Attachment E: Otago Regional Council response

Our Reference: A850487

27 October 2015

Queenstown Lakes District Council
Private Bag 50072
Queenstown 9348

Attention: Kim Banks, Senior Planner (Policy)

Dear Kim

Proposed Shotover Country Special Housing Area

In response to your letter of 28 September 2015, the Otago Regional Council (ORC) has been asked by Queenstown Lakes District Council to comment on the application to create a special housing area (SHA) on a low terrace of the Shotover River on the true left bank downstream from the State Highway 6 bridge.

The applicant (Shotover Country Limited) has provided the ORC with further information regarding the flood hazard for the proposed development site. The report was written by David Hamilton and Associates and titled, 'Shotover Country Ltd – Special Housing Area, Proposed Extension to Shotover Country Zone: Review of Proposed Development on Design Flood levels and Mitigation.' The report states that the proposed SHA is located in an area that may be subject to flood flows and therefore protection (in the form of raising the ground level by over 2m in general) is required.

Evidence provided by ORC staff (supporting the ORC submission on private plan change No. 41 by Shotover Country Ltd) provides detail on the Shotover River flood and erosive hazards, and is attached as Appendix 1. This information is also relevant for the current proposed development. The attached submission refers to previous work undertaken to assess high consequence events such as significant rockfall or landslide activity. A 2015 report by ORC entitled 'Seismic hazards in the Queenstown Lakes district' also provides a recent summary of current knowledge of earthquake hazards, including subsequent effects such as landslides, rockfall and channel aggradation. These assessments were not made in the context of a development such as the proposed SHA, but do provide sufficient background and justification to warrant a site-specific assessment for the proposed activity.

On 22 October 2015, Shotover Country Ltd provided a map showing the extent of land between certain elevations in the vicinity of the proposed SHA. However, no contextual information accompanied this map to address the ORC's concerns. Therefore, ORC considers Shotover Country Ltd has still not demonstrated sufficient consideration of the effect of high consequence events.

In addition to the information in Appendix 1, ORC emphasises that the Shotover River bed is a dynamic environment which experiences changes in channel location, fairway width, vegetation coverage as well as increases and decreases in bed level (Appendix 3). The Shotover River fairway (area of active river channel) has decreased in width between the years 1956 and 2014. This has constrained the ability of the river to migrate across the floodplain (Appendix 2) or occupy the full original bed when in flood. The reduction in the fairway width has occurred as a result of a number of factors including: vegetation growth, construction of flood protection structures, infrastructure, and housing development. The raising of a low terrace on the true left bank section of the proposed SHA is also likely to reduce the width of the active fairway and wider flood plain, further adversely affecting the flood levels in the area, as indicated in David Hamilton and Associates report (section 3.4 – model results). Constraining the channel leads to a change in flood processes and may cause increased water level, bed scour and bank erosion.

The flood control works (training line) and associated gravel extraction carried out by the ORC aim to direct flood flows in the Shotover River to exit the delta at the bottom left corner and to prevent a right side alignment of the river. It is proposed to locate the SHA on the left bank in close proximity to the preferred alignment of the Shotover River during high flows. Placing high density residential development in close proximity to a river with dynamic bed morphology, and which experiences flooding to a considerable depth and velocity should be considered carefully.

David Hamilton and Associates propose works to mitigate the flood and erosion hazards for the proposed SHA. However, the level of detail provided in the report is not sufficient for a full assessment of the proposed mitigation works, given the scale of the proposed development. If approved, any mitigation works are likely to require ongoing maintenance and repair following flood events. The responsibility for carrying out those works has not been clearly defined.

As noted above, there is potential for the area to be affected by seismic hazards. Development of a raised terrace raises questions about the proposed infill design to prevent effects such as lateral spreading through mobilisation of the underlying terrace embankment toward the river. The Shotover River basin (including the delta) where the development is proposed, is shown to be on ground or soils that are 'possibly susceptible' to liquefaction (Opus, 2005). Tonkin and Taylor (2012) completed a liquefaction assessment for the true right bank of the Shotover River and mapped it as having a 'probably low' liquefaction risk, mapping was not undertaken on the true left bank. No demonstrable remediation of this risk has been noted for the proposed SHA.

Yours sincerely

Fraser McRae
Director Policy, Planning and Resource Management

Appendix 1. **Otago Regional Council submission evidence, plan change (private) No. 41, Shotover Country Ltd**

BEFORE THE QUEENSTOWN LAKES DISTRICT COUNCIL

IN THE MATTER of the Resource Management Act 1991

OTAGO REGIONAL COUNCIL SUBMISSION EVIDENCE
PLAN CHANGE (PRIVATE) No. 41, SHOTOVER COUNTRY LTD.

EVIDENCE OF RAMON BLAIR STRONG

DATED 9 MARCH 2011

BRIEF OF EVIDENCE BY RAMON BLAIR STRONG

INTRODUCTION

1. My full name is Ramon Blair Strong.

2. I am authorized by the Otago Regional Council (ORC) to present this evidence on behalf of the ORC in relation to the submission the ORC has made on Plan Change (Private) No. 41 for Shotover Country Limited.

3. I hold a Bachelor of Engineering in Civil Engineering from the University of Canterbury. I am a Chartered Professional Engineer.

4. I have worked for 20 years in technical and managerial roles in the field of civil engineering throughout New Zealand, specifically in the fields of geotechnical engineering and river engineering, the latter encompassing both the operation of flood control and land drainage infrastructure and the investigation, numerical modelling and management of flood hazards. I have provided expert evidence to the Environment Court in regard to river management works proposed for the Shotover delta, a matter I will refer to in more detail in my evidence.

5. I am employed by the ORC as Manager Engineering, a position I have held since October 2004. I have management responsibility for the operation and on-going development of the flood control and land drainage schemes that the ORC is responsible for. Other responsibilities I have within the ORC including forming part of the Duty Flood Manager roster within Council and representing the ORC on the national River Managers Forum.

6. More specifically in relation to the Shotover delta, my role also involves management responsibility for implementing the river management works for the Shotover delta, including directing gravel extraction activities. Over the past three years I have also participated in the Shotover Working Party, a collaborative arrangement between ORC, QLDC and QAC in regard to the various infrastructure developments around the margins of the Shotover delta and the potential river management benefits those activities may provide.

7. I have read and agree to comply with the Code of Conduct for Expert Witnesses in the Environment Court Practice Note for Expert Witnesses (2006). I have complied with it in the preparation of this evidence.

8. I have visited the Shotover delta on many occasions over the past five years and make regular observations of the changes in river morphology from the Remarkables Skifield access road.

SCOPE OF EVIDENCE

9. My evidence relates to the nature of the physical environment and the importance of that context when considering the District Plan Change proposed, in particular the proposed change in land use of the lower terraces.

10. The matters covered in my evidence are:
    a. The fluvial geomorphology of the site;
    b. Matters influencing quantification of flood hazard as it relates to the site;
    c. Natural processes/ hazards that have the potential to influence both the flood and erosive hazard affecting the site.

12. In my opinion the decision made in to this District Plan change proposal requires a full appreciation of both what is known and not known about natural hazards as they relate to this area, and the appropriateness of the development ultimately proposed in this context.

EXECUTIVE SUMMARY

13. It is appropriate to apply the principles of NZS9401:2008 Managing Flood Risk – A Process Standard (the Standard) to the assessment of the flooding risk of this proposal and its consequential effects. The Standard represents modern thinking in regard to flood risk, adopting a holistic approach to consideration of flood risk that recognizes aspects such as the potentially dynamic nature of the hazard.

14. The Shotover River catchment encompasses a large area of geologically unstable and seismically active mountainous terrain immediately east of the Southern Alps. As such the true scale of the hazard associated with the development of low-lying areas adjacent to the Shotover River is largely

unknown. A precautionary approach to the assessment and management of flood risk is required.

15. The subject site is currently undeveloped and unoccupied. No persons or material property are at risk on the site. The proposed development creates a risk that does not exist at present by changing the land use to one that is vulnerable to river flooding and erosion, a hazard that will be further exacerbated in the future by variations (varying both in intensity and duration) in sediment supply. Such variations are inevitable and are likely to add to channel instability and the risk of any development being subject to erosive attack by the river.

16. The proposal is not readily reversed once it has been constructed and therefore creates a permanent risk requiring mitigation, monitoring and, at some future stage, intervention.

