flooding and deposition of sediment from the Cardrona River.

There is a potential for shoreline erosion in Lakes Wakatipu, Wanaka, and Hawea during periods of high lake levels due to the wave action. In Lake Wakatipu, strong southerly or south-westerly winds combined with high lake levels have the potential to cause lakeshore erosion. These conditions can also exacerbate flooding with wave surge in Queenstown bay.

Hawea - At Lake Hawea, high lake levels and strong nor-westerly winds can lead to lakeshore erosion adjacent to Hawea Township at the southern end of Lake Hawea (refer Hazard maps).

The maximum controlled Lake Hawea outflows are limited (to around 200 – 220 m^3/s) as the outflow channel is susceptible to erosion during high flows. Likewise the area in the vicinity of the Hawea River confluence with the Clutha River is prone to erosion.

Arrowtown - River bank erosion has the potential to affect the northern margins of Arrowtown, along the Arrow River. This is an area historically affected by episodes of erosion and large scale sediment deposition during the gold mining period. The erosion hazard area has been identified on the Hazard Maps.

3.5 Dam Break Flood

There is an area in the Hawea Flats where flood flows from the Gladstone Gap Emergency Spillway would discharge during an extreme flood event. This flood discharge spillway zone should be kept clear (or free) of buildings and has been identified on the Hazards maps.

A dam break flood discharge would also affect the area around Albert Town at the confluence of the Clutha and Hawea Rivers. The areas affected by a dam break flood are identified on the Hazard Maps and are reported in detail by Opus in their report titled Albert Town Flood Hazard Study (Opus,2001), which also referenced the earlier dam break study by Works (1990).

3.6 References

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Otago Regional Council (2000a). Clutha River Catchment Updated Flood Frequency Analyses Following the November 1999 Flood Event.

Woodward-Clyde (1998). Preparation of a District Hazard Register. Project Report and Updating Manual.

Works Consultancy Services(1990). Hawea Lake Control Dam: Report on Dam Break Analysis.

Works Consultancy Services (1996). Clutha Flood Report for Flood of 14 December 1995.

Photograph 1: 1878 view along Rees Street, Queenstown with water up to the base of windowsills at Eichardt's Hotel. Photo: Otago Daily Times

Photograph 2: 17 November 1999, the same scene during the 1999 flood, well before the flood peak. 1999 flood peak level was up to the window sills (see also Photograph 8). Photo: Otago Daily Times.

Photograph 3: Flooding at Wanaka, Helwick Street, November 1999. Photo: Otago Daily Times.

Photograph 4: Lake Wanaka spills across Ardmore Street and into the shopping area, November 1999. Photo: Otago Daily Times.

4 Appendix D : Review of Landfills, Contaminated Sites and Mine Workings

4.1 Introduction

Queenstown Lakes District Council commissioned Opus International Consultants to review the hazards in priority areas and carry out a study of risk management options as part of Part II, Stage 2 of the Hazards Register.

This study has included consideration of mine workings, contaminated sites and landfills, comprising :

- Reviewing information in the Hazards Register, in areas of priority;
- Identifying potential impact to development;

The Council has identified areas of priority for the hazard study, which comprised :

- Priority 1 areas, which have a higher priority
- Priority 2 areas with a lower priority for the consideration of hazards.

These priority areas include both areas of both existing and proposed development.

4.2 Research

4.2.1 Maps

The hazards in the existing hazards register and the areas of priority were superimposed, and 1:20,000 scale maps were printed and used in our assessment. These sheets covered Hawea; Wanaka; North Glenorchy; Glenorchy Area; Cardrona; East of Queenstown; District Plan Drawing numbers 26, 27, 28, 29, 30, 31, 33; South East Queenstown Area; District Plan Drawing numbers 32, 34, 35, 36, 37, 38; South West Queenstown (Walter Peak and Cecil Peak Stations); Kingston; and Queenstown Environs at 1:10000.

Larger 1:10,000 scale maps were used for the Queenstown-Frankton area showing DP Drawing 33 and DP Drawing numbers 32, 34, 36 and 37.

4.2.2 Otago Regional Council (ORC) Records

We received a set of records relating to landfill consents held by the QLDC. These consents were granted by the ORC and show the maximum amounts of waste permitted for each landfill site. They also detail the monitoring programmes that are requirements of the consents.

We contacted the ORC in Dunedin, through Jenny Lowe. We were given a copy of their list of potentially contaminated sites, which is included as Table 4. This list is not exhaustive, but it does cover many more sites than the information we received from QLDC.

We were given access to a report on the Environmental Sensitivity Rankings of landfills, prepared by Solutions in Environmental Management for the council last year. It contains information about all of the landfills in Otago. These have been ranked into priority order by factors such as groundwater proximity and usage, surface water proximity, usage and quality, geology, surrounding land use and topography. The report contains a lot of information on the zone 1 landfills (Fernhill, Wanaka and Luggate) but limited information on the zone 2 and unzoned sites.

4.2.3 Contaminated Site List

QLDC sent us a list of Potentially Contaminated sites that were excluded from those provided to Mountain Scene. This list provided the names of contaminated sites, why they were contaminated and information of varied quality on the location and current use of these sites.

4.2.4 Mining Claim Information

We received records detailing the mining claims in the area. These included prospecting and mining licences dating back for 20 years. Many of these related to sites outside the priority areas. This information included the rehabilitation conditions of the licences.

We are unsure of the amount of mining work that took place as a result of these licences.

4.2.5 Library Research

We visited the Dunedin, University of Otago and Queenstown libraries and Arrowtown museum to research the mining areas.

The sites identified were the larger mining sites, outside the priority areas. The Arrowtown museum archives room holds detailed information about the large, successful mines, but the information about mining within the priority areas was very limited.

4.2.6 Imtech Ltd

We held a meeting with Imtech Ltd and spoke with Glenn Parker and Curt Martin. In this meeting we discussed the project and all the information held by Imtech Ltd.

The information they hold includes details of the landfills and some limited information about mining in the area. They have no details about any of the contaminated sites.

4.3 Landfills

4.3.1 Landfill Hazards

This list of hazards is applicable to all of the closed landfills in the QLDC area.

Any or all of these landfills could have asbestos in them. The location and amounts of asbestos dumped are unknown, but it remains a possibility.

It is necessary to continue monitoring groundwater, surface runoff into watercourses and gas/odour emissions. These are conditions of the resource consents. The ORC receives these figures and can determine when the site is no longer hazardous due to either no landfill gas (LFG) and leachate or inert LFG and leachate. The Centre for Advanced Engineering (CAE) suggests this monitoring period should be at least 30-50 years.

Leachate generation volumes drop significantly at the time of capping and shortly after, become very low. Around 5 yrs after closure the leachate production is minimal. The QLDC sites were capped a few years ago, so the 5 year time will expire soon and leachate production will drop significantly.

Leachate changes composition over time. Organics are produced early on by break down of less stable materials (food, plant waste, paper, wood) while heavy metals increase in concentration over time. This makes it even more important to continue stringent monitoring to ensure the area is not polluted by heavy metals.

Landfill gas has 4 main hazards associated with it: greenhouse gas production, regional odours, local vegetation death and local flammable gas hazard. Methane (greenhouse gas) is oxidised in biologically active soil, which also filters odours. However this oxidation removes oxygen from the soil root zone, which kills plants and makes it hard to revegetate. Flammable gases are the most hazardous effect of LFG.

CAE suggests that probes be installed around the site boundary to measure LFG if development is within 250m of the landfill.

The landfill caps need to be mounded to prevent fissuring resulting from settlement. CAE states that between 5 and 30% settlement can be expected due to differential compaction rates within waste. They should also be vegetated to remove some of the LFG hazard. The cap should be monitored for fissures or cracks resulting from settlement of the waste.

If the sites are close to water resources they must be very closely monitored to ensure that there is no contamination of bores or aquifers.

Major geological structures need to be located. All of the QLDC landfills are away from fault zones, but close enough to major faults to be adversely affected in a major seismic event.

Tucker Beach has consent applicable to a closed landfill; stating that inspections must be carried out every 3 months to check for odours and gas bubbling in puddles or fissures in

the landfill cover. The consent holder must then remedy or mitigate the nuisance or hazard. We assume that all the closed sites are covered by a similar clause.

4.3.2 Geology

These landfills are all sited on fluvioglacial gravels within river valleys (Qmap 1:250,000 sheet 18, Wakatipu). These were deposited during or after the last glaciation and have been extensively reworked by rivers since then. The local geological setting is one where schist ranges are separated by valleys filled with these fluvioglacial deposits. The sites include outwash plains (such as Luggate), river terraces (Tucker Beach) and terminal moraines (Kingston). The gravels are highly permeable and have porosities in the region of 30%. High porosity gives a high potential for contaminant migration both on and off site. There are no large natural impermeable barriers to block contaminant migration downstream from any of the landfills. The landfills on outwash plains and moraines have drainage that is affected by till horizons, but these are discontinuous.

4.3.3 Sites List

Albert Town Landfill

Development Zone: Not within a priority zone.

Description/Details: This site is 1.5km north of Albert Town on a terrace 300m from the Hawea River. The surrounding land is used for agriculture. It has been partially capped since closure.

Dates Operational: We do not know when the landfill opened, but it was closed in 1995.

Materials deposited/filled/discharged/extracted

This site had municipal and domestic waste deposited. We are unsure how much was deposited.

Existing hazard details

The surrounding land is at minimal risk from the landfill. The site is in permeable gravels, so there is a chance of contamination spreading from leachate. This landfill could contain asbestos. A major earthquake could cause rapid settlement and result in cracks in the cap. This could expose the waste and create a health hazard. This would require rapid reinstatement or repair of the cover. Settlement could also occur with slow compaction that is not triggered by any specific event.

Potential Impact on existing development

The contaminated land potentially impacts on existing development because the surrounding land is used for farming. This uses the soil and therefore could allow the contaminants to spread.

Potential Impact on new development

The potentially contaminated land is unlikely to affect future development because the land is not zoned for development.

Arrowtown Landfill

Development Zone: Not within a priority zone.

Description/Details: This is located in Bush Creek, northwest of the town. The site is relatively small, with only around 4320m^3 of waste. It has been capped with 900mm of soil. The town supply bore is immediately downstream of this site, but has been regularly tested and has not shown any contamination.

Dates Operational: Unknown, but it has been closed for over 15 years.

Materials deposited/filled/discharged/extracted

This site had 4320m^3 of municipal and domestic waste deposited.

Existing hazard details

While the landfill is outside the development zones, the major hazard from this site is contamination of the town supply water bore, which is downstream of the landfill. The landfill has been capped and filled for a number of years, and the bore has been used for a long time. The bore has been regularly tested for contaminants, but no evidence has been found. This landfill could contain asbestos.

Potential Impact on existing development

The contamination of the bore is a potential risk to Arrowtown. Contaminated land has no effect on existing development because the land is not used.

Potential Impact on new development

Future contamination of the bore is a potential risk to Arrowtown. However, the bore and landfill have been adjacent to each other for a long time with no adverse effects. The flow of groundwater is rapid enough that the contaminant plume would have reached the bore site by now. Contaminated land has no effect on future development because the land is not zoned for development. A major earthquake could cause rapid settlement and result in cracks in the cap. This could expose the waste and create a health hazard. This would require rapid reinstatement or repair of the cover. Settlement could also occur with slow compaction that is not triggered by any specific event.

Fernhill Landfill

Development Zone: This site falls entirely within priority 2 land.

Description/Details: The landfill is located in river gravels in One Mile Creek, which is approximately 1km from Queenstown. The landfill is located 100m away from the creek, and 250m from Lake Wakatipu.

Dates Operational: We do not know when this landfill opened, but it was closed in 1965.

Materials deposited/filled/discharged/extracted

During its operational period the Fernhill landfill served as a dump for Queenstown. Municipal and domestic solid waste was deposited. We are unsure of the total waste volumes.

Existing hazard details

There is an aquifer beneath the site that is used for commercial purposes. Surface water is used as a back up for an aquatic centre. The ORC has sampled surface water and found no contaminants present. However the contamination of water remains a risk. This landfill could contain asbestos.

Potential Impact on existing development

The potential exists for contamination of the water supplies. Existing development is not close enough to the landfill to be affected by land contamination or escaping gas. We consider that both of these possibilities are highly unlikely since the site has not been used since 1965.

Potential Impact on new development

This landfill is contaminated land within development zone 2. However, it is in a shady gully and this makes development unlikely. This site is an historic one, so any LFG has probably escaped by now. The settlement associated with refuse breakdown has already occurred. A major earthquake could cause rapid settlement and result in cracks in the cap. This could expose the waste and create a health hazard. This would require rapid reinstatement or repair of the cover. Settlement could also occur with slow compaction that is not triggered by any specific event.

