R.J. Hall **MIPENZ**

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1 December 1999

R.Finlay
Milward Finlay Lobb
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Dear Russell

Flood Risk Assessment Report : Proposed Subdivision Pt. Lot 5, Lots 7 - 9 DP 75206
Glen Lyon Rd, Blk III, VI & VII Strachey SD.
Applicant : Ruataniwha Farm Ltd., (F.Hocken).

Attached please find my report on the flood and associated risk on the land incorporated in the proposed subdivision and recommended mitigation measures that could be undertaken to enable parts of the area covered by the proposed subdivision to be used for residential dwellings. If you require clarification on the contents of this report please feel free to contact me at your earliest convenience. Thank you.

Yours faithfully

R.J Hall
Civil & Environmental Engineering Consultant.

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Report : Flood Risk Assessment Proposed Subdivision
Pt. Lot 5, Lots 7, 8 and 9 Blk III, VI, VII, Strachey S.D.
Glen Lyon Road, Twizel.

R.J.Hall
Civil & Environmental Engineering Consultant

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1.0 Preamble.

The proposed subdivision lies to the north east of Glen Lyon Road, Twizel and is bounded in the west by the Frazer Stream and to the east, the Twizel River. A third water course of reasonable proportions, Dry Stream bisects the roughly triangular block of land lying between the Frazer Stream and the Twizel River. These three watercourses merge near the south eastern corner of the proposed subdivision to form the apex to the triangle. A cursory assessment of flood risk associated with the proposed subdivision was made by P.Lees (1999). That report concluded that the whole of the area enclosed in the proposed subdivision was vulnerable to flooding from the three watercourses described above and " If development of this area is anticipated, the siting and structural design of any proposed dwellings should be approached with a great deal of caution." In arriving at this conclusion based on anecdotal evidence and his own knowledge of the area he considered that break outs from the Twizel river in particular "could result in significant water velocities, transportation and subsequent deposition of gravels from the river bed and scouring of surrounding lands ". No attempt was made to quantify either the areas which he considered could be affected in this manner, nor the likely velocities and depths involved and hence no attempt was made to ascertain what categories of risk were involved in the manner required in Section 6 (e) (i) and (ii) of the Mackenzie District Council Proposed District Plan September 1999.

The purpose of this assessment is to endeavor to quantify the nature, scale and distribution of flood and associated risk in the proposed subdivision area an provide some direction the type of mitigation measures which could be employed in order to enable parts of the area to be used for residential purposes (dwellings).

2.0 Mackenzie District Plan

Section 6, Residential Zone Rules, subsection (e)(i) prohibits the erection of habitable residential buildings within areas of " High Flood Risk " whilst subsection (e)(ii) permits habitable residential buildings in areas of "Low Flood Risk " provided floor levels are set a minimum of 150 mm above the 0.2 % annual exceedance probability flood level (i.e. a 500 year return period flood). "High Flood Risk and Low Flood Risk " are defined in Section 2 as respectively those areas where the product of flood depth and velocity equal or exceed 1 (i.e. unity) or are less than 1 in the 0.2 % AEP flood event. In order therefore to ascertain if the proposed subdivision is suitable for habitable residential dwellings an assessment needs to be made of the extent of potential flooding in a 0.2 % AEP event and the likely distribution of velocities and depths associated with such flooding. Secondly the Plans reference is to flood events with the prescribed probability of occurrence based on the qualifying statement in brackets which forms part of subsections 6(e)(i) and (ii).

Red – residential buildings within areas of " High Flood Risk "
Blue – habitable residential buildings in areas of "Low Flood Risk "

– Insure Low
AMI – Sth Canterbury
Kerry Lamsey
$ no & normal Rates
High – Not cat all
Quote of $10K of fences = $ 68-55/yr
(flood, fire, vehicle)
(–) No