NZS9401:2008 Managing Flood Risk

17. My assessment of the proposal has been guided by NZS9401:2008 Managing Flood Risk – A Process Standard, published by Standards New Zealand. This Standard was prepared under the supervision of a committee which included representatives of the Department of Prime Minister and Cabinet, Ministry for the Environment, Insurance Council, ORC and two territorial authorities. It was first published, in its current form, on 17 November 2008.

18. In the Outcome Statement of NZS9401:2008 it is stated that its purpose is to:
Provide an agreed best practice for local and central government, professionals (planners, engineers, hydrologists, scientists, risk managers, lawyers, and so on), developers, utility suppliers, property owners, and communities to ensure that proper consideration is given to all aspects of flood risk when making decisions, so that over the longer term, the risk of adverse effects from flooding decreases.

19. In the section headed Scope it is stated that NZS9401:2008:
Should be applied to decision-making whenever flood risk is a factor, no matter the scale or purpose.

20. For these reasons I consider it appropriate to apply NZS 9401:2008 to the assessment of the flooding risk of this proposal and its consequential effects.

21. NZS9401:2008 presents six implementation principles to be followed in managing flood risk. Of particular relevance here are the following principles:

(b) *An understanding of natural systems and catchment processes and associated interactions is fundamental to managing flood risk. River systems are sensitive to intervention and the consequences of intervention need to be understood*;

(c) *An understanding of the catchment-wide interaction of natural and social systems and the effects of human interventions on the catchment is necessary to provide optimum sustainable solutions*;

(e) *All possible forms and levels of management are considered for existing assets within flood risk areas, and preference shall be given to avoidance where new development is proposed inside flood hazard areas*, and;

(f) *Residual risk remaining after mitigation (such as physical works and planning controls) shall be explicitly recognized and managed by readiness, response, and recovery activities, and planning. A level of residual risk will remain. This should be monitored to ensure the level remains tolerable and that other opportunities are taken to reduce this should they become evident.*

22. NZS9401:2008 evolved from the document "Managing Flood Risk, Draft New Zealand Protocol" ("Flood Protocol") published by the Centre for Advanced Engineering in December 2005. The Flood Protocol was developed by the Flood Risk Management Group comprising representatives of the Department of The Prime Minister and Cabinet, Ministry for the Environment, Local Government New Zealand (LGNZ), Institution of Professional Engineers New Zealand, The Centre for Advanced Engineering and three regional councils, including the ORC.

23. The conversion of the Flood Protocol to a New Zealand Standard was supported by LGNZ and formed part of a suite of measures promoted by LGNZ aimed at improving the way central government, local government and individuals manage flood risk in New Zealand. A copy of the LGNZ Position Statement issued in February 2007 is attached as Attachment A. Of particular note are the solutions proposed in relation to flood hazard assessment and residual risk, inappropriate Resource Management Act outcomes, *de facto* national standards (including the Building Regulations 1992 compliance standard regarding the 2% annual probability of surface water entering buildings) and repeat flood events.

SHOTOVER RIVER FLOOD AND EROSIVE HAZARD

24. I will now describe the Shotover River flood and erosive hazard as it applies to the site in question.

1 Flood Hazard

25. The Shotover River catchment lies east and north of Lake Wakatipu. The outline of the catchment is presented in Attachment C as Figure 1. It comprises part of the Clutha River catchment, accounting for 5% (1,100 km^2) of the total catchment area of 21,400 km^2.

26. The Shotover River is a tributary of the Kawarau River, whose source is Lake Wakatipu. Immediately upstream of the Kawarau confluence the Shotover adopts a delta form, reflecting the marked change in sediment transport potential between the Shotover and Kawarau Rivers, a function of the much flatter water surface slope that the Kawarau River has as far downstream as the Kawarau Gorge (refer to Figure 6 presented in Attachment C).

27. Accordingly, in moderate to large flood events the relatively slow-moving Kawarau River inundates the lower part of the delta and the lower-lying areas adjacent to it. Further up the delta the conveyance of the Shotover River dictates the nature of the flood hazard. That is, the nature of the flood hazard (extent, depth, velocity and duration of flooding) changes from one of relatively gradual but prolonged inundation to shorter duration but more rapid inundation by faster moving flood waters. Photograph 2 in Attachment B illustrates the nature of that hazard as the November 1999 event recedes. Figure 3 presented in Attachment C illustrates how much steeper the water surface profile is on the upper part of the delta when compared with the Kawarau River across the base of the delta.

28. Determining what constitutes an appropriate flow event with which to consider flood hazard as it relates to the proposal is problematic. The most reliable method involves statistical analysis of existing river flow data to determine flows

for set 'high end' return period[1] values (100 years, 200 years or larger). This requires a data set of suitable length, accuracy and proximity. Although the Bowens Peak recorder site is of sufficient length (1967 to the present day) and proximity (approximately 8 kilometres upstream) to be useful, it has an unreliable rating. That is, converting a water level to a flow throughout a given flood event has a large margin of error as the bed level (and therefore the rating) can change during the event. Figure 7 presented in Attachment C illustrates the change in mean annual water level at the recorder site over time.

29. The approach adopted in the evidence of David Hamilton utilises Regional Flood Estimation techniques to derive an estimate of the 100 year return period flow in the Shotover River, in turning concluding (utilising the work of Barnett and MacMurray) that the November 1999 event roughly equates to a 100 year return period event.

30. The November 1999 event was a significant climatic event that affected the upper Clutha River catchment and accordingly assessing the flood risk of the development proposed against such an event has merit. The methodology used to categorise this event in regard to return period is however, in my opinion, rather loose. An example is the rather slight difference between the derived 50 year and 100 year return period flow estimates (1,046 and 1,176 cubic metres per second respectively); applying the error percentage given of 28% yields 1,500m^3/s.

31. An obvious illustration of the significance of the November 1999 flood event is in relation to the level of Lake Wakatipu; the lake reached it's highest ever recorded level. A comparison of the level that the lake reached in November 1999 with other notable lake level events is presented in Figure 5, Attachment C. While the catchments of Lake Wakatipu and the Shotover River are geographically close, the lake catchment is much larger and the relationship between lake level and return period considerably more complex than the relationship between river flow and return period for the Shotover River catchment.

[1] Return period, also known as recurrence interval or average recurrence interval, is an estimate of the average interval of time within which the magnitude of a given event will be equaled or exceeded over (Chow).

32. The level of Lake Wakatipu is governed not only by the inflows that occur during a weather event, but also antecedent conditions and the rate of outflow. That is, a high lake level can be the cumulative result of many storms rather than one event. Although the November 1999 rated as an extreme event in both peak lake level and the amount of rise during a single event, the peak flow estimate for the Shotover River at Bowens Peak of 1,000 m^3/s did not significantly exceed the peak flow estimated to have occurred during the October 1978 (918 cumecs) some 20 years earlier.

33. Mr Hamilton makes reference to the Barnett and MacMurray work undertaken in 2006, and in particular the derivation of a Shotover River peak flow during the November 1999 event using data from the Kawarau River recorder site at Chards Road, approximately 9 kilometres downstream of the Shotover River confluence. The ability to undertake such analysis, combined with the length of record at this site (the data set extends back to 1962) would in my view enable a more robust derivation of peak flow versus return period relationship for the Shotover River. The assessment provided by Mr Hamilton is deficient in that regard.

2 ORC River Management Works on the Shotover Delta

34. As noted in Paragraph 32, the outflow of Lake Wakatipu is influenced by the constriction applied to Kawarau River flow by the Shotover delta. Data recorded suggests that the Shotover delta has been progressively further constricting flow in the Kawarau River over a 48 year period. This constriction, and the potential negative effects associated with it (the elevating effect on lake levels), is the main driver behind the river management works proposed by the ORC for the Shotover delta.

35. These works include managing gravel extraction to achieve a target profile for the Shotover delta to enhance it's ability to buffer sediment supply from the Shotover River to the Kawarau River, and the construction of a river training line to prevent undesirable (as they relate to the level of Lake Wakatipu) confluence alignments and to prevent sediment exchange to the Kawarau River where it has little sediment transport potential. The extraction area (identified in stages) and the training line location are presented in Figure 8, Attachment C. The Otago Regional Council has Resource Consent for both activities.