<u>Glenorchy Landfill</u>

Development Zone: This site falls entirely within priority 1 land.

Description/Details: The landfill is located within terrace gravels 600m from the township of Glenorchy. This site was used as a gravel pit and then filled with waste. It has no liner. It sits at about 4-6m above the water table. This water is part of an important aquifer for the township. The town water supply comes from the unconfined aquifer 700m away from the landfill site. There are 2 bores related to the landfill that are close by and 1 domestic bore 1km away has been sampled for water quality. The landfill is surrounded by a bund and contour drain. These measures prevent erosion and stop large quantities of storm water

entering the site during floods. The cap is constructed of local substrate and has been mounded to prevent ponding.

Dates Operational: We do not know when this landfill opened, but it was closed on 30th September 1999.

Materials deposited/filled/discharged/extracted

During its operational period the Glenorchy landfill disposed of up to 1250m^3 per year of municipal and domestic solid waste. Disposal of hazardous and liquid waste was not permitted. The closed landfill holds a permit to discharge up to 1950m^3 per year of leachate and contaminated stormwater. The site has a permit allowing the discharge of landfill gas, odours and dust to air.

Existing hazard details

The landfill is currently outside the town boundary and has not been developed. This means the land itself is not a current hazard. However the contamination of water is a risk. This landfill could contain asbestos.

Potential Impact on existing development

The potential exists for contamination of the water supplies. Existing development is not close enough to the landfill to be affected by land contamination or escaping gas.

Potential Impact on new development

This landfill is contaminated land within development zone 1. It must be controlled to ensure appropriate development takes place on the site, and in the immediate surroundings that could be at risk from landfill gas. A major earthquake could cause rapid settlement and result in cracks in the cap. This could expose the waste and create a health hazard. This would require rapid reinstatement or repair of the cover. Settlement could also occur with slow compaction that is not triggered by any specific event.

It also has the potential to contaminate the town water supply and a number of private bores. The water velocity in gravels such as those under the Glenorchy landfill is between 1 and 10^{-3} ms^{-1}. This means that the contaminant plume will have travelled a long distance from the landfill. It has not been picked up by any of the bores that are monitored, so it It is unlikely that any contaminants released will be any more harmful than those already released. These have not affected water supplies, so there is no reason to expect contamination of the water in the future. that the bores will become contaminated in the future.

<u>Hawea Landfill</u>

Development Zone: Not within a priority zone.

Description/Details: The Hawea landfill is unlined and is sited in terrace gravels for the Hawea River. It is 300m east of the river itself. It covers an area of approximately 20,000m^2. The groundwater flows in a northerly (down valley) direction and there is a borehole 100m south of the landfill site. The site has not been capped, but it is programmed to be capped by the end of the 2001-2002 financial year. The cap will be mounded local material with vegetation established on top.

Dates Operational: We do not know when this landfill opened, but it was closed on 30th August 1999.

Materials deposited/filled/discharged/extracted

The permit for waste disposal allowed 760m^3 per year of municipal and domestic solid waste. No hazardous waste was allowed at this site. A maximum discharge of 3220m^3 of leachate and contaminated stormwater is currently permitted each year.

Existing hazard details

The land is contaminated and groundwater flow around the site is likely to be polluted. There is a hazard from escaping landfill gas. This landfill could contain asbestos.

Potential Impact on existing development

The surrounding land is used for farming, and the site is about 1km away from the closest current residential land. This means that the impact of the land is minimal. However, the polluted groundwater could affect the farms if they access it from the aquifer.

Potential Impact on new development

This site is outside the development zones, so direct effects due to contamination of the land are unlikely to be realised in the near future. This site is not in a position to affect the Hawea town water supply. There is some zone 1 land immediately adjacent to the site that may be close enough to experience adverse effects from the contaminated land. A major earthquake could cause rapid settlement and result in cracks in the cap. This could expose the waste and create a health hazard. This would require rapid reinstatement or repair of the cover. Settlement could also occur with slow compaction that is not triggered by any specific event.

Kingston Landfill

Development Zone: Not within a priority zone.

Description/Details: The landfill is situated on the Kingston Formation moraine deposits, 1.2km south of Kingston Township. There is one monitored borehole at the inferred downstream end of the site. The site is currently used as a waste transfer station and is allowed to discharge dust, odour and litter. The landfill has been capped with local material in a mound to prevent ponding.

Dates Operational: We do not know when this landfill opened, but it was closed on 30th September 1999.

Materials deposited/filled/discharged/extracted

The maximum leachate discharge during operation was 870m^3 per year. The landfill held a permit to discharge up to 1940m^3 of contaminated stormwater. There was also a permit allowing the discharge of gas, odour and dust. No hazardous waste was allowed to be disposed of at this landfill.

Existing hazard details

There is no town supply of water in Kingston, so this cannot be affected by leachate from the landfill. Landfill gas from the site could contaminate local areas, but this is all farmland so the hazard is not high.

Potential Impact on existing development

The closest residential development is about 1km away from the landfill site. All of the land surrounding the landfill is farmland. The contamination from the landfill could have adverse effects on the farms, but this is unlikely to develop because the landfill is an old site. Borehole monitoring is carried out on a regular basis, so the groundwater is not currently contaminated.

Potential Impact on new development

New development is unlikely in the area because it is not zoned for development. A major earthquake could cause rapid settlement and result in cracks in the cap. This could expose the waste and create a health hazard. This would require rapid reinstatement or repair of the cover. Settlement could also occur with slow compaction that is not triggered by any specific event.

<u>Luggate Landfill</u>

Development Zone: Not within a priority zone.

Description/Details: The landfill is 1.5km out of the Luggate Township on the banks of the Clutha River. It fills an old gravel pit that was dug into terrace gravels deposited by the Clutha River. There is 1 borehole that is regularly monitored on the site. The consent holder must also monitor the Clutha River for any change in water quality caused by the landfill. The site must be monitored for erosion of the river terrace at 6 monthly intervals. The landfill has been capped with local materials formed into a mound.

Dates Operational: We do not know when this landfill opened, but it was closed in 1995.

Materials deposited/filled/discharged/extracted

The landfill currently holds a permit to discharge up of 2800m^3 of leachate and contaminated stormwater per year. This was from runoff and groundwater flow from site.

Existing hazard details

The bank on which the landfill sits has been identified as at risk from erosion by surface water running over it. This must be monitored every 6 months and remedied immediately any damage is seen. There is potential for farmers to take contaminated groundwater if a plume develops. However, the consent holders must take steps to avoid this, and monitor boreholes for pollutants. This landfill could contain asbestos.

Potential Impact on existing development

The only development near to the landfill is farming. This is not affected by the landfill any more now than it has been since the landfill opened.

Potential Impact on new development

The landfill site is outside development zones, so any further development is unlikely. A major earthquake could cause rapid settlement and result in cracks in the cap. This could expose the waste and create a health hazard. This would require rapid reinstatement or repair of the cover. Settlement could also occur with slow compaction that is not triggered by any specific event.

Makarora Landfill

Development Zone: The Makarora landfill is in priority zone 1.

Description/Details: The Makarora landfill is sited 500m south of Makarora Township. It is about 400m away from the Makarora River and is located in the gravels deposited by this river. It covers an area of approximately 10,000m^2. The borehole is located at the downstream end of the site to test for groundwater contaminants. A condition of the resource consent was that a bund be constructed to protect the site from flooding of the nearby Makarora River. It has not been capped, but the cap is programmed to be complete by the end of the 2002-2003 financial year. The cap will be mounded to prevent ponding and constructed out of locally available materials.

Dates Operational: We do not know when this landfill opened, but it was closed on 30th September 1999.

Materials deposited/filled/discharged/extracted

The permit for waste disposal allowed 175m^3 per year of municipal and domestic solid waste. No hazardous waste or liquid wastes were allowed at this site. An average of 61m^3 of leachate and contaminated stormwater, and a maximum of 85m^3 is currently permitted each year.

Existing hazard details

Flooding from the Makarora River is a hazard at this site, but there is a bund to provide some protection. It sustained no damage from the flood of 1999, so it is unlikely that future floods will damage the site. This flood was very large and any floods large enough to damage the landfill are unlikely. The site is on farmland with no housing nearby. This means that the hazard from the land, landfill gas and contaminated water is low. This landfill could contain asbestos. .

Potential Impact on existing development

The hazard is minimal because there is very little development close to the site.

Potential Impact on new development

We do not have the relevant plans of Makarora, but because it is in a remote location we assume that the site is not zoned for future development. This means that the potential impact on future development is low. A major earthquake could cause rapid settlement and result in cracks in the cap. This could expose the waste and create a health hazard. This would require rapid reinstatement or repair of the cover. Settlement could also occur with slow compaction that is not triggered by any specific event.

Tucker Beach Landfill

Development Zone: This landfill is within priority zone 2.

Description/Details: The Tucker Beach landfill is adjacent to the Shotover River just upstream from its confluence with the Kawarau River. It is dug into river gravels that form a terrace. There are 6 boreholes close to the site, in directions across flow and downstream of the landfill. This site had rock protection work done on a formed embankment to protect against flooding. This took place in 1998. It has been capped with local soils in a mound to prevent ponding. Trees and grass were planted to landscape the landfill, but the initial trees died. They will be monitored and replaced as is necessary.

Dates Operational: We do not know when this landfill opened, but it was closed on 30th June 1999.

Materials deposited/filled/discharged/extracted

The waste permitted was municipal and domestic solid waste, with no provision for the disposal of hazardous waste. However, asbestos and contaminated soils could be disposed of if permission was granted. The waste deposited was covered daily with 100-150mm of soil. There is a permit to dispose of 38400m^3 per year of leachate and 36150m^3 of contaminated stormwater. There is also a current permit to discharge landfill gas, dust and odours to air.

Existing hazard details

The site is at risk from erosion by the Shotover River. It should be checked frequently to minimise this risk. There is a potential for pollution of groundwater by leachate. This is regularly monitored, so the risk should be low. This landfill could contain asbestos.

Potential Impact on existing development

There is very little development close to this site. It has been landscaped and the land is unused. The surrounding land is farmland and the closest houses are about 1km away. This means that the risk from landfill gas and the contaminated land is currently low.

Potential Impact on new development

This land is within zone 2 for future development. This means that there is potential for a hazard to develop due to residential construction close to the landfill. This hazard could be due to contaminated groundwater being used, landfill gas or because of building too close to the contaminated land. A major earthquake could cause rapid settlement and result in cracks in the cap. This could expose the waste and create a health hazard. This would require rapid reinstatement or repair of the cover. Settlement could also occur with slow compaction that is not triggered by any specific event.

Victoria Flats

Development Zone: Not within a priority zone.

Description/Details: This is the current landfill site for the Queenstown-Lakes area, and receives refuse from transfer stations in the region. It is constructed with an impermeable liner ($k \leq 10^{-9} ms^{-1}$). It is situated in river gravels from the nearby Kawarau River. The consent required that 7 bores were constructed in the vicinity of the landfill. These are monitored every 3 months for water level, flow and quality.

Dates Operational: 1st July 1999 onwards.

Materials deposited/filled/discharged/extracted

The maximum permitted amounts of waste disposal are 40,000 tons of mixed solid waste (domestic and municipal) per year. With correct techniques mixed solid waste can be compacted to $0.8t/m^3$, so this is $50000m^3$. The site is also permitted to dispose $30,000m^3$ of leachate and contaminated stormwater per year. The landfill holds a permit to discharge landfill gas (LFG), dust and odours to the air. No hazardous goods are allowed to be disposed of at this site.

Existing hazard details

This site is totally reliant on the lining and cap system due to the high porosity and permeability of the enclosing gravels.

Liners always have small holes, but rarely bigger punctures. The expected flow of leachate through these small holes is around 14*l*/day/hectare.

The life of an HDPE liner at 25^0C (inner liner) should be 150yrs if well designed and made. The temperature rises as leachate head builds up, reducing the liner lifespan.

Potential Impact on existing development

There is no development that is close enough to this landfill to be at risk.

Potential Impact on new development

This landfill is in land that is not zoned for future development. However, the gas that is generated could be a hazard to vehicles using the adjacent state highway. The liner may break down a long time into the future, and the site needs to be zoned to preclude development until such time as it has been proven safe. A major earthquake could cause rapid settlement and result in cracks in the cap. This could expose the waste and create a health hazard. This would require rapid reinstatement or repair of the cover. Settlement could also occur with slow compaction that is not triggered by any specific event.

Wanaka Landfill

Development Zone: Not within a priority zone.