3.0 Summary

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The area enclosed and forming the proposed subdivision is in essence is part of the Frazer Stream, Twizel River fan and incorporates an inter-fan depression. The construction of the Pukaki - Ohau Canal which passes to the north of the proposed subdivision has effectively restricted the area of the remnant fan that these watercourses have access to in times of flood. The culverts beneath the canal are considered sufficiently large to pass the 500 year floods although the heading up required in such an event and the associated up-stream ponding which occurs will effectively reduce peak flows by an estimated 10 % so that the 500 year peak discharge downstream of the culverts will be 90 % of that approaching the culverts on the upstream side. Topography in the area where the Twizel River emerges from its culvert is such that the true left berm is lower than the true right berm. This effect diminishes as the stream progresses downplain but is considered sufficient to encourage approximately two thirds of the out of channel spill in the 500 year event to disperse away from the true left bank towards SH 8 in the vicinity of the Twizel airport, the balance spilling south west towards the Frazer - Twizel confluence.

The Frazer stream is effectively bounded on its true right bank by a high terrace and as a consequence out of channel spill from this channel is predominantly to the south east to merge with that spilling from the Twizel River and Dry Stream. The passage of these flood spills down plain across the proposed subdivision in the 500 year event can be expected to cover sufficient area to warrant the assumption that the whole of the area of the subdivision could be affected to a greater or lesser extent. Initially flow is likely to be confined to old swales etched into the surface by water during the evolution of the alluvial fans which comprise this area. As flood spills increase towards their respective peaks these flow paths could surcharge spill and hence coalesce.

Those area immediately adjacent to the water courses can be expected to erode during flood events in events of a much lesser intensity than the 500 year event and as a consequence regard needs to be had for the risks associated with this type of flood induced action. The possibility exists for avulsions to occur during or as a consequence of large floods with return periods less than the 500 year event and again regard should be had for the risks associated with such occurrences. The potential exists also for the occurrence of high intensity localised storms (e.g. summer convective storms) although the flooding which is to be expected from such events is considered likely to be less severe than that associated with 500 year events on the major watercourses in the area. These events will be of a relatively short duration typically up to 1 hour and have the potential to surcharge the swales but will clear relatively quickly. Provisions made to mitigate flooding from the major watercourses are expected to ensure that the effects of these short duration events are equally mitigated. To the west of Dry Stream across to the Twizel river is an area where groundwater emergence and wet ground conditions occur, these conditions being most noticeable following persistent rain. These conditions will inhibit the losses which normally occur during rainstorms and as a consequence will tend to exacerbate surface flooding effects during any rainstorms where high antecedent rainfall conditions have occurred.

In addressing the flood potential of the site it is also necessary to evaluate the risks associated with the Pukaki - Ohua Canal arising from catastrophic failure of that structure up-plain from the subdivision. It is considered that such failure is most likely to arise from movement on the Osler Fault where it crosses the canal alignment near the Frazer Stream. In making this assumption it is necessary also to ascribe a probability of movement on a scale sufficient to destabilize the structure sufficiently to induce failure. It is assumed that movement on the fault is most likely to arise from sympathetic movement induced by an earthquake on the Alpine Fault rather than the Osler Fault in isolation. The actual risk though for the subdivision must modify this probability of occurrence to allow for release to either side of the canal and for failure to occur at points along the canal which will not result in canal breach flood waters reaching the subdivision. The probability for movement on the Alpine Fault has been obtained from Yetton M. D. (1998).

Having determined the scale of potential flood releases either from the rivers or the failure of the canal an assessment is then made on the likely depths and velocities of these floodwaters across the proposed subdivision, the use of these values to determine the scale of flood risk required by the Plan and consideration of surface erosion and sediment transport potential of these floodwaters. Finally a strategy can be developed incorporating a combination of both avoidance and mitigation measures to enable habitable residential building to be erected in areas designated as Low Flood Risk. Any areas which cannot meet the Low Flood Risk criteria of the Plan must be excluded as potential sites for dwellings.

Blue Areas

4.0 Conclusions

4.1 The whole of the proposed subdivision is subject to inundation to varying degrees from flood spill from either or all of the following Frazer Stream, Dry Creek or the Twizel River in a 0.2 % AEP flood event.

4.2 The whole of the proposed subdivision is subject to the risk of surface flooding in short duration high intensity localised rainstorms with an AEP of 0.2 %.