3 Erosive Hazard

36. As the terracing over which the development proposal is concentrated suggests, the area between Lake Hayes and Lake Wakatipu has been heavily influenced by fluvial[2] processes. Sediment deposited by the Shotover river progressively separated Lake Hayes from Lake Wakatipu, with the change in Lake Wakatipu outlet location from Kingston to Frankton then causing the Kawarau and Shotover rivers to cut back down into these deposits.

37. Figure 2 also illustrates the similarity in topography between the current active riverbed and the river terrace immediate East of the delta. Photograph 8, Attachment B reinforces those similarities. Photograph 7 in Attachment B gives an appreciation of how little elevation difference existed between these two areas at that time, and how easily river bank erosion can occur in the absence of stabilisation measures.

38. Figure 2 presented in Attachment C and the elevations in Figure 4 reinforce the fact that the area that lies immediately east of the delta is a less active (at present) part of the delta.

4 Exacerbating Factors

39. Both the flood and erosive hazard that areas adjoining the active delta are subject to are also influenced by sedimentation; increased rates of sediment deposition influence the mobility of the active river channel and an elevated river bed has less ability to contain flood flows.

40. The Shotover River makes a significant contribution to sediment load in the Clutha River, much greater than as a proportion of total catchment area. Perhaps the most definitive work in regard to sedimentation was the assessment undertaken by the National Institute of Water and Atmospheric Research (NIWA) on behalf of Contact Energy Limited, reported in November 2000.

41. The NIWA study noted that under a natural regime, ie without the effects of the dams, the fraction of sediment originating from the Shotover River catchment as

[2] Produced by the action of a stream or river.

a percentage of the total sediment load passing Balclutha would be 60%. It is therefore the largest single contributor of sediment to the Clutha River catchment.

42. Most of this sediment is suspended sediment or suspended load. Wikipedia defines suspended load as "sediment particles which settle slowly enough to be carried in flowing water either without touching the bed or while only intermittently touching it. These particles are generally of the fine sand, silt and clay size, although larger particles may be carried in suspension depending on the intensity of flow". Sediment that is predominantly or continually in contact with the river bed is termed bed load, and it's composition is gravel and coarser sand.

43. The proportion of bed load as a percentage of total sediment load reduces as the sediment is transported by the river system, particularly where the parent rock mass is a relatively weak rock (schist), due to the abrasion that results from the transport process.

44. It is also important to note that the maximum sediment size carried in suspension, and the minimum sediment size moved as bed load, relates to the nature of the river system, and that those thresholds vary over any given reach of a river.

45. Sediment sizes, as they accumulate on the Shotover delta, are influenced by the interaction between the Shotover and Kawarau Rivers. Most of the sediment transport in a river system occurs under flood conditions, an exponential relationship between flow and sediment transport rate. High flow events in the Shotover River also typically, but not always, coincide with elevated levels in Lake Wakatipu and consequently high flows in the Kawarau River.

46. In such circumstances the Kawarau River inundates a part of the delta. Accordingly the proportion of suspended load to bed load changes when the delta is reached, with a significant portion of the sediment accumulating of the delta being sand sized.

47. When the flood event recedes that equilibrium changes, with smaller 'freshes' mobilising some of that sediment off the delta and into the Kawarau River, evident in Attachment B, Photograph 3 (four months after the November 1999 flood event). Although the water surface slope of the Kawarau River is steeper in a high 'normal flow' condition, it's sediment transport potential is still limited.

48. NIWA, in their November 2000 report, estimated the total sediment yield from the Shotover catchment to be 1.315 million tonnes per year, of which 263,000 tonnes or 17% was estimated to be bed load. They also determined that "between April 1994 and February 2000, the Kawarau Arm [of Lake Dunstan] has been accumulating sediment at a rate of 1.45 million cubic metres per year". The differences between the two (aside from the measurement units used) are accounted for by way of the other contributions (the Arrow River, the Nevis River and the gorge itself) and the fact that the two estimates encompass different time periods.

49. Photographs 10 to 15 presented in Attachment B clearly illustrate just why the Shotover River makes such a significant contribution to sediment loads, a function of the catchment size, geology, seismicity, topography and climate. As noted previously, the volume of sediment transported by a river is a function of river flow, that is larger flows progressively mobilise more sediment.

50. Sediment transport potential also relates to the availability of sediment, and one significant influencing factor in that regard is seismicity. Dr. Tim Davies[3], in his Evidence in Chief to the Environment Court in relation to the proposed river management works on the Shotover delta, notes that the Shotover catchment "is located in an area of high seismicity". An earthquake in the Shotover catchment would trigger numerous landslides and rockfalls and would, as Dr Davies notes, "greatly increase the rate of sediment delivery to the Shotover delta". The front page of today's Otago Daily Times provides a good overview of seismicity over the Otago region; the likelihood of an alpine fault rupture in the next 50 years is estimated to lie in the range 24 to 35%[4].

51. To give this some perspective, estimated rates of uplift in the Shotover catchment have been assessed at between 1 and 4mm per year, with the higher rates of uplift closer to the main divide. Over the 1,100 km^2 catchment area this equates to a net volume increase of between 1.1 and 4.4 million cubic metres per year.

[3] Assoiate Professor, Department of Geological Sciences, University of Canterbury
[4] Rhoades and Van Dissen (2003).

52. The landslide induced dams also have the potential to increase sediment loads; depdning on their location, they also have the potential to rapidly inundate lower lying areas adjacent to the Shotover River.

53. In May 1996 Royden Thomson prepared a report for the ORC titled Landslide Dam Scenarios in the Upper and Lower Reaches of the Kawarau and Shotover Rivers Respectively. The conclusions reached in this report (amongst others) are that "Within the Shotover Gorge the risk of a river blockage by a rapid failure of an element of an existing slide is relatively high. The dam would have a moderate duration but impounded sediment volumes are likely to be small".

54. The report then concludes that "Large scale slides or rockfall blockages in the Shotover Gorge are much less likely scenarios. A dam would probably not be prone to rapid failure and impounded sediment would be released progressively".

55. In my view, given the geology, the nature of the catchment and the seismic hazard that prevails, large scale slide or rockfall blockages are more likely than indicated by Mr Thomson. Similarly more rapid landslide dam failure is also more likely than the level of risk concluded by Mr Thomson. Photograph 12 in Attachment BAttachment is one recent example of such a scenario on a relatively small scale.

56. In his final conclusion Mr Thomson makes it clear that the assessment in regard to the lower Shotover Valley is in the context of hazards to Queenstown and clearly not in the context of the development contemplated by this plan change.

57. Any development on this lower terrace could also potentially be affected by landslide dam scenarios in the Kawarau River, if not directly resulting in inundation exacerbating flood hazard and making the alignment of the Shotover River on the delta more unstable. The area that is now identified as a regionally significant wetland has in my view clearly been formed as a result of such influences that have occurred in the past.

58. Mr Thomson also considers such scenarios in his report, assessing a number of landslides along the Kawarau River between the Shotover delta and the Gibbston Valley, the closest of which lies on the slopes of the Remarkables between the delta and the Rastus Burn.

59. In this regard Mr Thomson concludes that "scenario slides within the Kawarau Valley that have the potential to block the river and raise the level of Lake Wakatipu can be determined. The risk of failure, with consequent adverse effects, is greater downstream from the Arrow River confluence than within the upper valley reaches".

60. Mr Thomson goes on to say that "there is significant potential for small-scale rockfalls to block the Kawarau River in the inner gorge downstream from the Arrow River confluence. A larger failure, with adverse impacts on Queenstown, has a much lower probability; such a first time failure event may be linked to a large earthquake on a nearby fault". Whether this scenario considers landslide activity as the sole factor with the potential to adversely impact on Queenstown, or in combination with a high (and relatively frequent) lake level event is not clear. Again this report clearly is not contemplating development at the location proposed.

61. I note that recently (2009) the ORC was advised by consulting geologist Mr Jeff Bryant of cracks identified in the riverbank cliff opposite the Owen Creek confluence with the Kawarau River. Further investigation concluded that there is a risk of river blockage at this point (not previously identified in the 1996 report) but that the risk "to those living upstream due to inundation is very low to extremely low". Again these comments are made in the context at that time, and don't apply to development in the context of what is proposed.

SHOTOVER COUNTRY PLAN CHANGE

62. I will now comment on the plan change proposed by Shotover Country Limited in the context of the hazards I have just outlined.