Description/Details: This landfill is sited 2km away from Wanaka. It is in a river terrace adjacent to the Cardrona River. There are 6 boreholes that are monitored for water quality within 200m of the landfill. These are to be monitored every 3 months until a 2 year period passes without significant contaminants being detected. This site has also been used for a composting facility and pesticide depot. The active landfill areas have been capped, but part of the site is still being used. This is for a green waste and composting facility and for clean hardfill material.

Dates Operational: We do not know when this landfill opened, but it was closed on 30th September 1999.

Materials deposited/filled/discharged/extracted

The permit during operation allowed 2500m^3 per year of domestic and municipal solid waste, with no provision for hazardous or liquid wastes. 16800m^3 per year of leachate and contaminated stormwater was permitted. The landfill held a permit to discharge dust, landfill gas and odours to the air. The compost facility has a permit to dispose 6000m^3 of plant waste provided that all non composting or hazardous material has been removed from it. Odours from composting and leachate were permitted on condition that they were minimised. Clean hardfill is also currently being deposited.

Existing hazard details

The hazards from the Wanaka landfill are landfill gas, groundwater pollution and odours from the composting facility. The contaminated land is also a potential hazard which would preclude development of the site itself. The site could contain asbestos. Within the landfill there is a sarcophagus containing hazardous material. We do not know the exact location or contents of this.

Potential Impact on existing development

The Wanaka landfill is sited on farmland with no residential land in the immediate area. The risk to this development is low. The monitoring bores should find any contaminants in the groundwater before they become a hazard to the farmers. Composting odours are not a hazard to farms.

Potential Impact on new development

This land is not zoned for future development so the site is unlikely to have any future impact. A major earthquake could cause rapid settlement and result in cracks in the cap. This could expose the waste and create a health hazard. This would require rapid reinstatement or repair of the cover. Settlement could also occur with slow compaction that is not triggered by any specific event.

Warren Park Landfill

Development Zone: This landfill is within priority zone 1.

Description/Details: This is sited in central Queenstown. It was located adjacent to the creek, which has since been realigned. We do not know where the landfill is sited in relation to the current course of the creek. It is either under the Wakatipu High School field or beneath residential land on the other side of the creek. The landfill is likely to have been capped with local substrate.

Dates Operational: We do not know when it was operational, but it has been unused for at least 20 years.

Materials deposited/filled/discharged/extracted

We are unsure of the exact waste deposited here, but assume it to be domestic waste.

Existing hazard details

This site is at risk from erosion by the local creek, which runs very close to the site. There is a risk of the site contaminating groundwater in the area, and of the ground being contaminated with pollutants. Landfill gas could be emitted from the waste, which is hazardous to the surrounding school and residential land. This landfill could contain asbestos waste.

Potential Impact on existing development

The existing development in the area is a school, residential land and parkland. The site could pose a health hazard to current development. Immediate attention would be required if the creek were to erode into the waste.

Potential Impact on new development

New contaminants could be released by future breakdown of waste and could pose a risk to development, depending on the land use. There is the possibility of exposure of the waste, and the location and cover of the waste needs to be determined.

A major earthquake could cause rapid settlement and result in cracks in the cap. This could expose the waste and create a health hazard. This would require rapid reinstatement or repair of the cover. Settlement could also occur with slow compaction that is not triggered by any specific event.

4.4 Contaminated Sites

From our research on contaminated or potentially contaminated sites we have compiled a hazard list. Some are specific to certain types of site, while others are generic to all contaminated sites.

The sites that are listed in our report are those that QLDC identified as potentially contaminated. There are many more potentially contaminated sites in the region, and some of these have been identified by the ORC. We obtained a copy of the list of potentially contaminated sites identified by the ORC. This is included as appendix 1. The sites that have red boxes are priority one sites, while those in green boxes are priority 2 sites as defined by the QLDC. The priority listing used in the spreadsheet is based on a combination of hazard and vulnerability. These priorities have been assigned by the ORC. The sites that are listed as being under investigation are those that the ORC has deemed to be the highest risk.

During our research we found hazard registers compiled for other areas. These identified other types of contamination that may be present in the QLDC area. These site types are listed in section 4.4.

4.4.1 Service Stations

Hazards include spillage or leakage of:

- Hydrocarbons;
- Lead and other heavy metals.

These are released into the environment through leakage into the ground or groundwater.

Older stations may also have released contaminants from spillage into municipal stormwater drains.

Modern stations have oil interceptors that remove all of the hydrocarbons from stormwater before releasing into municipal drains.

4.4.2 Timber Treatment

Hazards from timber treatment come from spillage of chemicals. The most common contaminants are:

- Tanalising chemicals and equipment;
- Copper/Chrome/Arsenic treatment.

Arsenic is a carcinogen; chromates are very soluble in water and can contaminate groundwater rapidly over large areas.

Modern facilities discharge through settlement ponds before entering watercourses. This process removes most of the chemicals, but leaves a potentially contaminated site created by the pond.

4.4.3 Drycleaners

This is another category of hazard that has been greatly reduced recently as the chemicals become less toxic. Older machines used carbon tetrachloride. This is highly carcinogenic.

Modern machines use perchloroethylene, which is recycled within the process. However, there is some leakage from the machines. Machines produce a sludge of used chemicals, but this is generally removed and treated off site.

4.4.4 Other Sites

Other sites that may be contaminated in various ways include:

- Painting facilities;
- Motor repair sites;
- Dentists;
- Photographers;
- Fertiliser storage sheds;
- Metal treatment works;
- Orchards and Vineyards (herbicides).

The information we have obtained on each of the sites at this stage is very limited. We do not have precise locations of many of the sites (and therefore do not know which development zone they are in) and so their potential impact on existing or future development cannot be reliably assessed.

The assessment of contamination at a site and its impact on development is usually performed using a staged approach whereby the extent of the problem is defined to a level appropriate for the particular site and circumstances.

There are basically four stages of site assessment:

- Preliminary site investigation;
- Detailed site investigation;
- Site remedial action plan;
- Validation and monitoring.

Because we do not have precise locations of many of the sites further research is going to be needed. Such information would include charting the site history of development, visiting

each broad area for signs of contamination and by interviewing residents who have lived in the area for many years.

A great deal of information can be gained by looking at the site history, building plans and by inspecting the sites. A useful technique is to use a Photo Ionisation Detector (PID) during the walkover which can pick up organic vapours. The walkover would also include a detailed photographical record.

Once this initial field screening work is complete recommendations can be made for further detailed investigation, if necessary. This would include soil sampling and groundwater testing.

We have not progressed this work at this stage, which would be beyond our scope as it stands. For those sites where information is limited a process described above would be appropriate.

4.4.5 Sites List

Alex Burt, Queenstown

Development Zone: Unknown.

Description/Details: This site was a service station.

Dates Operational: During the late 1950's and early 1960's.

Materials deposited/filled/discharged/extracted

There is potential for leakage from underground fuel and oil tanks.

Existing hazard details.

The potential for soil and groundwater contamination with lead and hydrocarbons exists.

Potential Impact on existing development

We do not know where the site is located, so are unable to comment on the hazard it presents to development.

Potential Impact on new development

The information on the contamination at this site is limited. Further investigation on the contamination is necessary to determine the potential impact on either existing or new development.

Arrowtown Motors

Development Zone: This site is in zone 1 land.

Description/ Details: This is located at 38 Buckingham Street, Arrowtown. The site is currently used for retail purposes.

Dates Operational: We do not know when this site was active, but it is not currently active.

Materials deposited/filled/discharged/extracted

There is potential for leakage from underground fuel and oil tanks.

Existing hazard details

The soil on this site could be contaminated with hydrocarbons and/or lead.

Potential Impact on existing development

This should have minimal impact on retail development because the soil is not used. Groundwater contamination does not present a significant hazard because the water is not extracted.

Potential Impact on new development

The information on the contamination at this site is limited. Further investigation on the contamination is necessary for the site to be assessed.

Ballantyne Road, Wanaka

Development Zone: Depending upon the location of this site, it may be in zone 1 or unzoned land.

Description/ Details: This land has been used for tanning and associated trades. The location of the site is Pt Lot 1, DP 17827.

Dates Operational: This site was active in 1985, but we do not know when it opened or closed. It is not currently active.

Materials deposited/filled/discharged/extracted

The potential exists for spillage or leakage of chemicals used in the tanning process. We do not know at this stage whether any leakage has occurred.

Existing hazard details

The potential hazard at this site is soil and groundwater contamination from chemical spillage.

Potential Impact on existing development

We are unsure of the location of the site, so cannot comment on the risk to existing development.

Potential Impact on new development

The information on the contamination at this site is limited. Further investigation on the contamination is necessary before development is permitted.

Bryan L Umbers, Wanaka

Development Zone: Unknown.

Description/Details: It is listed as a potentially contaminated service station site. We do not know the exact location of the site on Ardmore Street, Wanaka.

Dates Operational: We know the site was active in 1961, but do not know exactly when it opened or closed. It is not currently active.

Materials deposited/filled/discharged/extracted

There is potential for leakage from underground fuel and oil tanks.

Existing hazard details

There is the potential for the soil on this site to be contaminated with hydrocarbons and/or lead.

Potential Impact on existing development

We are unsure of the location of the site, so cannot comment on the risk to existing development.

Potential Impact on new development

The information on the contamination at this site is limited. Further investigation on the contamination is necessary before development is permitted.

D M McLeod, Wanaka

Development Zone: This site is in zone 1 land.

Description/ Details: This site is located on Warren St in Wanaka and is currently residential land.

Dates Operational: We know this site was active sometime during the period from 1940-1951.

Materials deposited/filled/discharged/extracted

There is potential for leakage from underground fuel and oil tanks.

Existing hazard details

The risk is dependant upon any future land use. Intensive use of the soil is unlikely because the site is in central Wanaka.

Potential Impact on existing development

Residential development in this area could be at risk. If gardens are planted, the plants could extract contaminants from the soil and pose a health hazard. Groundwater contamination does not present a significant hazard because the water is not extracted.

Potential Impact on new development

The risk is dependant upon the proposed land use. It would be prudent for developers to carry out a full investigation of the nature of contamination before proceeding.

Frankton Service Station

Development Zone: This site is in zone 1 land.

Description/ Details: This is located on Frankton Road in Frankton. It is still used as a service station.

Dates Operational: This service station opened in 1961 and is currently operational.

Materials deposited/filled/discharged/extracted

There is potential for leakage from underground fuel and oil tanks.

Existing hazard details

The potential does exist for the contamination of the soils and groundwater with lead and hydrocarbons.

Potential Impact on existing development

This site is still used as a service station, so there should be minimal impact. Groundwater contamination does not present a significant hazard because the water is not extracted.

Potential Impact on new development

The information on the contamination at this site is limited. The risk is dependant upon the proposed land use. It would be prudent for developers to carry out a full investigation of the nature of contamination before proceeding.

Jas J Cockburn, Queenstown

Development Zone: This site is in zone 1 land.

Description/ Details: This site is located at 29-35 Ballarat St in Queenstown. It was used as a petrol station. Retail premises currently occupy it.

Dates Operational: This site was active in the period between 1956 and 1961, but we are unsure exactly when. It is not currently active.

Materials deposited/filled/discharged/extracted

There is potential for leakage from underground fuel and oil tanks.

Existing hazard details

The potential for contaminated soils and groundwater does exist with lead and/or hydrocarbons.

Potential Impact on existing development

This should have minimal impact on retail development because the soil is not exposed. Groundwater contamination does not present a significant hazard because the water is not extracted.

Potential Impact on new development

The information on the contamination at this site is limited. The risk is dependant upon the proposed land use. It would be prudent for developers to carry out a full investigation of the nature of contamination before proceeding. .

John Nolan, Wanaka

Development Zone: Priority1.

Description/ Details: This site is listed as potentially contaminated because it was used as a timber treatment plant. This site was on Faulks Terrace in Wanaka. The timber mill did not do much treatment, and burned down in 1970. The land is now used for housing.

Dates Operational: We do not know when this site was active, but it is no longer active.

Materials deposited/filled/discharged/extracted

There is potential for chemicals used in timber treatment to have spilled and percolated into the ground.

Existing hazard details

The potential hazard from this site is contaminated soil and groundwater.

Potential Impact on existing development

Potential risks from contaminated soil exist. Any gardens could extract contaminants and be a health risk to residents who eat their produce.

Potential Impact on new development

As above. The information on the contamination at this site is limited. Further investigation on the contamination is necessary. The risk is dependant upon the proposed land use. It would be prudent for developers to carry out a full investigation of the nature of contamination before proceeding.

Manson's, Wanaka

Development Zone: This site is in priority 1 land.

Description/ Details: This site is used as a service station. It is located at 53 Ardmore St in central Wanaka. It has been known as Wm Mason, Manson's Wanaka Motors, Ltd and is currently known as BP Wanaka.