4.3 The natural (active) banks of the Frazer Stream, Dry Creek and Twizel River are vulnerable to stream bank erosion during and as a consequence of flood flows generally with an AEP of 20 %. The extent to which such erosion is likely is proportionately greater for the Frazer Stream and Twizel River than for Dry Creek because of the likely size and duration of events on these two watercourses relative to Dry Creek.

4.4 In times of major flood events probably with AEP in excess of 2 % and or where aggressive channel aggradation or channel obstruction occurs in lesser events major channel re-alignment is possible (avulsion). It is opined that where such phenomena

occur they are most likely to be confined to the low lying berm areas immediately adjacent to the present watercourses.

4.5 In a 0.2 % AEP flood event on the three watercourses a 10 % reduction in flood peak can be expected to occur as the flood hydrograph is routed through storage on the upstream side of the Pukaki - Ohau Canal. Furthermore it is estimated that out of channel spill from the Twizel river in the 0.2 % AEP event will be proportionately greater to the true left than to the true right estimated conservatively at 2/3 to 1/3 respectively.

4.6 Under normal channel conditions it is estimated in a 0.2 % AEP event that the proportion of flow retained in the confines of the active stream channels will be in the order of a 20 % AEP flood flow for each of the three watercourses, the balance being spilt onto each channels flood plains.

4.7 The following flood flows have been estimated for the three watercourses considered using Twizel River hydrometric records and synthetic flood estimation techniques with 10 % routing effects incorporated

AEP (%)		Frazer Stm. (cumec)	Dry Ck. (cumec)	Twizel R. (cumec)
20	(5 year)	35	20	50
0.2	(500 year)	88	41	119

4.6 The estimated flood spills into the proposed subdivision in a 0.2 % AEP event is assessed as follows

Frazer Stream (cumec)	Dry Creek (cumec)	Twizel River (cumec)	Combined Flow (cumec)
53	21	23	97

Adopt 100 cumec

4.7 The estimated peak outflow from the Pukaki - Ohau Canal during catastrophic failure to the true right wall only is estimated at 240 cumec (3.5 m cubic metres in 1.5 hrs. : Method - Allen P.H.[1995]). Allowing for 30 % loss to existing stream channels and a further 30 % peak reduction over the flood plain prior to arrival of the surge into the proposed subdivision through floodplain storage dispersal and attenuation residual peak flow is estimated at 113 cumec.

4.8 The probability of 0.2 % AEP event generated flood spill into the proposed subdivisi in the next 50 years estimated at 10 %.

4.9 The probability of catastrophic failure of the Pukaki - Ohau Canal generating a 115 cumec flood surge in the proposed subdivision in the next 50 years is estimated at 10 to 15 %.

4.10 On the assumption that in a 0.2 % AEP event flood waters will be confined on the floodplain to between 1 / 3 to 1 / 2 of any contour arc centered on the Frazer Stream and Twizel River confluence, bounded by the true right bank of the Frazer Stream and similarly the Twizel River and that uniform flow occurs then the following average flow parameters could be expected in the proposed subdivision

Velocity (m / s)	Velocity Head (m)	Depth (m)	Static Depth (m)	Risk Parameter (Velocity x Depth)
0.6 to 0.7	0.02	0.19 to 0.22	0.21 to 0.24	0.12 to 0.14

Note : localised effects could elevate flows or cause localised accelerations to occur in the absence of avulsion, which could increase the risk parameter above those determined by analysis. It is considered unlikely that risk parameters values in excess of 0.6 will occur in such circumstances likely. Where avulsions occur the risk parameter may well exceed 1.0. Static depth refers to " stalled flow " i.e. the conditions prevailing upstream of a flow obstruction where ponding is evident.

4.11 Depths, velocities, static depths and risk parameters for the catastrophic canal failure scenario will be comparable to those determined for the 0.2 % AEP natural flood event.

4.12 Except where deep soils occur, the risk of scour arising and destabilizing building foundations in the proposed subdivision is considered minimal because of the limited depth and associated low velocity of the floodwaters on the floodplain combined with scour resistance of paved and grassed surfaces in combination with dense sandy gravel subsoil profiles. Bare soil areas particularly if located in swales where flood waters concentrate may experience erosion but this will be limited in depth by the gravel subsoil. These comments do not apply where deep (i.e. greater than 600 mm) of silts or sandy silts exist over the underlying gravels or in area vulnerable to lateral stream bank erosion or avulsion.