63. NZS9401:2008 does not prescribe or recommend particular standards of flood protection as it is a process standard designed to guide decision-making on flood risk. In my opinion it clearly expects that standards of flood protection are based on consideration of the level of residual risk, regardless of the degree to which the pre-existing hazard will be mitigated. This is especially true for new developments which create a risk that does not already exist.

64. The site that is the subject of this proposal is currently undeveloped and unoccupied. No persons or material property are at risk on that site. In my view the lower terrace area is a less active (at present) part of the delta, with all of the consequent risk that entails.

65. Figure 4 presented in Attachment C demonstrates how close to inundation the area of terrace immediately East of delta was during the November 1999 event. Although this was an extreme flood event it also occurred in an environment where sediment rates of supply have been declining (refer to Figure 7, Attachment C) and where the nature of the delta has changed considerably (contrast Photograph 5 and Photograph 6, presented in Attachment B). Declining in this context meaning that estimates of total sediment load are much less than the additional uplift volume being added to the catchment.

66. The proposed development creates a risk that does not exist at present by changing the land use to one that is vulnerable to river flood and erosive hazards. The proposal involves mitigation (but not elimination) of the hazard, but there is a net increase in risk.

67. The original proposal has been amended to adopt a more robust method of mitigating flood hazard, dispensing with a floodbank and instead proposing to elevate a part of the lower terrace while ensuring that it is contiguous with the adjoining higher terraces. This largely eliminates issues such as the potential for seepage/ upwelling in behind the bank and piping failure of the bank (or other possible floodbank failure modes). It also in part eliminates (in part) matters relating to roles and responsibilities in maintaining that infrastructure in perpetuity (maintaining adequate grass cover, ensuring rabbit numbers are controlled and that burrowing damage is repaired etc.).

68. However with a platform two critical issues will persist; what platform height will provide an acceptable level of risk (with adequate surety in regard to the level of risk determined) and what provision/ arrangements will be made, in perpetuity, to monitor changes in the active delta. The logical progression from that consideration is what level of change will require intervention, who will undertake that intervention and (ultimately) who will pay for such interventions.

THE RIVER AND FLOODING RISK ASSESSMENT REPORT PREPARED BY DAVID HAMILTON AND ASSOCIATES LIMITED

69. I will now make further comment on the assessment report prepared by David Hamilton and Associates Limited, in particular addressing the points covered in the Executive Summary of that report.

70. Referring to Figure 4 presented in Attachment C, recorded peak flood levels from the November 1999 flood event suggest that this event came close to inundating the area of river terrace immediately East of the Shotover delta. It also occurred in a relatively favourable context (relatively low sediment transport rates, minimal landslide influence).

71. As I identified earlier in my evidence, deriving accurate flow estimates for 'high end' return period events is problematic for the Shotover River using the Bowens Peak dataset. Mr Hamilton has instead based his assessment on regional estimation techniques. In my view more detailed analysis is warranted of the Kawarau River at Chards Road dataset to derive more reliable high end return period flow estimates; quantification of risk in this environment must be as accurate as possible.

72. While minor delta aggradation will undoubtedly have a consequential relatively minor effect on the flood hazard affecting adjoining areas, my evidence clearly identifies the potential for larger scale changes in the future and consequential large scale effects on river flood and erosion hazard.

73. Mr Hamilton's assessment in regard to landslide dam scenarios and consequential effects relies heavily on work previously commissioned by the ORC some time ago, work not intended to be applied to the development scenario now being contemplated.

74. While a joint strategy exists between the Otago Regional and Queenstown Lakes District Councils in regard to the flood hazard associated with Lakes Wakatipu and Wanaka, the document outlining this strategy is headed Learning to Live With Flooding. It emphasizes a multi-facted approach, a key element of which is flood sensitive urban planning.

75. As noted earlier in my evidence, the sole focus of the works proposed by the ORC for the delta relate to the interaction between the Shotover and Kawarau Rivers and it's consequential effect on the lake outlet characteristic.

76. River modeling work has been commissioned by the ORC in the course of developing the river management proposals for the Shotover delta. The primary focus of this modeling work was quantifying downstream effects on the Kawarau River and upstream effects on the level of Lake Wakatipu; the modeling work had more of a focus on relativities rather than absolute accuracy and was less guided by return period. That is, it was not undertaken for the purpose of determining flood hazard as it relates to the development contemplated.

77. As noted in Figure 3, Attachment C, the flood level recorded during the November 1999 event was 313.37, just over 0.3m lower than the minimum platform levels proposed.

78. As noted in my evidence, landslide dams have the potential to influence the flood and erosive hazard pertaining to areas that adjoin the delta. Consideration given to this as part of the plan change proposal has relied on work previously commissioned by the ORC some time ago. This work cannot have contemplated the development proposal being put forward. Further, the assumption that local government at a district or regional level would intervene would not seem to be a prudent hazard mitigation approach to adopt.

79. The suggestion that mitigation measures (at best channel shaping work with a bulldozer, at worse extraction and stockpiling large quantities of sediment) could be employed in a rapid aggradation scenario inevitably poses many questions – some of these are; who would undertake the monitoring, what would the intervention trigger be, who would undertake the work, who would fund it, what would the nature of that mitigation work be, would resource consent for undertaking such works be likely to be granted.

80. While river bank protection is essential (refer to Photograph 7, Attachment B) if any development of the adjoin river terraces is to be permitted, the detail in regard to what type of protection is appropriate, the standard that it is maintained to, what inspection/ monitoring regime is required, and how the works and their maintenance is funded are important considerations.

CONCLUSIONS

81. The size and nature of the Shotover River catchment equate to significant flood flows, combined with an almost limitless sediment supply. The equilibrium state evident today is almost certain to significantly alter in the future; when and by how much is a function of a number of natural processes

82. Although not currently part of the active delta, the area of river terrace immediately north-east of the Shotover River is a relatively recent formation clearly similar in nature to the currently active delta area. Development of this terrace creates a risk that does currently not exist, exposing a future community to a flood hazard. Although many such hazards are currently prevalent throughout the District, it would be unwise to add to that level of exposure.

83. The hazard assessment work in support of the application has a relatively narrow focus on analytical flood hazard models. As my evidence shows, a full appreciation of natural processes is much more important in regard to attempting to predict what may happen in the future. In my opinion much of this work has been undertaken as an after thought and relies heavily on work commissioned by the ORC some time ago and for a different context. In my opinion it is not sufficiently rigorous or comprehensive to give sufficient certainty in regard to the level of river flood and erosion risk that the proposed development will be subject to.

84. The works that the Otago Regional Council has planned for the Shotover River delta are principally aimed at endeavouring to prevent further decline in the outlet differential associated with Lake Wakatipu. They are not intended to provide any beneficial effect in regard to the flood hazard affecting properties adjoining the Shotover delta. While some incidental effect may arise in that regard, it would be unwise to rely on such effects, particularly in the context of residential subdivision.

RAMON BLAIR STRONG

9 March 2011

Document ID A324250

Flood Risk Management

A Position Statement from Local Government

27 February 2007

FLOOD RISK MANAGEMENT - A POSITION STATEMENT FROM LOCAL GOVERNMENT

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FLOOD RISK MANAGEMENT - A POSITION STATEMENT FROM LOCAL GOVERNMENT

1 Introduction

This Paper has been developed by the Regional Affairs Committee Flood Management Sub-Committee. It sets out the local government perspective on the current and future management of flood risks in New Zealand, with a particular emphasis on identifying central and local government actions required to achieve a robust decision making framework for sustainable flood management.

Foremost amongst the issues to be addressed is the lack of community and personal understanding and recognition of residual flood risk, a reluctance to consider asset retreat and relocation as the best option in some circumstances, and a disparity in the level of community and council funding and resources available for flood management.

The flood risks of communities in New Zealand are a product of previous central and local authority policies, community values and land-use decisions. This means in looking forward to the future protection of our communities and catchments, we inevitably have a legacy of flood risk that will require careful management in the transition to the future. This legacy must not be seen as a blame issue, but should be focused upon as a learning experience, as we move towards a wider sustainable catchment management approach when considering protection and resilience of our communities.

2 Local Government Aim

The aim of local government with regards to flood management can be stated as:

> *Sustainable river and catchment management that achieves the particular level of flood hazard protection desired and accepted by each distinct community of interest, with residual risks fully understood and taken into account.*

This aim acknowledges that communities and individuals must be responsible for articulating the particular level of flood protection that is appropriate for their circumstances. It recognises that a "one size fits all" approach to flood management is unrealistic.