Dates Operational: This site has been trading under a variety of names since 1951. It is currently active.

Materials deposited/filled/discharged/extracted

There is potential for leakage from underground fuel and oil tanks.

Existing hazard details

The potential for contaminated soils and groundwater with lead and hydrocarbons does exist.

Potential Impact on existing development

This site is still used as a service station, so there is minimal impact on development because the soil is not used. Groundwater contamination does not present a significant hazard because the water is not extracted.

Potential Impact on new development

The information on the contamination at this site is limited. The risk is dependant upon the proposed land use. It would be prudent for developers to carry out a full investigation of the nature of contamination before proceeding. .

Mt Cook and Southern Tourist Co Ltd, Queenstown

Development Zone: This site is in priority 1 land.

Description/ Details: This site is located at 2 Rees St in Queenstown. It is currently used for retail and parking facilities.

Dates Operational: This site was active sometime around 1951.

Materials deposited/filled/discharged/extracted

There is potential for leakage from underground fuel and oil tanks.

Existing hazard details

The site potentially has contaminated soils and groundwater. These could be contaminated with lead and hydrocarbons.

Potential Impact on existing development

This should have minimal impact on retail development because the soil is not exposed. Groundwater contamination does not present a significant hazard because the water is not extracted. The whole site is either built upon or sealed, so the contaminated soil cannot be accessed.

Potential Impact on new development

The information on the contamination at this site is limited. The risk is dependant upon the proposed land use. It would be prudent for developers to carry out a full investigation of the nature of contamination before proceeding.

Mt Iron Timber Mill, Wanaka

Development Zone: This site is in priority 1 land.

Description/ Details: This is on the corner of Anderson and Mt Iron roads, in Wanaka. It has been used for timber treatment and there may have been spillage or leakage of treatment chemicals.

Dates Operational: This plant opened in 1982 and it is still active.

Materials deposited/filled/discharged/extracted

The site currently treats timber with boron. There is no tanalising of timber carried out on site.

Existing hazard details

The potential hazard from this site is in the form of contaminated stormwater runoff and leakage into the ground. Current practise is to collect stormwater in a settlement pond before discharging it. We are unsure if this site uses settlement ponds, and if it does, when they were installed.

Potential Impact on existing development

This site is still a timber treatment plant, so the contaminated ground does not affect it. However, contaminated run off into water courses could affect property downstream.

Potential Impact on new development

The information on the contamination at this site is limited. Further investigation on the contamination is prudent before development. This could include soil testing and possibly surface water run-off testing.

Queenstown Motors Co Ltd

Development Zone: This site is in priority 1 land.

Description/ Details: The unit title of this site is: Pt Sec 1, Blk V, town of Queenstown. This plot is on Shotover St. It is currently used as a service station.

Dates Operational: We are unsure exactly when the service station opened, but it was in the late 1950's. It is currently operational.

Materials deposited/filled/discharged/extracted

There is potential for leakage from underground fuel and oil tanks.

Existing hazard details

The site potentially has contaminated soils and groundwater. These could be contaminated with lead and hydrocarbons.

Potential Impact on existing development

There is minimal impact on current development because the site is still used as a service station. Groundwater contamination does not present a significant hazard because the water is not extracted.

Potential Impact on new development

As above. The information on the contamination at this site is limited. The risk is dependant upon the proposed land use. It would be prudent for developers to carry out a full investigation of the nature of contamination before proceeding.

Ratcliff Wrought Iron, Queenstown.

Development Zone: This site is in zone 1 land.

Description/ Details: This is located at 57 Industrial Place, Queenstown. The site has been used for treating metals.

Dates Operational: This site was active in 1971, but we do not know exactly when it opened and closed.

Materials deposited/filled/discharged/extracted

This site has been used for treatment of metals and has had many of toxic chemicals used. There is the potential for leakage to have occurred.

Existing hazard details

This site could have contaminated soils from chemicals used in processing and treating the wrought iron.

Potential Impact on existing development

This land is used for industry, so the contaminated soil hazard is minimal.

Potential Impact on new development

The information on the contamination at this site is limited. The risk is dependant upon the proposed land use. It would be prudent for developers to carry out a full investigation of the nature of contamination before proceeding.

Shaw's Motors, Arrowtown

Development Zone: This site is in priority 1 land.

Description/ Details: This is located at 8 Berkshire St in Arrowtown. The service station still exists.

Dates Operational: The premises began trading in 1965 and are currently active.

Materials deposited/filled/discharged/extracted

There is potential for leakage from underground fuel and oil tanks.

Existing hazard details

The site potentially has contaminated soils and groundwater. These could be contaminated with lead and hydrocarbons.

Potential Impact on existing development

This site has minimal impact on current development because the site is still a service station. Groundwater contamination does not present a significant hazard because the water is not extracted.

Potential Impact on new development

The information on the contamination at this site is limited. The risk is dependant upon the proposed land use. It would be prudent for developers to carry out a full investigation of the nature of contamination before proceeding.

Taylor's Dry Cleaning and Laundry Services, Queenstown

Development Zone: This site is in priority 1 land.

Description/ Details: This is located at 51 Gorge Road, Queenstown. We do not know whether the chemical tanks have been removed. This site is also known as High Peaks Dry cleaning.

Dates Operational: The premises began trading in the late 1970's and burned out last year.

Materials deposited/filled/discharged/extracted

The potential exists for leakage of dry cleaning chemicals and solvents. However, we are unsure if any leakage has occurred.

Existing hazard details

The hazard from this site is contaminated soils and possibly the presence of dry cleaning fluid tanks.

Potential Impact on existing development

We are unsure of what the land is currently used for, so cannot comment on the hazard to existing development.

Potential Impact on new development

The information on the contamination at this site is limited. The risk is dependant upon the proposed land use. It would be prudent for developers to carry out a full investigation of the nature of contamination before proceeding.

W H Overton, Queenstown

Development Zone: We do not know which zone this site is in, but it could be in zone 1.

Description/ Details: We do not know the location of the potentially contaminated site. It is in Queenstown.

Dates Operational: This site is listed in the Otago and Southland Directory from 1935.

Materials deposited/filled/discharged/extracted

There is potential for leakage from underground fuel and oil tanks.

Existing hazard details

The site potentially has contaminated soils and groundwater. These could be contaminated with lead and hydrocarbons.

Potential Impact on existing development

We do not know the exact location of this site, so are unable to comment on the hazard it poses to development. If it is in a residential area then it is a potential hazard, but retail premises are not affected significantly. Groundwater contamination does not present a significant hazard because the water is not extracted.

Potential Impact on new development

The information on the contamination at this site is limited. Further investigation on the contamination is prudent before development.

Wakatipu Motors Ltd, Queenstown

Site: Wakatipu Motors Ltd

Development Zone: This site is in zone 1 land.

Description/ Details: This site is located at 49 Beach St, Queenstown. The land is currently used for retail purposes.

Dates Operational: The site was active in the late 1950's and early 1960's. It is not currently active.

Materials deposited/filled/discharged/extracted

There is potential for leakage from underground fuel and oil tanks.

Existing hazard details

The site potentially has contaminated soils and groundwater. These could be contaminated with lead and hydrocarbons.

Potential Impact on existing development

This should have minimal impact on retail development because the soil is not used. The whole site is sealed or built upon, so the contaminants are unlikely to escape. Groundwater contamination does not present a significant hazard because the water is not extracted.

Potential Impact on new development

The information on the contamination at this site is limited. The risk is dependant upon the proposed land use. It would be prudent for developers to carry out a full investigation of the nature of contamination before proceeding.

Walter J Taylor, Hawea Flat

Development Zone: We do not have the exact location of this site on Camphill road, but it could be within priority 1 land. It is on Lot 3, DP 7106, Blk V, Lower Hawea SD.

Description/ Details: This site is located on Camphill Rd, Hawea Flat. It is currently used as a workshop.

Dates Operational: This site was operational in and around 1956, and it is not currently active.

Materials deposited/filled/discharged/extracted

There is potential for leakage from underground fuel and oil tanks.

Existing hazard details

The hazard from this site is from contaminated ground. There is a chance that the soil may be contaminated with lead and hydrocarbons.

Potential Impact on existing development

We are unsure of the current land use. The contamination came from a workshop, so we assume that the land is a derelict workshop and is not used. However, it could be used as farmland, in which case there is a potential risk that the crops will extract contaminants from the soil.

Potential Impact on new development

The risk will be significantly reduced if the land is outside zone 1, but we are unsure of its exact location. The information on the contamination at this site is limited. The risk is dependant upon the proposed land use. It would be prudent for developers to carry out a full investigation of the nature of contamination before proceeding.

Wm Mason, Wanaka

Development Zone: This site is in zone 1 land.

Description/ Details: This is the name that was used for the service station trading at the premises currently used as a service station by BP Wanaka. After 1961 the name changed to Manson's Wanaka Motors Ltd see section 4.5.9 above.

Dates Operational: 1956-1961.

4.5 Mining

Hazards normally associated with mine workings relate particularly to:

- deep abandoned shafts or stopes.
- deep open excavations.
- ore processing – use of chemicals.
- movement of plant – dust, noise vibration etc.
- disturbed or soft / loose ground associated with workings

The mine workings records we have obtained do not indicate that any of the above are likely to be a problem. Mining in the area was largely alluvial gold mining, only one site was identified as being open cast coal, mining. Licenses indicate that reinstatement was required once the license expired.

Mining licences 32:2400 and 32:2186

Development Zone: Partially priority 1

Description/ Details: These are located in the Cardrona Valley opposite the Cardrona Hotel. Alluvial mining was permitted, with replacement of all material to a similar state. However, the council had difficulties with reinstatement requirements. We have no conclusive correspondence, but it seems that the sites?? could have been left partially reinstated, possibly with settlement ponds in situ.

Dates Operational: Licence 32:2400 was valid from 23/7/87 until 22/6/94. Licence 32:2186 appears to have been forfeited some time shortly after April 1995.

Materials deposited/filled/discharged/extracted

Gold was removed from the site. The Lakes Council had previously removed gravel from the site.

Existing hazard details

This type of alluvial gold mining is a limited hazard. It does not involve the use of hazardous chemicals or any underground construction. The licence is no longer valid so there is no hazard associated with heavy machinery.

Potential Impact on existing development

Existing development is not affected by this claim because it is no longer producing dust or noise. There are no underground workings that could lead to destabilising the ground.

Potential Impact on new development

The claim is unlikely to have any significant effects on new development.

Prospecting licence 31 1940

Development Zone: Mainly within priority 1.

Description/ Details: This is a prospecting claim that covers an area of 40ha. It is on the edge of the Rees Valley and includes the bed and immediate surroundings of the Precipice Creek for about an 800m length. The prospectors will replace any disturbed vegetation.

Dates Operational: The application was lodged in 1987 for a 3 year period.

Materials deposited/filled/discharged/extracted

The prospectors intended to remove bulk samples amounting to 300m^3 and process them for gold on the site.

Existing hazard details

This land is currently used for farming. The licence was only for prospecting and expired 10 years ago. The associated hazard is minimal. Any 20m^3 sample holes had to be filled with local material.

Potential Impact on existing development

The farmland was not affected by the prospecting.

Potential Impact on new development

There was no underground working associated with this licence, so there is no hazard associated with settlement. The resource consent did not permit any working as it was for prospecting only, so there is hazard from loose ground. As the claim is no longer valid the hazard will not develop.

Prospecting licence 31 2017

Development Zone: This land is partially within priority 1, but mainly not within a priority zone.

Description/ Details: This is a prospecting licence covering about 30km^2 in the Cardrona Valley. It includes the land for 12km downstream of the Cardrona township on the true left bank, and about 3km up the adjoining hills.

Dates Operational: The licence was applied for in 1987 and surrendered on 9/5/91.

Materials deposited/filled/discharged/extracted

The prospectors stated that they intended removing up to the maximum 20m^3 of samples per hectare. It would be screened on site, so would not be removed from the claim location. Any gold found was taken off site.

Existing hazard details

This prospecting licence is no longer valid, so hazards from dust and emissions do not exist. No samples were removed, so there are no ground settlement issues. The land is mainly a riverbed, so disturbing the soil has no effects on development. The prospecting did not involve using hazardous chemicals to extract the gold.

Potential Impact on existing development

The land that is not riverbed is farmland which would not be affected by soil disturbance. Any damage to the vegetation had to be repaired under the terms of the licence.

Potential Impact on new development

There is only a small area of this licence area within development priority 1, so the impact is minimal.

Prospecting licence 31 2022

Development Zone: This land is partially within zone 1, but mainly not within a priority zone.