4.13 Active sediment transport and deposition over the greater part of the proposed subdivision in areas away from the active watercourses of the Frazer Stream, Dry

Creek and Twizel River and where stream bank erosion and avulsion is unlikely is expected to be limited to fine suspended sediment. At active stream bank erosion sites and the areas immediately downstream plus those areas where an avulsion occurs the erosion, transport and deposition of coarse fractions ranging from coarse sand through gravel to cobbles is possible in addition to the fine sediments previously described.

4.14 Differentiation between areas at risk from erosion, deposition, avulsion and where elevated risk parameters are likely and / or excessive ground saturation (high water tables) can arise versus areas where such risks are minimal is considered possible and reasonable on the basis of the field evaluations, knowledge of the flood propensity of the area, and the assumption and calculations undertaken as part of this assessment.

Appended to this report is a copy of the proposed subdivision plan marked up to define four separate zones associated with varying degrees of risk to flooding, erosion, deposition, avulsion and high groundwater - excessively wet ground conditions. Those areas cross hatched in red or blue are areas where the construction of dwellings could only proceed on a case by case basis having particular regard to the vulnerability of a particular site to any or all of the constraints referred to above. These physical constraints need to be well understood and quantified and acceptable engineering solutions developed sufficient to meet the requirements of the Building Act 1991. Where this cannot be demonstrated no habitable residential dwellings should be permitted i.e. it must be assumed in the absence of such site specific information and engineering design solutions that such areas have a status comparable to " High Flood Risk " under the Plan.

Those areas edged in pink outside the red and blue cross hatched areas are areas where active stream bank erosion is considered likely and should be avoided. This areas is the riparian margins of Dry Creek. The subdivision proposal requires the provision for land to be set aside along this watercourse for public access purposes i.e. esplanade provisions of Part IV (A) Section 24 of the Conservation Act 1987. A set back of not less than 20 m from the landward edge of each side of the esplanad reserve is recommended to minimize the risk of foundation instability to habitable residential dwellings arising from active stream edge erosion and associated slumping

This is area we build on.

It is considered that the balance of the proposed subdivision area is suitable for the erection of habitable residential dwellings provided careful consideration is given on a site by site basis to ensure that the requirements of Section 6 (e)(ii) and the relevant requirements of the Building Act 1991 can be met in full. In this regard it is suggested that mitigation measures such as (but not limited by) pole housing, buildings positioned over groundline basement garages and compacted gravel foundation pads could be considered to provide the necessary compliance's required