Local government acknowledges that residual risks could remain at a 'higher than desirable' level where the community decides for affordability and other reasons to accept a lower level of protection. Dealing with this residual risk will need to be addressed at the district or regional level.

3 Available Tools

Local government largely has sufficient statutory flood management tools available to it.

These tools include hazard avoidance achieved by land use planning under the RMA; the provision of physical flood protection works and flood warning systems under the Soil Conservation and Rivers Control Act, Land Drainage Act and Local Government Act; and the identification of flood risk and the delivery of community wide civil defence responses during and after flood events under the Civil Defence and Emergency Management Act.

However, there are issues that prevent local government achieving its flood management aim in a consistent and effective manner nationwide. The resolution of many of these issues relies on Government action.

Some of the necessary Government actions could feasibly reside within a non-prescriptive process based National Policy Statement (NPS) developed under the RMA, while others must be separately delivered by Government outside of the RMA framework.

Local government sees no role for a prescriptive standards based NPS that attempts to set mandatory flood design standards or require mandatory flood protection measures.

4 Issues and Solutions

The issues and their solutions are listed below. The solutions are tabulated and the assessed ability of a NPS to deliver them is shown.

4.1 Collective Capacity

Multiple community needs and Government legislative requirements coupled with a limited rating base and staff resources, leads some councils to assign a lower priority to flood management activities.

A lack of appropriately skilled and experienced practitioners can hinder councils attempting to manage catchments in a holistic manner, for example by failing to link upper catchment land use to lower catchment flood risks.

Solutions - Institutional Capacity		
Solution	Delivery	NPS
Make flood management a matter of national importance	Government	Yes
Facilitate holistic catchment management that integrates flooding from all sources and the impacts of catchment land use	Government and Councils	Yes
Facilitate the training of flood management practitioners	Government, Councils and Professional bodies (IPENZ, NZPI, etc)	No

4.2 Flood Hazard Assessment and Residual Risk

Local government considers that each community exposed to a flood hazard risk is entitled to have that level of risk assessed, with appropriate avoidance and mitigation strategies being subsequently developed in consultation with those communities. Different strategies will be required for urbanised (brown fields) and non-urbanised (greenfields) areas.

The impacts of climate change on flood frequency and severity (and associated matters such as sea level rise) should be addressed by local government and the community in a nationally consistent manner. This can be facilitated through Government advice and guidance.

Communities generally, and some decision makers, do not seem to understand that even with appropriate avoidance and mitigation strategies in place, there will always be a level of residual risk from either flood events larger than the design event, or from flood protection scheme and flood warning system failures and shortcomings.

There can never be a guaranteed 100% level of flood protection within a flood plain.

There is too little action being taken to acknowledge, determine and proactively plan for the consequence of residual flood hazard risks.

Solutions -Flood Hazard Assessment and Residual Risk		
Solution	Delivery	NPS
Require community scale assessments of flood hazard risks to be undertaken in a nationally consistent manner, with appropriate avoidance and mitigation strategies being developed by local government for each community of interest	Government and Councils	Yes
Include impacts of climate change in flood hazard risk assessments	Government and Councils	Yes
Require disclosure of residual risk to communities	Councils	Yes
Proactively plan for and manage residual risk and its consequences	Government and Councils	Yes

4.3 Inappropriate RMA Outcomes

RMA policy documents and regional and district plans sometimes fail to require hazard avoidance in preference to hazard remediation or mitigation.

At times there is also a failure to steadfastly implement the hazard avoidance provisions that RMA policy documents and regional and district plans do contain, at both a council and Environment Court level. This reflects the ability of persuasively argued private property rights to dominate matters of public interest.

Unforeseen or faster than anticipated land use intensification can exacerbate adverse cumulative effects and cause flood hazard land use planning and physical flood protection schemes to become obsolete, or make their nature and scale inappropriate.

Solutions - Inappropriate RMA Outcomes		
Solution	Delivery	NPS
Require preference to be given to flood hazard avoidance in RMA documents	Government and Councils	Yes
Consistently implement hazard avoidance provisions in RMA documents	Councils	No
Balance private property rights with public interest matters in high flood risk areas	Government and Councils	Yes
Better review of and response to land use intensification	Councils	No

4.4 De facto National Standards

There are a number of de facto flood management standards that are sometimes advocated by councils and landowners, or incorporated into District and Regional Plans. These include the 1:100 year urban and 1:50 and 1:20 rural flood protection standards promoted by the former National Water and Soil Conservation Organisation, and the 1:50 year standard for habitable structures included in the current Building Act.

These standards are often assumed to be the general level of flood protection that should be provided for communities. Local government considers that what is required instead is a flexible and participatory process that determines suitable flood protection standards for individual communities. In some cases the level of flood protection should be very high (for nationally important infrastructure for example) and in some cases it can be much lower (for low intensity rural land use areas for example).

The appropriate level of flood protection (and associated residual risk) must be determined by councils in consultation with their individual communities.

Solutions - De facto National Standards		
Solution	Delivery	NPS
Remove presumption that former NWASCO and current Building Act flood protection standards are always appropriate values to use.	Government	Yes

4.5 Repeat Events

There is a reluctance to acknowledge that some public and private infrastructure, buildings and other assets are simply located in inappropriate and high risk floodable areas. This results in the Government, councils and the insurance industry enabling the reinstatement of those assets in locations where they will be repeatedly flooded. In some cases the relocation of assets would be more appropriate.

There is a lack of clear and certain statutory tools to require the relocation or staged retreat of at risk assets. Currently the only viable option is voluntary purchase. Local government

acknowledges that there maybe options under the Building Act and Health Act for declaring buildings dangerous or uninhabitable, and that District and Regional Plans can establish exclusion zones for new development.

This tendency to avoid making hard decisions on the relocation or retreat of at risk assets, coupled with the ready provision of financial assistance to rebuild or restore them in-situ, often precludes individuals from exercising self-responsibility in dealing with the residual flood hazard risks that they face. Local government considers it desirable that the insurance industry gains a better understanding of the undesirability of reinstating some assets in areas subject to repeat flood events.

Solutions - Repeat Events		
Solution	Delivery	NPS
Acknowledge that some infrastructure, buildings and other assets are simply located in inappropriate and high risk floodable areas	Government and Councils	No
Overtly consider the merits of relocation or staged retreat as opposed to the reestablishment of infrastructure, buildings and other assets	Government and Councils	Yes
Provide statutory tools to enable councils to require the relocation or retreat of infrastructure, buildings and other assets from high flood risk areas	Government	No
Make necessary hard decisions on asset relocation	Government and Councils	No
Provide clear policies which persuade or require individuals to exercise self responsibility regarding residual flood hazard risk	Government and Councils	No

4.6 Affordability

Some communities simply cannot afford to fund desirable flood protection measures, be they flood protection schemes or flood warning systems. This can be addressed through the provision of "safety net" funding for poorly resourced communities, akin to the existing Government grant scheme for small community wastewater treatment systems and water supply quality.

Some councils lack the necessary funding and staff resources to utilise and effectively implement the full range of statutory flood management tools available to them. This is exacerbated by a general shortage of appropriately trained and experienced flood management practitioners.

Society, including Government, tends to underestimate the true cost of responding to flood events that could have been avoided through appropriate land use planning decisions or the provision of flood protection measures. Such costs include the reinstatement of infrastructure, costs to business and the mental and physical health of flood victims. This tends to favour reestablishment of assets as opposed to their relocation.

There is a general lack of Crown infrastructure and land owner contribution towards the funding of community flood alleviation schemes. Local government considers that the Government needs to accept it responsibilities as a good neighbour, for example where poorly managed Crown land exacerbates upper catchment runoff and erosion. Consequently, the Government should allow Crown owned land to be subject to the same local government funding regime as private land. The inability to rate Crown land is an unacceptable inequity that transfers costs to private landowners.

local government also considers that where statutory functions undertaken by local government have a tangible component of national interest or provide a clear national benefit (such as some aspects flood management), then commensurate national funding should be available to assist with the local government delivery of those functions.