Description/ Details: This licence covers the riverbed and terraces in the valley floor of the Cardrona Valley for about 20km downstream of the Cardrona township. The licence is for prospecting and associated screening of material only.

Dates Operational: This licence expired in 1992, after a 3 year term.

Materials deposited/filled/discharged/extracted

There was minimal removal of material because all screening was done on site. The alluvial gravels were screened, but not removed.

Existing hazard details

This prospecting licence is no longer valid, so hazards from dust and emissions do not exist. No samples were removed, so there are no ground settlement issues. The land is mainly a riverbed, so disturbing the soil has no effects on development. The prospecting did not involve using hazardous chemicals to extract the gold.

Potential Impact on existing development

The land that is not riverbed is farmland which would not be affected by soil disturbance. Any damage to the vegetation had to be repaired under the terms of the licence.

Potential Impact on new development

There is only a small area of this licence area within development zone 1. There is a hazard associated with loose, uncompacted ground.

Mining licence 32 1498

Development Zone: This land is partially in zone 2, with the remainder being unzoned.

Description/Details: This licence covers 10ha between SH6 and the Arrow River, downstream of the Arrow River Bridge. The licence is for mining, and the holder intends to sluice for gold.

Dates Operational: This licence was granted in March 1983 and runs for a term of 21 years. It is valid until March 2004.

Materials deposited/filled/discharged/extracted

The permit was to extract gold.

Existing hazard details

This licence is currently valid, but not being worked, so hazards from dust and emissions do not exist. No samples were removed, so there are no ground settlement issues. The land is mainly a riverbed, so disturbing the soil has no effects on development. The prospecting did not involve using hazardous chemicals to extract the gold.

Potential Impact on existing development

This licence is still valid, although it is not currently being worked. If the area was mined, dust and noise could present a hazard to development. Any damage to the vegetation had to be repaired under the terms of the licence, so this could be a short term problem.

Potential Impact on new development

This licence area is within development zone 2. However, most of the area is the Arrow River bed, which is not suitable for development. The sluicing could leave oversteepened slopes that present a hazard to development. There could also be areas of loose ground that are unsuitable for building on.

Mining licence 32 2194

Development Zone: This land is entirely within zone 2.

Description/ Details: This claim relates to the Arrow River bed and gorge between State Highway 6 and the Kawarau River. A condition of the licence was that the land be restored to its pre-mining state.

Dates Operational: The licence was granted on 8/5/84, and surrendered on 4/10/93.

Materials deposited/filled/discharged/extracted

No chemicals were used in on site processing of the gold. Gold was the only mineral extracted.

Existing hazard details

This licence is no longer valid, so hazards from dust and emissions do not exist. The land is mainly a riverbed, so disturbing the soil has no effects on development. The licence did not allow the use of hazardous chemicals to extract the gold.

Potential Impact on existing development

The land that is not riverbed is farmland which would not be affected by soil disturbance. Any damage to the vegetation had to be repaired under the terms of the licence.

Potential Impact on new development

This licence is in zone 2 land, but most of it is a riverbed that is not suitable for development. The land had to be restored to its pre mining state, so there is minimal hazard to new and existing development.

Mining Licence 32 2196

Development Zone: This land is within priority zone 1.

Description/ Details: This claim was for land South East of the Kawarau Victoria Bridge, in the Waitiri bend. The licensees were required to rehabilitate the land to its original state. There is no suggestion that this was not done.

Dates Operational: This licence was granted on 6/6/84 and surrendered on 24/4/91

Materials deposited/filled/discharged/extracted

Gold was extracted and the treatment took place off site, so no chemicals were present on the site.

Existing hazard details

The licence has been surrendered for 10 years, so there will not be any operational hazards. There was no underground mining, so there is no danger of tunnel collapse.

Potential Impact on existing development

This land is currently used for farmland, so this claim has no effect on existing development.

Potential Impact on new development

This land was to be restored to its original state, so it is unlikely that there are any hazards remaining from the work. There could be patches of loose ground that are unsuitable for building on.

Mining Licence 322224

Development Zone: This claim is within priority zone 1 land.

Description/ Details: This land is located west of claim 32 2225, on the terrace immediately east of Nevis Bluff. The ground was to be rehabilitated to its original condition.

Dates Operational: This licence was granted on 26/7/84 and surrendered on 24/4/91.

Materials deposited/filled/discharged/extracted

Gold was extracted from this site and processed elsewhere.

Existing hazard details

This licence has been inactive for 10 years, so there are no operational hazards. Chemical processing did not take place on site, so there is no contamination from this. No underground work took place, so there is no danger of workings collapsing.

Potential Impact on existing development

This land is currently used for vineyards, so the fact that vegetation and soil may have been disturbed does not matter.

Potential Impact on new development

The mining had minimal impact on the environment and left no lasting damage. This means that the danger to new development is negligible.

Mining Licence 32 2225

Development Zone: This claim falls within priority zone 1 land.

Description/ Details: This land is on the flats next to the Kawarau River, west of Nevis Bluff. A condition of the licence was for rehabilitation to its former state as farmland.

Dates Operational: This licence was granted on 26/7/84 and surrendered on 24/4/91.

Materials deposited/filled/discharged/extracted

All amalgamation was carried out off site, so no chemicals were used on site.

Existing hazard details

This licence has been inactive for 10 years, so there are no operational hazards. Chemical processing did not take place on site, so there is no contamination from this. No underground work took place, so there is no danger of workings collapsing.

Potential Impact on existing development

As above. This land is currently used for vineyards, so the fact that vegetation and soil may have been disturbed does not matter.

Potential Impact on new development

As above. The mining had minimal impact on the environment and left no lasting damage. This means that the danger to new development is negligible.

Mining Licence 32 2756

Development Zone: This land is partially in zone 1, but mainly in unzoned land.

Description/ Details: This licence covers the bed of the Cardrona River upstream of the Cardrona township, and the banks within the township. The licensee intended to use a suction dredge that would disturb the river bed and surroundings. Most of the area is gravel, so the effect would be minimal.

Dates Operational: This licence was granted in April 1989 for 10 years. The area within zone 1 was surrendered on 5/6/92.

Materials deposited/filled/discharged/extracted

The gold was to be extracted using dredging, so no overburden material would be removed from the site. There was to be no chemical treatment of gold, so chemical contamination is not an issue.

Existing hazard details

This licence has been inactive for 9 years, so there are no operational hazards. Chemical processing did not take place on site, so there is no contamination from this. No underground work took place, so there is no danger of workings collapsing.

Potential Impact on existing development

This land is mostly in the riverbed, so it is not developed. The remainder is farmland which is not affected by the soil disruption 9 years ago. The dredge could have left a lake where it was floated out, but this is only small and would not affect farming.

Potential Impact on new development

The mining had minimal impact on the environment and left no lasting damage. This means that the danger to new development is negligible. There was only a small area of the licence in zone 1, and the fact that the licence for this area was surrendered after 3 years suggests that it was not profitable. The land may have been disturbed, leaving loose areas that would not support buildings or roads.

Mining licence 37 093

Development Zone: This land is predominantly in zone 1, with the remainder unzoned.

Description/ Details: This licence allowed opencast coal mining on the terrace adjacent to the Kawarau River. The licence required total reinstatement of the land to its original condition upon completion of works.

Dates Operational: This licence was granted in September 1987 for a 10 year term.

Materials deposited/filled/discharged/extracted

The permit was only for coal extraction.

Existing hazard details

If this licence was used, it was for opencast mining that had to be filled in once the project was completed. The licence is no longer valid, so there are no operational hazards.

Potential Impact on existing development

Once rehabilitated there would be minimal hazard to existing development. The topography and vegetation had to be restored, and there was no permit for underground workings. There may have been chemicals discharged from processing ponds that could have contaminated the surrounding soil.

Potential Impact on new development

The rehabilitation process ensures that any risk to future development is minimal.

4.6 Summary

We have researched the following sources:

- ORC records;
- QLDC contaminated sites list provided to us;
- Mining claim information (QLDC information);
- Libraries;
- Imtech Ltd information (from meeting).

The main points to emerge from the work are:

(a) We do not know an accurate position of the Warren Park Landfill. Because of its position in central Queenstown, it needs to be located accurately. Drilling and soil sampling may be necessary to establish this;

(b) The amount and locations of asbestos dumped need to be identified if possible. This may not be a practical task, so we suggest that the hazard is identified. This could be achieved by monitoring dust at the landfills. If the asbestos is being released as dust, it is a hazard, while if it remains below ground then it is not an immediate hazard. Dust monitoring would show whether it is a hazard. If any development was to be proposed on the sites of the landfills, soil drilling and sampling may be necessary to ensure safety;

(c) The sarcophagus in the Wanaka landfill needs locating and we need to find out what it contains. The landfill operator should hold this information;

(d) The waste make up in the Arrowtown and Glenorchy landfills needs to be identified to ensure the risk to the water supply is minimised. This could be achieved by soil sampling;

(e) We have limited information on potentially contaminated sites. The ORC and the Ministry for the Environment conducted a study that identified all of the potentially contaminated sites in the area. This study is unconfirmed, and site visits together with sampling will be needed to establish the hazards beyond doubt;

(f) The Tucker Beach landfill needs to be carefully monitored to ensure it remains vegetated and if the trees die again, perhaps other solutions to the current cap may have to be investigated. Solutions may include installing an impermeable barrier and establishing vegetation on top of this. This is more of a risk because it is within land zoned for development;

(g) We did not establish when the landfill sites opened. This information would allow an estimate of waste volumes to be calculated. QLDC hold this information and we need to obtain it;

(h) There is a current mining licence in the Arrow River in land zoned for development. If the area was to be developed the mining licence may need to be revoked;

(i) We have licences giving maximum amounts of material mined but the actual amounts extracted may have been nil, or significantly less than was permitted.

4.7 Recommendations

The main areas of limited information relate to the contaminated sites. Prior to us being able to make definitive statements about the potential hazards to existing or new development further work will be required.

We recommend a staged approach. The information gained should be reviewed before deciding to proceed to the next stage.

- Investigate the site history;
- Site inspection, interview local residents;
- Photo ionisation detection;
- Soil sampling;
- Remediation measures;
- Monitor and validate the remediation measures.

QLDC would be of assistance in several of these stages particularly with site history, building plans records etc.

It would be prudent to provide information on mining, landfills and contaminated sites held by the council and make potential developers aware of the potential risks through PIMs and LIMs.

4.8 References

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www.landcare.cri.nz We used various papers from this site.

www.mfe.govt.nz/issues/contam.htm

Table 4 - Potential Contaminated Sites (Otago Regional Council, 2001)