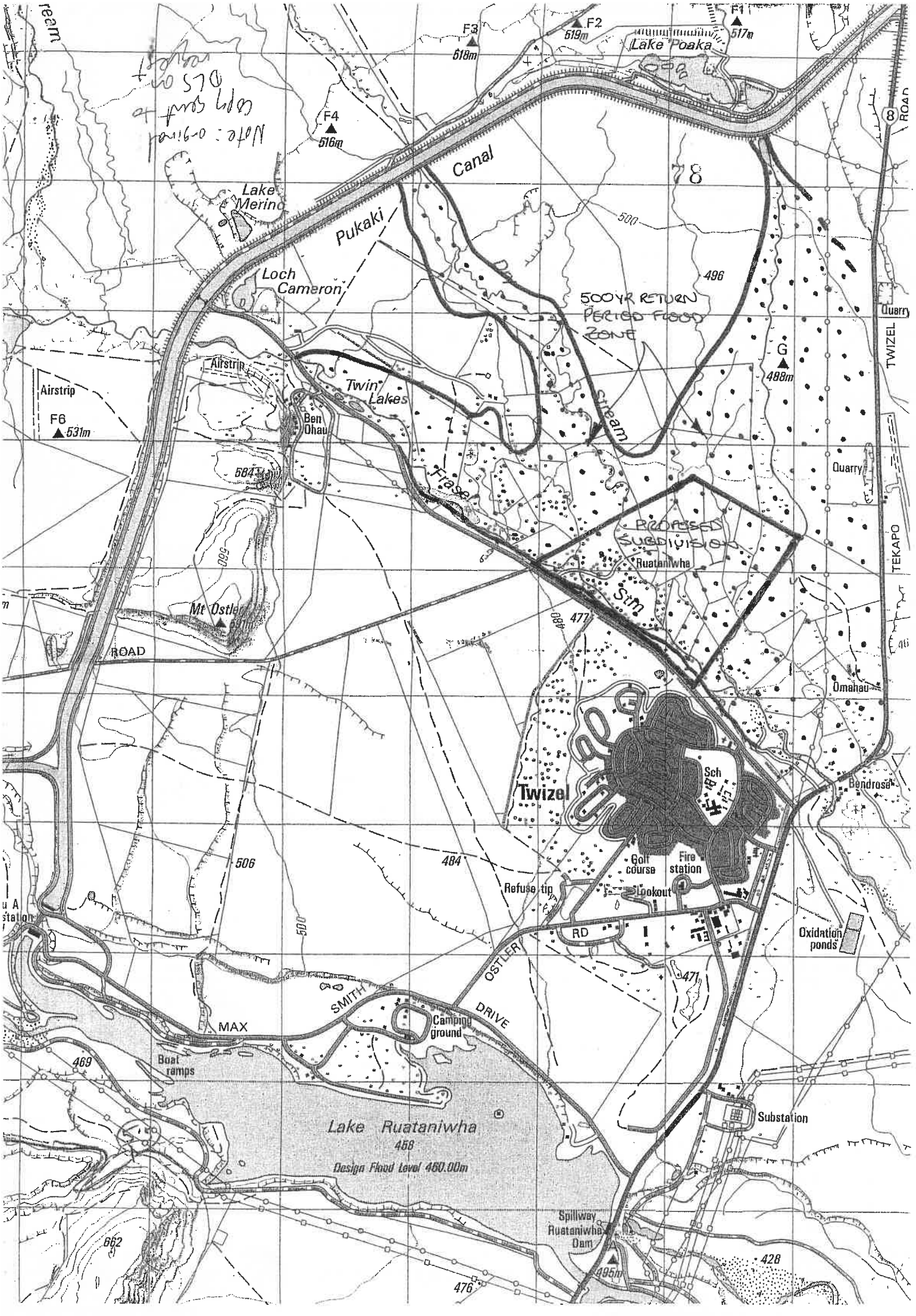
in the Resource Management Act 1991 and the Building Act 1991 for the purposes of this subdivision application.

5.0 References.

5.1 Allen P.H. (1995) " Dam Break Mechanisms " NZSOLD Newsletter No. 31, January 1995.

5.2 Yetton M.D., Wells W., and Traylen N.J. (1998) "The Probability and Consequences of the next Alpine Fault Movement " EQC Research Report 95 / 193.

5.3 Lees P.(1999) Canterbury Regional Council correspondence to Milward Finlay Lobb. File No. AD5T - 0002, Ref 99099. " Flood Hazard Assessment - Proposed Subdivision, Ruataniwha Station, Glen Lyon Road, Twizel. Subdivision of Pt. Lot 5 and Lots 7 - 9 DP 75206."


F3
518m
F2
519m
F1
517m
Lake Poaka
F4
516m
Canal
Lake Merino
Pukaki
Loch Cameron
500
496
500YR RETURN PERIOD FLOOD ZONE
Quarry
TWIZEL
G
488m
Airstrip
Airstrip
F6
531m
Twin Lakes
Ben Ohau
Stream
Fraser
Quarry
PROPOSED SUBDIVISION
Ruataniwha
TEKAPO
Stm
Mt Ostler
477
ROAD
Omahau
Twizel
Sch
Bendrosa
506
484
Golf course
Fire station
Refuse tip
Lookout
RD
Oxidation ponds
OSTLER
471
SMITH
DRIVE
MAX
Camping ground
469
Boat ramps
Lake Ruataniwha
458
Design Flood Level 460.00m
Substation
Spillway
Ruataniwha Dam
662
476
495m
428