Solutions - Affordability		
Solution	Delivery	NPS
Provide "safety net" funding to at risk communities for flood avoidance, protection or warning systems	Government and Councils	No
Provide funding assistance to under resourced councils to boost their institutional capacity	Government	No
Properly consider the true cost of responding to flood events when assessing appropriate responses and recognise who actually pays for remediation	Government and Councils	No
Provide funding in recognition of the national interest nature of, and national benefit provided by, some flood management activities	Government	No
Allow Crown land to be rated (or payments to be made in lieu of rates) in the same manner as private land for flood management purposes	Government	No
The Crown and its agencies to acknowledge their responsibilities as infrastructure owners, land owners and 'good neighbours'	Government	No

4.7 Inappropriate Infrastructure

At times infrastructure, such as road and rail bridges and culverts, are under sized in terms of the floods they are required to pass. The infrastructure also needs to be protected from flood events and the infrastructure owners may not be aware of the importance of upstream flood protection works in that regard. This arises due to funding constraints and a lack of knowledge of flood events.

Crown agencies can have conflicting objectives set by the Government, such as Transit New Zealand and OnTrack being required to run their networks, efficiently, with a performance measure being to keep them open during a flood. Raising a road or railway line to keep it flood free can cause flooding elsewhere in the catchment.

Solutions - Inappropriate Infrastructure		
Solution	Delivery	NPS
Require infrastructure to cater for known flood hazard risks and avoid exacerbating those risks	Government and Councils	Yes
Require all Crown agencies and other national bodies to have an objective to reduce the impact of their activities on the flood risk in local catchments.	Government	Yes
Require Crown agencies and other national bodies to contribute to flood avoidance or mitigation measures where they adversely impact on those measures or receive benefits from them.	Government	No

5 Existing Work Streams

Apart from the addressing the issues described above, there are other complimentary and necessary Ministry for the Environment and local government flood management work streams in place that local government is committed to continuing with. These are:

- Conversion of the Draft New Zealand Protocol on Managing Flood Risk into a New Zealand Standard
- Clarifying Government, local government and private sector roles and responsibilities for flood management. This includes confirming the local government management role for rivers beds subject to Treaty of Waitangi claims

- Identifying and promulgating Best Practice Guidance on risk assessment, cost benefit analysis, flood hazard land use planning, flood protection schemes, and flood warning systems
- Providing accurate weather forecasts and heavy rain warnings
- Gathering and reporting information on the level of flood hazard risks in New Zealand and the performance of existing avoidance and mitigation strategies.

Other substantive Ministry for the Environment work programmes also have positive synergies with sustainable flood management. These include the Government's:

- Sustainable land management programme
- Water programme of action
- Climate change programme.

The importance and benefits of these existing Government initiatives is acknowledged by local government.

Local government considers, however, that an additional work stream is required that involves working with the Insurance Industry to establish a collaborative process for assessing whether or not flood affected assets should be relocated or retreated as opposed to being rebuilt in their original locations. Local government considers that there is also scope for insurance premium differentials to better reflect flood risks, including residual risks.

6 Summary and Conclusions

Local Government largely has available to it the statutory tools necessary to achieve effective and appropriate flood management. However there are identifiable issues preventing the consistent nationwide implementation of those tools. There are readily identifiable solutions to those issues and many of them require Government action and support.

Some Government led solutions could be embodied in a non-prescriptive and process oriented RMA NPS. These are:

- Make flood management a matter of national importance
- Facilitate holistic catchment management that integrates flooding from all sources and the impacts of catchment land use
- Require community scale assessments of flood hazard risks to be undertaken in a nationally consistent manner, with appropriate avoidance and mitigation strategies being developed by local government for each community of interest
- Include impacts of climate change in flood hazard risks assessments
- Require disclosure of residual risk to communities
- Proactively plan for and manage residual risk and its consequences
- Overtly consider the merits of relocation or staged retreat as opposed to the reestablishment of infrastructure, buildings and other assets
- Require preference to be given to flood hazard avoidance in RMA documents
- Balance private property rights with public interest matters in high flood risk areas
- Remove presumption that former NWASCO and current Building Act flood protection standards are always appropriate values to use
- Require infrastructure to cater for known flood hazard risks and avoid exacerbating those risks
- Require all Crown agencies and other national bodies to have an objective to reduce the impact of their activities on the flood risk in local catchments.

Some barriers can be addressed by Local Government themselves. These are:

- Consistently implement hazard avoidance provisions in RMA documents
- Better review of and response to land use intensification.

However, other critical barriers must be resolved by Government actions undertaken outside of a RMA NPS. These actions are:

- Provide funding assistance to under resourced councils to boost their institutional capacity
- Provide funding in recognition of the national interest nature of, and national benefit provided by, some flood management activities
- Facilitate the training of flood management practitioners
- Provide "safety net" funding to at risk communities for flood avoidance, protection or warning systems
- Properly consider the true cost of responding to flood events when assessing appropriate responses and recognise who actually pays for remediation
- Allow Crown land to be rated (or payments to be made in lieu of rates) in the same manner as private land for flood management purposes
- The Crown and its agencies to acknowledge their responsibilities as infrastructure owners, land owners and 'good neighbours'
- Acknowledge that some infrastructure, buildings and other assets are simply located in inappropriate and high risk floodable areas
- Make necessary hard decisions on asset relocation
- Provide statutory tools to enable councils to require the relocation or retreat of infrastructure, buildings and other assets from high flood risk areas
- Provide clear policies which persuade individuals to exercise self responsibility regarding residual flood hazard risk
- Require Crown agencies and other national bodies to contribute to flood avoidance or mitigation measures where they adversely impact on those measures or receive benefits from them.

Local Government may have difficulty supporting the Government proceeding with a NPS if the barriers listed above were not addressed concurrently by Government.

6 Attachment B

Photograph 1 – View of the Shotover delta from the Remarkables, 1976

Photograph 2 – Looking ESE along the Kawarau River at the Shotover River Confluence (Centre) with Lake Wakatipu in the distance, falling limb of the November 1999 event

Photograph 3 – Shotover delta, March 2000

Photograph 4 – Shotover delta, February 2011

Photograph 5 – Looking down the delta, 1952

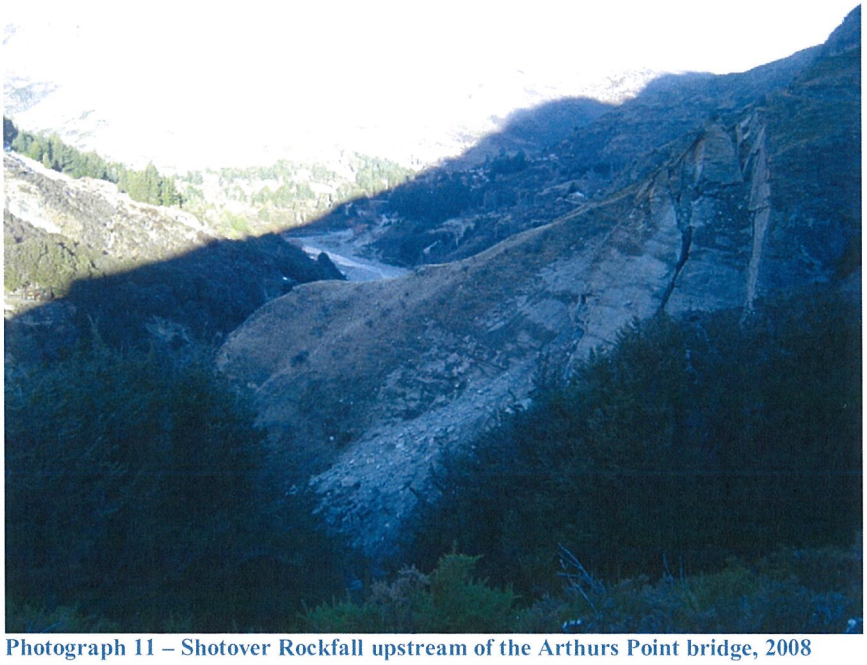
Photograph 6 – Looking down the delta, 2010

Photograph 7 – Shotover delta left bank (date unknown but thought to be mid-1970's)

Photograph 8 – Looking SW across the Shotover Country site toward the Shotover River, 1952

Photograph 9 – Shotover delta, 10 July 2008

Photograph 10 – Skippers Canyon Terraces



Photograph 11 – Shotover Rockfall upstream of the Arthurs Point bridge, 2008

Photograph 12 – The Left Bank of the Shotover River Upstream of the Moonlight Creek Confluence (colloquially known as The Squeeze). The Shotover River occupies a narrow gorge in behind the helicopter.