CONTAMINATED_AREAS.NAME	Address	Town	Land_Use	map_reference	easting	northing	operation_start_date	operation_stop_date	operating	COMMENTS	PRIORITY	UNDER_INVESTIGATION	PREVIOUS_NAME	INFORMATION_SOURCE	Legal_Desc	Roll_Number	Assessment	Bar_No	Suffix	AREA_ID
Albert Town Landfill		Albert Town	Landfill	F40:086-080	2208600	5608000			FALSE	Site closed around 1995). Site was used for domestic waste disposal. Controls inadequate - some capping. [Former Site Id: 140]	Medium	FALSE		ESR Report by SEM NZ Ltd (March 2000) Vol 2.	SEC 42 SO 17404 SEC 52 SO 19768 BLK V LOWER WANAKA SD - RECREATION RESERVE	29082	7	0		26
Alpine Automart	Stanley Street	Queenstown	Service Station	E41:138-773	2113800	5577300			TRUE	[Former Site Id: 367] [Map Ref: E41: 138-773] [Lot: LOT 1 DP 4793] [VNZ: 27080/4900] [Site Phone: 442 8664]	Unclassified	FALSE		N/A	LOT 1 DP 4793	27080	49	0		47
Auto Wreckers Wanaka	Anderson Road	Wanaka	Automotive Dismantlers	F40:044-059	2204400	5605900			TRUE	[Former Site Id: 180] [Map Ref: F40: 044-059] [Lot: Sec 77 Blk XIV Lower Wanaka SD SO 20189] [VNZ: 29052/41700] [Site Phone: 443 1161]	Unclassified	FALSE		N/A	SEC 77 BLK XIV LOWER WANAKA SD	29052	417	0		110
Auto Wreckers Wanaka [2]	Anderson's Road	Wanaka	Automotive Dismantlers	F40:044-060	2204400	5606000			TRUE	[Former Site Id: 179] [Map Ref: F40: 044-060] [Lot: Lot 3 DP 19791] [VNZ: 29052/41200] [Site Phone: 443 1161]	Unclassified	FALSE		N/A	LOTS 2-3 DP 19791	29052	412	0		111
Wanaka Laundry and Linen Hire Service	Ballantyne Road	Wanaka	Tanning & Assoc. Trades						FALSE	Land use consent granted by Queenstown Lakes District Council on the conditions that assessment of the site be undertaken. This was scheduled to be done by Royds Consulting. Has been done but report not sighted. Postal address: PO Box 1562, Dunedin	Unclassified	FALSE	Ballantyne Rd/ Wanaka Leathers ltd/ Quality Tanning	N/A	UNITS C-D DP 300253 ON PT LOT 1 DP 17827	29061	38	0		120
BP Remarkable Motors (Boyd)	Camp Streets	Queenstown	Service Station						TRUE	[Former Site Id: 401] [Site Phone: 442 7530]	Unclassified	FALSE	Downing Motors Ltd. (1965)	Wises NZ Post Office Directory Otago Southland 1975						218
BP Wanaka (Dean Telfor)	Ardmore Street	Wanaka	Service Station	F40:039-054	2203900	5605400			TRUE	[Former Site Id: 251] [Map Ref: F40: 039-054] [Lot: LOT 2 DP 10132] [VNZ: 29053/6100] [Site Phone: 443 7424]	Unclassified	FALSE	Mansons Wanaka Motors Ltd (1971-75); Mason Wm (1956-61)	Wises NZ Post Office Directory Otago Southland 1956-61 and 1971-75	LOT 2 D P 10132	29053	61	0		221
Burt Alex		Queenstown	Service Station				1956	1961	FALSE	[Former Site Id: 1532]	Unclassified	FALSE		Wises NZ Post Office Directory Otago Southland 1956-61						295
Caltex Queenstown	Gorge Road	Queenstown	Service Station	E41:682-669	2168200	5566900			TRUE	[Former Site Id: 403] [Map Ref: E41: 682-669] [Lot: LOT 12, 13 DP 7727] [VNZ: 29106/27700] [Site Phone: 442 6412]	Unclassified	FALSE		N/A	LOTS 12-13 DP 7727	29106	277	0		313
Caltex Wanaka / Ardmore Service Station	Ardmore Street	Wanaka	Service Station						TRUE	Loaders Autocentre is noted in the "Register of Industries/Land Uses which use Hazardous Substances in the Otago Region" but has not been registered on this database. The site is adjacent to Caltex Wanaka but they are separate sites. [Former Site Id: 4	Unclassified	FALSE		N/A	LOT 1 DP 11431	29053	55	0		314
Central Otago Building Systems	60 Church Road	Luggate	Timber Treatment	G40:150-007	2215000	5600700	1964		TRUE	CCA and boron treatment, CCA plant owned and operated on site by Odlins. B plant seperate from CCA plant at Luggate Sawmill (according to	High	FALSE	Luggate Timber, Upper Clutha Transport, Carter Merchants,	Timber Preservation Authority 122A	LOTS 1-2 DP 20587 BLK VI TARRAS SD	29063	77	0		344

CONTAMINATED_AREAS.NAME	Address	Town	Land_Use	map_reference	easting	northing	operation_start_date	operation_stop_date	operating	COMMENTS	PRIORITY	UNDER_INVESTIGATION	PREVIOUS_NAME	INFORMATION_SOURCE	Legal_Desc	Roll_Number	Assessment	Bar_No	Suffix	AREA_ID
										Jim Smith 9/3/99). [Former Site Id: 42] Site visit by Brendon Love (30 April 1999) found staining in the wet t			Haast Timbers Ltd							
Central Otago Building Systems	60 Church Road	Luggate	Timber Treatment	G40:149-008	2214900	5600800	1964		TRUE	CCA and boron treatment, CCA plant owned and operated on site by Odlins. B plant seperate from CCA plant at Luggate Sawmill (according to Jim Smith 9/3/99). [Former Site Id: 42] Site visit by Brendon Love (30 April 1999) found staining in the wet t	High	FALSE	Luggate Timber, Upper Clutha Transport, Carter Merchants, Haast Timbers Ltd	Timber Preservation Authority 122A	LOTS 1-2 DP 20587 BLK VI TARRAS SD	29063	77	0		344
Central Otago Building Systems	60 Church Road	Luggate	Timber Treatment	G40:149-008	2214900	5600800	1964		TRUE	CCA and boron treatment, CCA plant owned and operated on site by Odlins. B plant seperate from CCA plant at Luggate Sawmill (according to Jim Smith 9/3/99). [Former Site Id: 42] Site visit by Brendon Love (30 April 1999) found staining in the wet t	High	FALSE	Luggate Timber, Upper Clutha Transport, Carter Merchants, Haast Timbers Ltd	Timber Preservation Authority 122A	LOTS 1-2 DP 20587 BLK VI TARRAS SD	29063	77	0		344
Central Otago Building Systems	60 Church Road	Luggate	Timber Treatment	G40:149-008	2214900	5600800	1964		TRUE	CCA and boron treatment, CCA plant owned and operated on site by Odlins. B plant seperate from CCA plant at Luggate Sawmill (according to Jim Smith 9/3/99). [Former Site Id: 42] Site visit by Brendon Love (30 April 1999) found staining in the wet t	High	FALSE	Luggate Timber, Upper Clutha Transport, Carter Merchants, Haast Timbers Ltd	Timber Preservation Authority 122A	LOTS 1-2 DP 20587 BLK VI TARRAS SD	29063	77	0		344
Central Otago Building Systems	60 Church Road	Luggate	Timber Treatment	G40:151-007	2215100	5600700	1964		TRUE	CCA and boron treatment, CCA plant owned and operated on site by Odlins. B plant seperate from CCA plant at Luggate Sawmill (according to Jim Smith 9/3/99). [Former Site Id: 42] Site visit by Brendon Love (30 April 1999) found staining in the wet t	High	FALSE	Luggate Timber, Upper Clutha Transport, Carter Merchants, Haast Timbers Ltd	Timber Preservation Authority 122A	LOTS 1-2 DP 20587 BLK VI TARRAS SD	29063	77	0		344
Central Otago Building Systems	60 Church Road	Luggate	Timber Treatment	G40:150-007	2215000	5600700	1964		TRUE	CCA and boron treatment, CCA plant owned and operated on site by Odlins. B plant seperate from CCA plant at Luggate Sawmill (according to Jim Smith 9/3/99). [Former Site Id: 42] Site visit by Brendon Love (30 April 1999) found staining in the wet t	High	FALSE	Luggate Timber, Upper Clutha Transport, Carter Merchants, Haast Timbers Ltd	Timber Preservation Authority 122A	LOTS 1-2 DP 20587 BLK VI TARRAS SD	29063	77	0		344
Central Otago Building Systems	60 Church Road	Luggate	Timber Treatment	G40:151-007	2215100	5600700	1964		TRUE	CCA and boron treatment, CCA plant owned and operated on site by Odlins. B plant seperate from CCA plant at Luggate Sawmill (according to Jim Smith 9/3/99). [Former Site Id: 42] Site visit by Brendon Love (30 April 1999) found staining in the wet t	High	FALSE	Luggate Timber, Upper Clutha Transport, Carter Merchants, Haast Timbers Ltd	Timber Preservation Authority 122A	LOTS 1-2 DP 20587 BLK VI TARRAS SD	29063	77	0		344

CONTAMINATED_AREAS.NAME	Address	Town	Land_Use	map_reference	easting	northing	operation_start_date	operation_stop_date	operating	COMMENTS	PRIORITY	UNDER_INVESTIGATION	PREVIOUS_NAME	INFORMATION_SOURCE	Legal_Desc	Roll_Number	Assessment	Bar_No	Suffix	AREA_ID
Central Otago Building Systems	60 Church Road	Luggate	Timber Treatment	G40:150-008	2215000	5600800	1964		TRUE	CCA and boron treatment, CCA plant owned and operated on site by Odlins. B plant seperate from CCA plant at Luggate Sawmill (according to Jim Smith 9/3/99). [Former Site Id: 42] Site visit by Brendon Love (30 April 1999) found staining in the wet t	High	FALSE	Luggate Timber, Upper Clutha Transport, Carter Merchants, Haast Timbers Ltd	Timber Preservation Authority 122A	LOTS 1-2 DP 20587 BLK VI TARRAS SD	29063	77	0		344
Central Otago Building Systems	60 Church Road	Luggate	Timber Treatment	G40:151-008	2215100	5600800	1964		TRUE	CCA and boron treatment, CCA plant owned and operated on site by Odlins. B plant seperate from CCA plant at Luggate Sawmill (according to Jim Smith 9/3/99). [Former Site Id: 42] Site visit by Brendon Love (30 April 1999) found staining in the wet t	High	FALSE	Luggate Timber, Upper Clutha Transport, Carter Merchants, Haast Timbers Ltd	Timber Preservation Authority 122A	LOTS 1-2 DP 20587 BLK VI TARRAS SD	29063	77	0		344
Central Otago Building Systems	60 Church Road	Luggate	Timber Treatment	G40:151-008	2215100	5600800	1964		TRUE	CCA and boron treatment, CCA plant owned and operated on site by Odlins. B plant seperate from CCA plant at Luggate Sawmill (according to Jim Smith 9/3/99). [Former Site Id: 42] Site visit by Brendon Love (30 April 1999) found staining in the wet t	High	FALSE	Luggate Timber, Upper Clutha Transport, Carter Merchants, Haast Timbers Ltd	Timber Preservation Authority 122A	LOTS 1-2 DP 20587 BLK VI TARRAS SD	29063	77	0		344
Central Otago Building Systems	60 Church Road	Luggate	Timber Treatment	G40:149-008	2214900	5600800	1964		TRUE	CCA and boron treatment, CCA plant owned and operated on site by Odlins. B plant seperate from CCA plant at Luggate Sawmill (according to Jim Smith 9/3/99). [Former Site Id: 42] Site visit by Brendon Love (30 April 1999) found staining in the wet t	High	FALSE	Luggate Timber, Upper Clutha Transport, Carter Merchants, Haast Timbers Ltd	Timber Preservation Authority 122A	LOTS 1-2 DP 20587 BLK VI TARRAS SD	29063	77	0		344
Central Otago Building Systems	60 Church Road	Luggate	Timber Treatment	G40:149-008	2214900	5600800	1964		TRUE	CCA and boron treatment, CCA plant owned and operated on site by Odlins. B plant seperate from CCA plant at Luggate Sawmill (according to Jim Smith 9/3/99). [Former Site Id: 42] Site visit by Brendon Love (30 April 1999) found staining in the wet t	High	FALSE	Luggate Timber, Upper Clutha Transport, Carter Merchants, Haast Timbers Ltd	Timber Preservation Authority 122A	LOTS 1-2 DP 20587 BLK VI TARRAS SD	29063	77	0		344
Central Otago Building Systems	60 Church Road	Luggate	Timber Treatment	G40:150-007	2215000	5600700	1964		TRUE	CCA and boron treatment, CCA plant owned and operated on site by Odlins. B plant seperate from CCA plant at Luggate Sawmill (according to Jim Smith 9/3/99). [Former Site Id: 42] Site visit by Brendon Love (30 April 1999) found staining in the wet t	High	FALSE	Luggate Timber, Upper Clutha Transport, Carter Merchants, Haast Timbers Ltd	Timber Preservation Authority 122A	LOTS 1-2 DP 20587 BLK VI TARRAS SD	29063	77	0		344
Central Timber Treatment Plant	Main Road	Hawea Flat	Timber Treatment	G40:127-147	2212700	5614700	1982		TRUE	Operating 1982-present (1999), tanalise timber and fence posts. According to Jim Smith (9/3/99) not much CCA treatment ongoing here. [Former Site Id: 2226] [Contact: Allen Gray] [Site Phone: 03 443	Medium	FALSE	Central Timber Treatments	Wises NZ Post Office Directory Otago Southland 1985 Timber Preservation Authority 27A	LOT 1 DP 25670 LOT 1 DP 21563 SECS 4-5 PT SEC 25 BLK IV LOWER HAWEA SD	29084	15	0		346