Photograph 13 – View of the Upper Shotover River including The Branches Station Homestead

Photograph 14 – Typical tributary confluence, Upper Shotover River

Photograph 15 – View of the Shotover River catchment

7 Attachment C

Figure 1 – Plan Showing the Catchments of Lake Wakatipu and the Shotover River

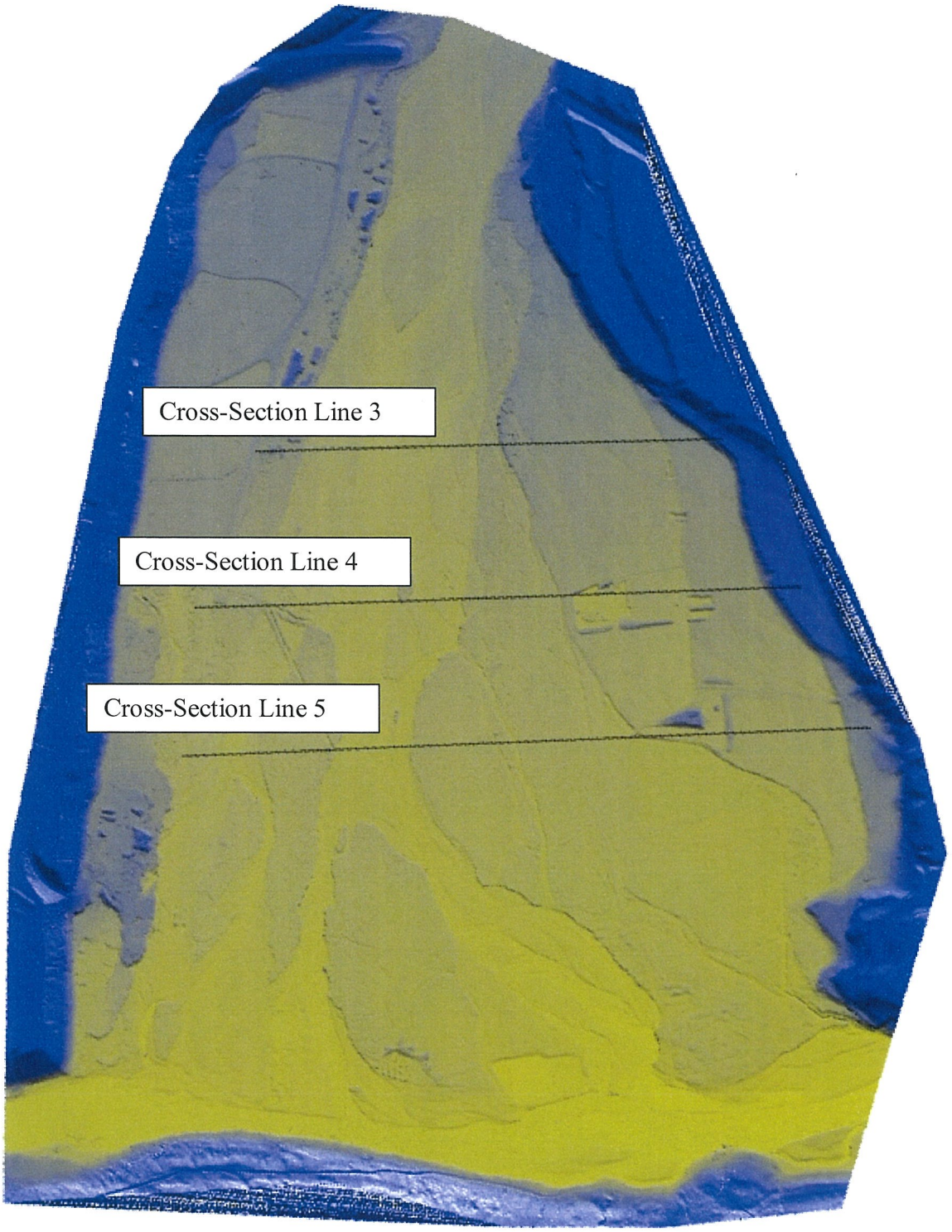


Figure 2 – LiDAR Image of the Shotover delta with Cross-section Lines Overlaid

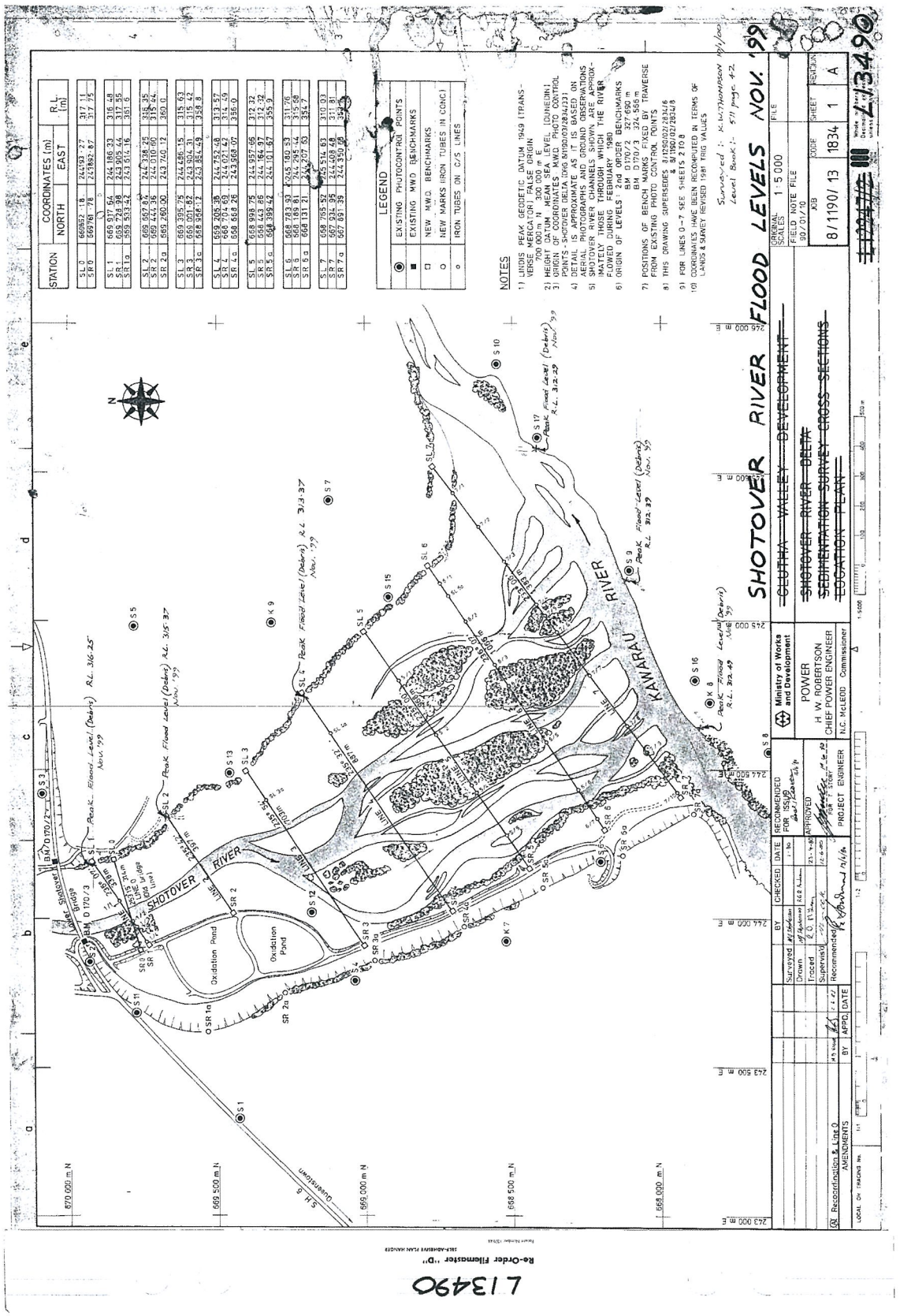


Figure 3 – Maximum Flood Levels, Shotover delta, November 1999