CONTAMINATED_AREAS.NAME	Address	Town	Land_Use	map_reference	easting	northing	operation_start_date	operation_stop_date	operating	COMMENTS	PRIORITY	UNDER_INVESTIGATION	PREVIOUS_NAME	INFORMATION_SOURCE	Legal_Desc	Roll_Number	Assessment	Bar_No	Suffix	AREA_ID
										1702]. Site visit by Brendon Love (30 April 1999)										
Cockburn, Jas C	Ballarat Street (29 - 35)	Queenstown	Service Station				1956	1961	FALSE	Site now used for retail. [Former Site Id: 1571]	Unclassified	FALSE		Wises NZ Post Office Directory Otago Southland 1956-61	SECS 1-3 27 PT SEC 26B BLK II QUEENSTOWN TN	29105	43	0		391
Frankton Auto Wreckers	Frankton Industrial	Queenstown	Automotive Dismantlers						TRUE	[Former Site Id: 186] [Site Phone: 442 2222]	Unclassified	FALSE		N/A						602
Frankton Automart / Mobil (M Murphy)	Frankton Road	Queenstown	Service Station				1961		TRUE	This Mobil Service station operates under the name of Frankton Automart. It used to be Frankton Service Centre Ltd. in 1961. [Former Site Id: 349] [Site Phone: 442 2077]	Unclassified	FALSE	Frankton Service Centre Ltd. (1961)	Wises NZ Post Office Directory Otago Southland 1961						603
Glenorchy Airfield			Airfield						FALSE	[Former Site Id: 238]	Unclassified	FALSE		N/A						661
Glenorchy Landfill	Shiel Street	Glenorchy	Landfill	E41:463-848	2146300	5584800		1999	FALSE	Site closed 1999. Was used for disposal of domestic waste. Capping and surface water diversion complete. Consented site. [Former Site Id: 110]	Medium	FALSE		ESR Report by SEM NZ (March 2000)	SEC 4 BLK XIX GLENORCHY TN	29111	205	0		662
Glenorchy Landfill	Shiel Street	Glenorchy	Landfill	E41:463-848	2146300	5584800		1999	FALSE	Site closed 1999. Was used for disposal of domestic waste. Capping and surface water diversion complete. Consented site. [Former Site Id: 110]	Medium	FALSE		ESR Report by SEM NZ (March 2000)	SEC 4 PT SECS 1/2 BLK XIX GLENORCHY TN	29111	201	0		662
Glenorchy Motors Ltd.	Mull Street	Glenorchy	Service Station	E41:452-850	2145200	5585000			TRUE	[Former Site Id: 350] [Map Ref: E41: 452-850] [Lot: SEC 27 BLK 1 TN OF GLENORCHY SO 14285] [VNZ: 29111/7800] [Site Phone: 442 9913]	Unclassified	FALSE	Smith Lawn I (1956-61)	Wises NZ Post Office Directory Otago Southland 1956-61	SECS 24-27 BLK I GLENORCHY TN	29111	78	0		663
Hawea Landfill	Domain Road	Hawea	Landfill	G40:128-139	2212800	5613900		1999	FALSE	Site closed June 1999. Was used for disposal of domestic wastes. Capping and surface water diversion completed. Consented site - groundwater monitoring every 3 months. [Former Site Id: 112]	Medium	FALSE		ESR Report by SEM NZ (March 2000)	LOT 1 DP 20555 LOT 1 DP 24534 BLK IV LOWER HAWEA SD	29082	62	0		696
Hawea Landfill	Domain Road	Hawea	Landfill	G40:128-139	2212800	5613900		1999	FALSE	Site closed June 1999. Was used for disposal of domestic wastes. Capping and surface water diversion completed. Consented site - groundwater monitoring every 3 months. [Former Site Id: 112]	Medium	FALSE		ESR Report by SEM NZ (March 2000)	LOT 1 DP 20555 LOT 1 DP 24534 BLK IV LOWER HAWEA SD	29082	62	0		696
Hawea Motors	Haast Pass Highway	Hawea	Service Station	G40:123-149	2212300	5614900			TRUE	[Former Site Id: 271] [Map Ref: G40: 123-149] [Lot: SEC 20 BLK III LOWER HAWEA SD, SO 18138] [VNZ: 29084/300]	Unclassified	FALSE		N/A	SEC 20 BLK 3 LOWER HAWEA SD	29084	3	0		697

CONTAMINATED_AREAS.NAME	Address	Town	Land_Use	map_reference	easting	northing	operation_start_date	operation_stop_date	operating	COMMENTS	PRIORITY	UNDER_INVESTIGATION	PREVIOUS_NAME	INFORMATION_SOURCE	Legal_Desc	Roll_Number	Assessment	Bar_No	Suffix	AREA_ID
High Peaks	Gorge Road	Queenstown	Dry Cleaning Establish.				1985	1985	FALSE	This site was noted as 19 Gorge Road but this was thought to be an error - should be 51 Gorge Road. Fire at site in 2000 - no longer active. [Former Site Id: 804] [Map Ref: E41: 682-666; 682-667] [Site Phone: 03 442 8621]	Unclassified	FALSE	Taylors Dry Cleaning & Laundry Services	Wises NZ Post Office Directory Otago Southland 1975-80 and Wises NZ Post Office Directory Otago Southland 1985	UNIT PLAN 24470 OVER LOTS 1-3 DP 7727 BLK XX SHOTOVER SD	29106	263	0		728
John Nolan	Faulks Terrace	Wanaka	Timber Treatment						FALSE	B plant. According to Jim Smith the site didn't do much treatment. Houses now on site. Mill burnt down during 1970 [Former Site Id: 2243] Map Ref: appr. F40:039-045	Low	FALSE		Timber Preservation Authority 330						786
Kingston Landfill		Kingston	Landfill	F42:743-318	2174300	5531800		1999	FALSE	Site closed in June 1999. Was used for the disposal of domestic wastes. Capping and surface water diversions in place. Consent 95282 requires groundwater monitoring every 3 months. Run 323A Kingston, Lorn nad Rockyside SD. [Former Site Id: 109	Medium	FALSE		ESR Report by SEM NZ (March 2000)						831
Luggate Closed Landfill	Church Road	Luggate	Landfill	G40:151-011	2215100	5601100		1995	FALSE	The site was used by the community for the purpose of domestic waste disposal until the mid 1990s. Landfill is consented and monitoring (surface water and groundwater) is required as part of consent 95537. None done to date. Compliance issue with QLDC	Medium	TRUE		ESR Report by SEM NZ (March 2000) and files						872
Makarora Landfill		Makarora	Landfill	F38:086-565	2208600	5656500		1999	FALSE	Site closed in June 1999. Was used for the disposal of domestic wastes. Capping and surface water diversion completed. Consented site requires groundwater sampling every 3 months. Pt 21027, Blk I, McKerrow SD SO 2059 [Former Site Id: 113]	Medium	FALSE		ESR Report by SEM NZ (March 2000)						894
Makarora Services / Makarora Country Café	SH 6	Makarora	Service Station						TRUE	Makarora Services is a different site to Makarora Tourist Centre. Makarora Services includes a café and petrol pump (Shell) [Former Site Id: 310] [Contact: Clinton O'Brian, Barbara O'Brain] [Site Phone: 443 8255 and 443 8207]	Unclassified	FALSE		N/A						895
Makarora Tourist Centre		Makarora	Service Station						TRUE	Makarora Tourist Centre is different to Makarora Services. MTC includes tourist accommodation and a petrol pump (Mobil). [Former Site Id: 270]	Unclassified	FALSE		N/A						896

CONTAMINATED_AREAS.NAME	Address	Town	Land_Use	map_reference	easting	northing	operation_start_date	operation_stop_date	operating	COMMENTS	PRIORITY	UNDER_INVESTIGATION	PREVIOUS_NAME	INFORMATION_SOURCE	Legal_Desc	Roll_Number	Assessment	Bar_No	Suffix	AREA_ID
McLeod, D M (Service Station)	Warren Street	Wanaka	Service Station				1940	1951	FALSE	This site used to be on Tenby. According to Colin Walker (ORC) the site changed to Upper Clutha Transport then moved to Ballantyne Road. Maybe dwellings on original site? [Former Site Id: 1737]	Unclassified	FALSE		Stone's Otago & Southland Directory 1940-51						953
Mount Cook & Southern Tourist Co Ltd	Rees Street (2)	Queenstown	Service Station				1951	1951	FALSE	Site now used for various retailers. [Former Site Id: 1748]	Unclassified	FALSE		Stone's Otago & Southland Directory 1951	LOT 1 DP 20357 BLK XIV QUEENSTOWN TN	29106	478	0		1053
Mt Iron Timber mill	Cnr Outlet Rd and Anderson Rd	Wanaka	Timber Treatment	F40:059-073	2205900	5607300	1982		TRUE	Only treat with boron, have never tanalised timber on site. Still active (23/11/01). Postal address: C/- Urquart, RD2, Wanaka. [Former Site Id: 41]	Low	FALSE		Timber Preservation Authority 17A	SECS 6 68-69 & 1 OF 5 BLK XIV LOWER WANAKA SD	29051	2	0		1055
Northern Southland Transport Ltd.	Gorge Road	Queenstown	Service Station						TRUE	According to Colin Walker (ORC, Q'town) this site is adjacent to the BP Bus Park (Site No: 368). Site would be used for supply of petrol and diesel to trucks. [Former Site Id: 2249] [Site Phone: 03 442 7240]	Unclassified	FALSE		Telephone directory (1999)						1145
Overton, W H		Queenstown	Service Station				1935	1935	FALSE	[Former Site Id: 1773]	Unclassified	FALSE		Stone's Otago & Southland Directory 1935						1231
Queenstown Airfield		Queenstown	Airfield	E41:737-683	2173700	5568300			FALSE	[Former Site Id: 239] [Map Ref: E41: 737-683] [Lot: PT SEC 5 BLK XXI SHOTOVER SD SO 1516 SO 6431] [VNZ: 29103/40400]	Unclassified	FALSE		N/A	LOT 1 DP 26426 PT SEC 5 BLK XXI SHOTOVER SD	29103	404	0		1331
Queenstown Auto Centre Ltd.	Industrial Place (4)	Queenstown	Service Station	E41:682-676	2168200	5567600			TRUE	This site is used as a workshop. Wakatipu Auto Services Ltd and Remarkable Motors amalgamated to form Queenstown Auto Centre Ltd. A second site (Queenstown Auto Centre Ltd is at 97 Gorge Road - see Site No: 1608). Queenstown Auto Wreckers/ Auto Spares	Medium	FALSE	Wakatipu, Remarkable Motors Ltd	Wises NZ Post Office Directory Otago Southland 1956-61	LOT 5 DP 18169	29107	75	0		1332
Queenstown Auto Centre Ltd (see also site No: 1805)	Gorge Road	Queenstown	Service Station						TRUE	According to Colin Walker (ORC, Q'town) Downing Motors Ltd is now Remarkable Motors. This has now amalgamated to form Queenstown Auto Centre Ltd. A second site is located in Industrial Place and is used as a workshop (see site No: 1805). [Former Site	Unclassified	FALSE	Remarkable Motors	Wises NZ Post Office Directory Otago Southland 1965 (Downing) and Wises NZ Post Office Directory Otago Southland 1956-61 (Wakatipu)						1333
Queenstown Auto Spares	Industrial Place (30, 40 and 48)	Queenstown	Automotive Dismantlers	E41:681-676	2168100	5567600			TRUE	Queenstown Auto Centre is a different site - see Area 1332. [Former Site Id: 190] [Map Ref: E41: 681-676] [Lot: Lot 18 DP 16439] [VNZ: 29107/8000(+A,B)] [Site Phone: 442 6089]. According to 1999 telephone directory, Queenstown Auto Wreckers was	Unclassified	FALSE	Queenstown Auto Wreckers	N/A	LOT 1 DP 27697	29107	80	0		1334

CONTAMINATED_AREAS.NAME	Address	Town	Land_Use	map_reference	easting	northing	operation_start_date	operation_stop_date	operating	COMMENTS	PRIORITY	UNDER_INVESTIGATION	PREVIOUS_NAME	INFORMATION_SOURCE	Legal_Desc	Roll_Number	Assessment	Bar_No	Suffix	AREA_ID
Queenstown Commercial Vehicle Services / BP Coach Park	Gorge Road	Queenstown	Service Station						TRUE	Queenstown Truckstop was noted in "Register of Industries/land users which use hazardous substances in the Otago Region" - no other info on this site. It may or may not be the same site as the BP Coach Park. The current site use includes vehicle servici	Unclassified	FALSE	Queenstown Truckstop?	Telephone directory (1999) / "Register of Industries/land users which use hazardous substances in the Otago Region"						1335
Queenstown Marinestop	Centennial Drive	Queenstown	Service Station						TRUE	This site was noted in "Register of Industries/land users which use hazardous substances in the Otago Region". No other info. on this site. [Former Site Id: 369] [Site Phone: 442 8665]	Unclassified	FALSE		"Register of Industries/land users which use hazardous substances in the Otago Region"						1336
Queenstown Motor Co Ld / Queenstown Motors Ltd.	Camp Street	Queenstown	Service Station				1956	1956	FALSE	According to Colin Walker Queenstown Motor Co. Ltd. and Queenstown Motors Ltd were the same. Now BP Service station? There are buildings on most of the site now. [Former Site Id: 1792]	Unclassified	FALSE		Wises NZ Post Office Directory Otago Southland 1956						1337
Ramsay Automotors	Industrial Place	Queenstown	Service Station				1961	1961	TRUE	Queenstown Motors have now become Ramsay Automotors. [Former Site Id: 1793] [Site Phone: 03 442 7350]	Unclassified	FALSE	Queenstown Motors Ltd. (1961)	Wises NZ Post Office Directory Otago Southland 1961						1346
Ratcliff Wrought Iron Centre	Industrial Place (57)	Queenstown	Metal Treatment				1971	1971	FALSE	[Former Site Id: 1139]	Unclassified	FALSE		Wises NZ Post Office Directory Otago Southland 1971	LOT 44 DP 16439 BLK XX SHOTOVER SD	29107	95	0		1352
Shaws Motors Ltd	35 Wiltshire Street	Arrowtown	Service Station	F41:809-770	2180900	5577000	1961	1961	TRUE	[Former Site Id: 1828] [Contact: J Mck Shaw] [Site Phone: 03 442 1808]	Unclassified	FALSE	Arrowtown Motors (1965)	Wises NZ Post Office Directory Otago Southland 1961 and Wises NZ Post Office Directory Otago Southland 1975.	SEC 1 BLK XIII ARROWTOWN TN2918234300	29182	342	0		1463
Shell Queenstown	Frankton Road	Queenstown	Service Station	E41:724-679	2172400	5567900			TRUE	[Former Site Id: 324] [Map Ref: E41:724-679] [Lot: LOT 1 DP 21015] [VNZ: 29103/31900] [Contact: Tom Mockford, Shirley Mockford] [Site Phone: 442 3500]	Unclassified	FALSE		N/A	LOT 1 DP 21015 SEC 1 SO 22923 BLK XXI SHOTOVER SD	29103	319	0		1478
Smith and Dennison	Council Commonage	Arrowtown	Timber Treatment						FALSE	No treatment carried out at this site (23/11/01). Now residential landuse. [Former Site Id: 17]	Unclassified	FALSE	portable	Timber Preservation Authority 483						1496
Smith Lawn I		Glenorchy	Service Station				1956	1961	FALSE	[Former Site Id: 1841]	Unclassified	FALSE		Wises NZ Post Office Directory Otago Southland 1956-61						1499
State Mines		Glenorchy	Mining & Extractive Indust.				1945	1945	FALSE	State sheelite mines - inactive. [Former Site Id: 1166]	Unclassified	FALSE		Stone's Otago & Southland Directory 1945						1534
Taylor Wltr J	Camphill Road (538)	Hawea Flat	Service Station				1956	1956	TRUE	Site currently used as workshop. Postal address: RD2, Wanaka [Former Site Id: 1859]	Unclassified	FALSE		Wises NZ Post Office Directory Otago Southland 1956	LOT 3 DP 7106 BLK V LOWER HAWEA SD	29082	170	0		1583
Tuck and Watkins Ltd	Frankton Junction	Queenstown	Timber Treatment						FALSE	According to Jim Smith this site is in Hamilton not Otago - requires confirmation before deletion. [Former Site Id: 18]	Unclassified	FALSE		Timber Preservation Authority						1634

CONTAMINATED_AREAS.NAME	Address	Town	Land_Use	map_reference	easting	northing	operation_start_date	operation_stop_date	operating	COMMENTS	PRIORITY	UNDER_INVESTIGATION	PREVIOUS_NAME	INFORMATION_SOURCE	Legal_Desc	Roll_Number	Assessment	Bar_No	Suffix	AREA_ID
Tucker Beach Landfill	Tucker Beach Road	Queenstown	Landfill	F41:741-718	2174100	5571800			TRUE	Site stopped receiving domestic waste <20 years ago. Capping and surface water diversion in place. Consented landfill - monitoring required under consent 95285. [Former Site Id: 108]	Medium	FALSE		ESR Report by SEM NZ (March 2000) and consent files	C L ADJ SEC 1 SO 23650 BLK II SHOTOVER SD	29071	463	0		1635
Tucker Beach Landfill	Tucker Beach Road	Queenstown	Landfill	F41:741-718	2174100	5571800			TRUE	Site stopped receiving domestic waste <20 years ago. Capping and surface water diversion in place. Consented landfill - monitoring required under consent 95285. [Former Site Id: 108]	Medium	FALSE		ESR Report by SEM NZ (March 2000) and consent files	C L ADJ SEC 1 SO 23650 BLK II SHOTOVER SD	29071	463	0		1635
Umbers Bryan L	Ardmore Street	Wanaka	Service Station				1961	1961	FALSE	According to Colin Walker (ORC) this site now has a building over it. [Former Site Id: 1869]	Unclassified	FALSE		Wises NZ Post Office Directory Otago Southland 1961						1643
Upper Clutha Transport	State Highway 6	Luggate	Service Station						TRUE	There is also an Upper Clutha Transport site at Balantyne Road, Wanaka (Site ID: 374) [Former Site Id: 354] [Map Ref: G40: 143-002; 144-001; 144-003; 145-001] [Lot: PT SEC 25 BLK VI TARRAS SD SO 7459; PT SEC 1 BLK VI SO 7373; PT SEC 1248R BLK VI TAR	Unclassified	FALSE		N/A	LOT 1 DP 12354 PT SECS 1 4 25 1248R BLK VI TARRAS SD	29083	91	0		1651
Upper Clutha Transport [2]	Balantyne Road	Wanaka	Service Station						TRUE	There is also an Upper Clutha Transport site at SH 6, Luggate (Site ID: 354) [Former Site Id: 374] [Site Phone: 443 7833]	Unclassified	FALSE		N/A						1652
Wakatipu Motors	Beach Street (49)	Queenstown	Service Station				1956	1961	FALSE	According to Colin Walker (ORC) this site now has buildings over it. Now Westpac Bank. [Former Site Id: 1881]	Unclassified	FALSE		Wises NZ Post Office Directory Otago Southland 1956-61	LOT 1 DP 22252	29106	455	0		1693
Wanaka Airfield		Wanaka	Airfield	F40:049-049	2204900	5604900			FALSE	[Former Site Id: 240] [Map Ref: F40: 049-049] [Lot: PT LOT 1 DP 17123] [VNZ: 29061/900]	Unclassified	FALSE		N/A	PT LOT 1 DP 17123 BLK III LOWER WANAKA SDA SD	29061	9	0		1707
Wanaka Closed Landfill	Riverbank Road / Ballantyre Road	Wanaka	Landfill	F40:056-035	2205600	5603500		1998	FALSE	The site was used as a general purpose domestic landfill for the Wanaka community until 1998. Review of existing data (consent 95276) is required to acertain site status. Classed as medium priority as there are no immediate environmental or health r	Medium	TRUE		ESR Report by SEM NZ (March 2000)	SEC 37 PT 38 BLK III LOWER WANAKA SD-GRAVEL RESERVE-	29061	27	0		1708
Wanaka Closed Landfill	Riverbank Road / Ballantyre Road	Wanaka	Landfill	F40:056-035	2205600	5603500		1998	FALSE	The site was used as a general purpose domestic landfill for the Wanaka community until 1998. Review of existing data (consent 95276) is required to acertain site status. Classed as medium priority as there are no immediate environmental or health r	Medium	TRUE		ESR Report by SEM NZ (March 2000)	SECS 1 2 BLK IX CARDRONA TOWN	29061	250	0		1708
Wanaka Leather Co	Ballantyne Road	Wanaka	Tanning & Assoc. Trades				1985	1985	FALSE	See also area 120. Maybe same site? [Former Site Id: 2184]	Unclassified	FALSE		Wises NZ Post Office Directory Otago Southland 1985						1709

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Waste liquid dump near Wanaka or Luggate Refuse tip	Crn Ballantyne & Riverbank Roads	Wanaka	Tanning & Assoc. Trades						FALSE	Liquid tannery wastes believed to have been deposited in vicinity of Wanaka dump. Site now used as waste transfer station. [Former Site Id: 43]	Unclassified	FALSE		N/A						1714
Luggate Sawmill (Colin Nolan)	Highway 6	Luggate	Timber Treatment	G40:147-001	2214700	5600100	1955	1978	FALSE	Not the same as Luggate Timber. Located at the other side of Church Road. Burnt down in 1978. Stage 1 (Preliminary) Investigation revealed no contaminants discharging from site.	Low	FALSE			PT LOT 2 DP 22087 BLK VI TARRAS SD	29063	79	0		1793
Fernhill Closed Landfill	One Mile Road	Queenstown	Landfill	E41:671-655	2167100	5565500		1965	FALSE	The landfill closed in approx. 1965 and was used by the local community for the purpose of domestic waste disposal. Registered well (E41010) is 281 m downgradient of the landfill. On investigation this well has never actually been drilled.	Low	FALSE	One mile tip	ESR Report by SEM NZ (March 2000)	SEC 1 SO 24350 SEC 106 PT SECS 105 107 109-110 BLK XX SHOTOVER SD - EASEMENT DP OVER PT SEC 110	29106	540	0	B	1809
Fernhill Closed Landfill	One Mile Road	Queenstown	Landfill	E41:668-655	2166800	5565500		1965	FALSE	The landfill closed in approx. 1965 and was used by the local community for the purpose of domestic waste disposal. Registered well (E41010) is 281 m downgradient of the landfill. On investigation this well has never actually been drilled.	Low	FALSE	One mile tip	ESR Report by SEM NZ (March 2000)	SEC 141 SO 22016 BLK XX SHOTOVER SD	29106	540	1		1809
Fernhill Closed Landfill	One Mile Road	Queenstown	Landfill	E41:671-655	2167100	5565500		1965	FALSE	The landfill closed in approx. 1965 and was used by the local community for the purpose of domestic waste disposal. Registered well (E41010) is 281 m downgradient of the landfill. On investigation this well has never actually been drilled.	Low	FALSE	One mile tip	ESR Report by SEM NZ (March 2000)	SEC 141 SO 22016 BLK XX SHOTOVER SD	29106	540	1		1809
Fernhill Closed Landfill	One Mile Road	Queenstown	Landfill	E41:668-655	2166800	5565500		1965	FALSE	The landfill closed in approx. 1965 and was used by the local community for the purpose of domestic waste disposal. Registered well (E41010) is 281 m downgradient of the landfill. On investigation this well has never actually been drilled.	Low	FALSE	One mile tip	ESR Report by SEM NZ (March 2000)	SEC 1 SO 24350 SEC 106 PT SECS 105 107 109-110 BLK XX SHOTOVER SD - EASEMENT DP OVER PT SEC 110	29106	540	0	B	1809
Fernhill Closed Landfill	One Mile Road	Queenstown	Landfill	E41:667-656	2166700	5565600		1965	FALSE	The landfill closed in approx. 1965 and was used by the local community for the purpose of domestic waste disposal. Registered well (E41010) is 281 m downgradient of the landfill. On investigation this well has never actually been drilled.	Low	FALSE	One mile tip	ESR Report by SEM NZ (March 2000)	SEC 1 SO 24350 SEC 106 PT SECS 105 107 109-110 BLK XX SHOTOVER SD - EASEMENT DP OVER PT SEC 110	29106	540	0	B	1809

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Helicopter Line - Queenstown Airport	Lucas Place	Frankton	UST Site	F41:742-674	2174200	5567400			TRUE	Two USTs (petrol) removed by BP Oil NZ Ltd. on 10 Feb 2000. Tank removal report done by WC and found on File MCS22. No signs of contamination. No material removed.	Unclassified	FALSE		UST pull report - inwards corr no.: 518930	L384602 LOTS 2-3 DP 12475 PT SEC 6 BLK XXXIV FRANKTON TN	29101	1	0	B	1812
Victoria Flats Landfill	Kawarau Gorge	Queenstown	Landfill	F41:968-657	2196800	5565700			TRUE	Consent 97163 to land, 97165 discharge to land, 97166 to take up to 5L per second of groundwater from a bore. Victoria Flats - supply water services, firefighting. 99100 to construct a bore	Low	FALSE		ESR report by SEM March 2000						1874
Victoria Flats Landfill	Kawarau Gorge	Queenstown	Landfill	F41:968-657	2196800	5565700			TRUE	Consent 97163 to land, 97165 discharge to land, 97166 to take up to 5L per second of groundwater from a bore. Victoria Flats - supply water services, firefighting. 99100 to construct a bore	Low	FALSE		ESR report by SEM March 2000						1874
Victoria Flats Landfill	Kawarau Gorge	Queenstown	Landfill	F41:968-657	2196800	5565700			TRUE	Consent 97163 to land, 97165 discharge to land, 97166 to take up to 5L per second of groundwater from a bore. Victoria Flats - supply water services, firefighting. 99100 to construct a bore	Low	FALSE		ESR report by SEM March 2000						1874
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