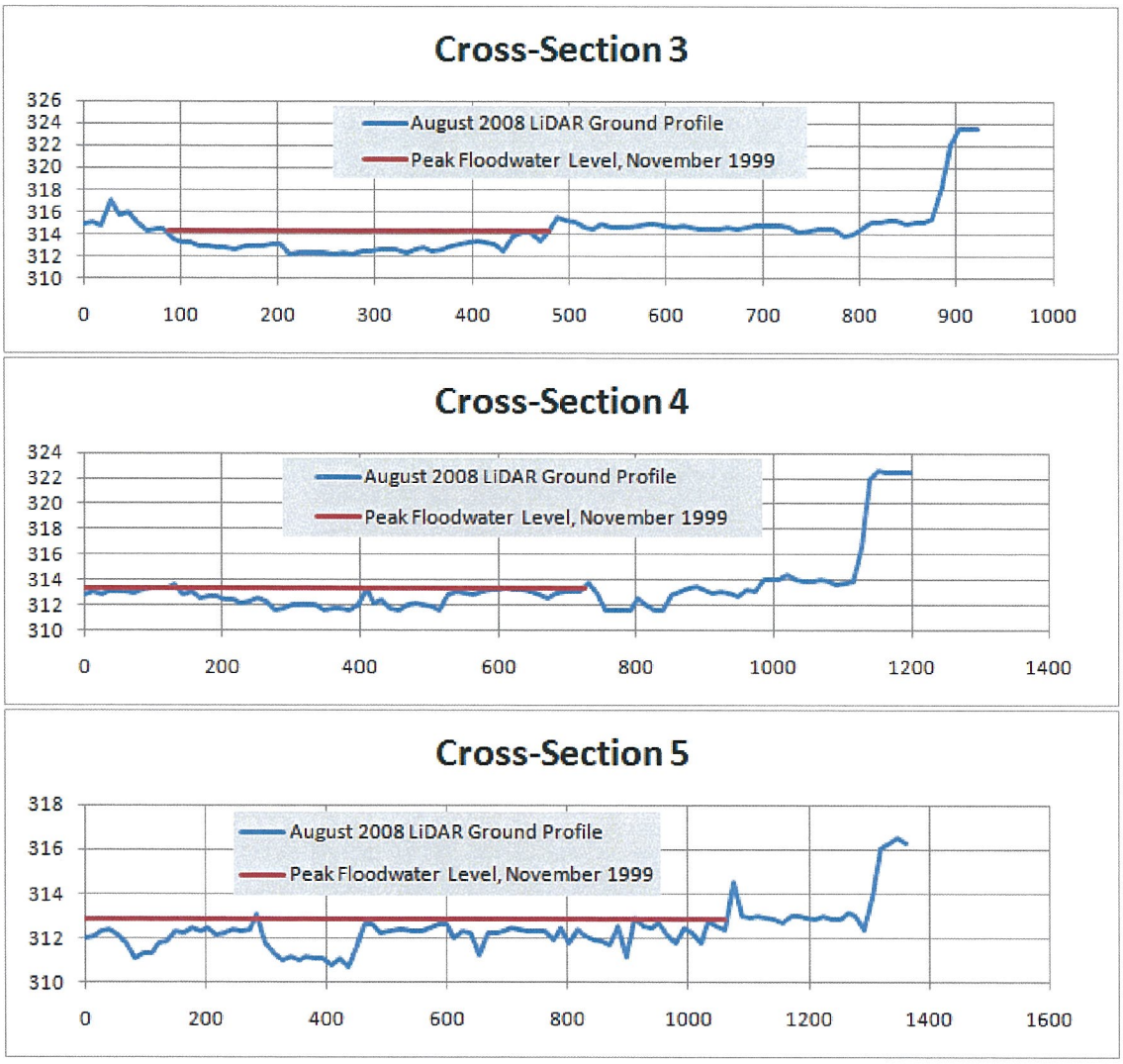


Figure 4 – Cross- Sections 3 to 5 (Refer to Figure 2) with November 1999 Flood Level. Note that the levels for Cross-sections 3 and 5 are interpolated. Note also that Cross-section 4 passes through a borrow pit.

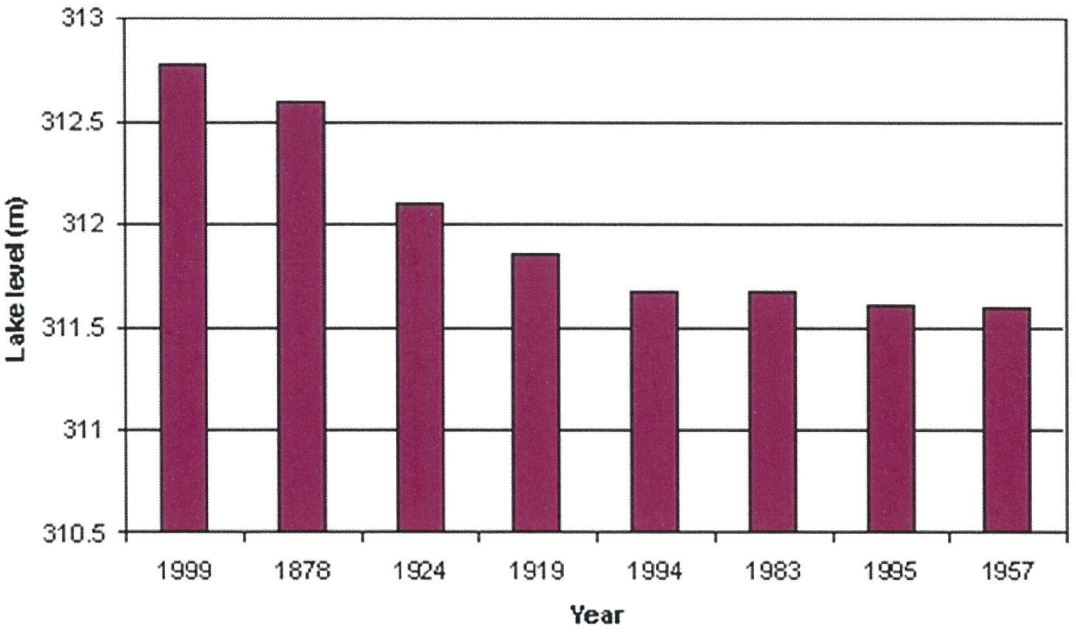


Figure 5 – Ranking of High Lake Wakatipu Level Events

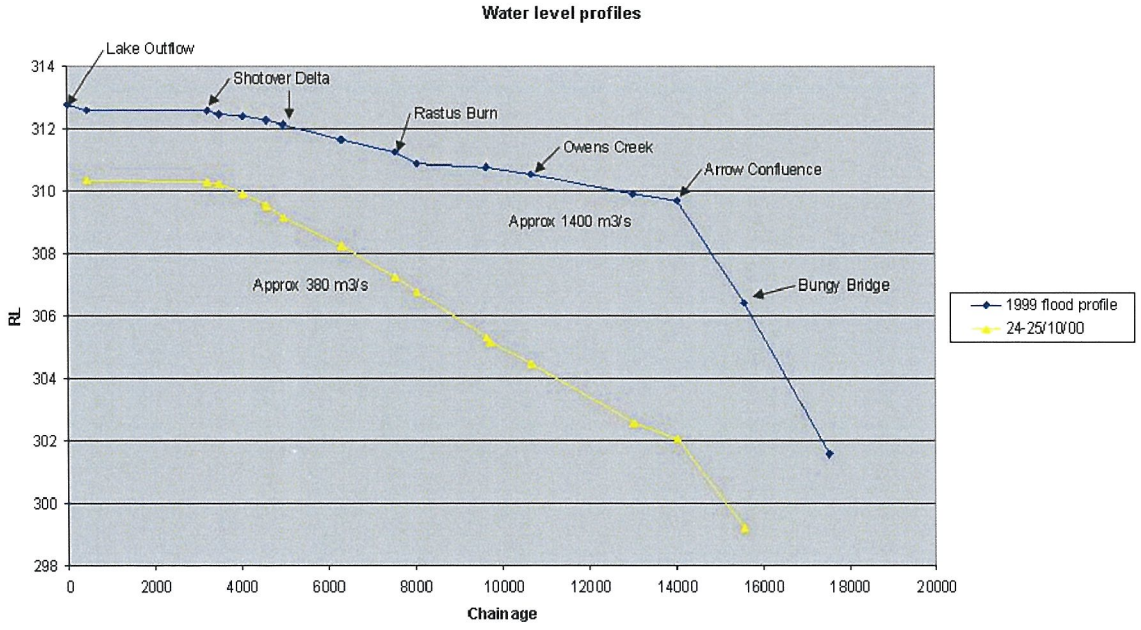


Figure 6 – Longitudinal Water Surface Profiles, Kawarau River from Lake Wakatipu to the Kawarau Gorge

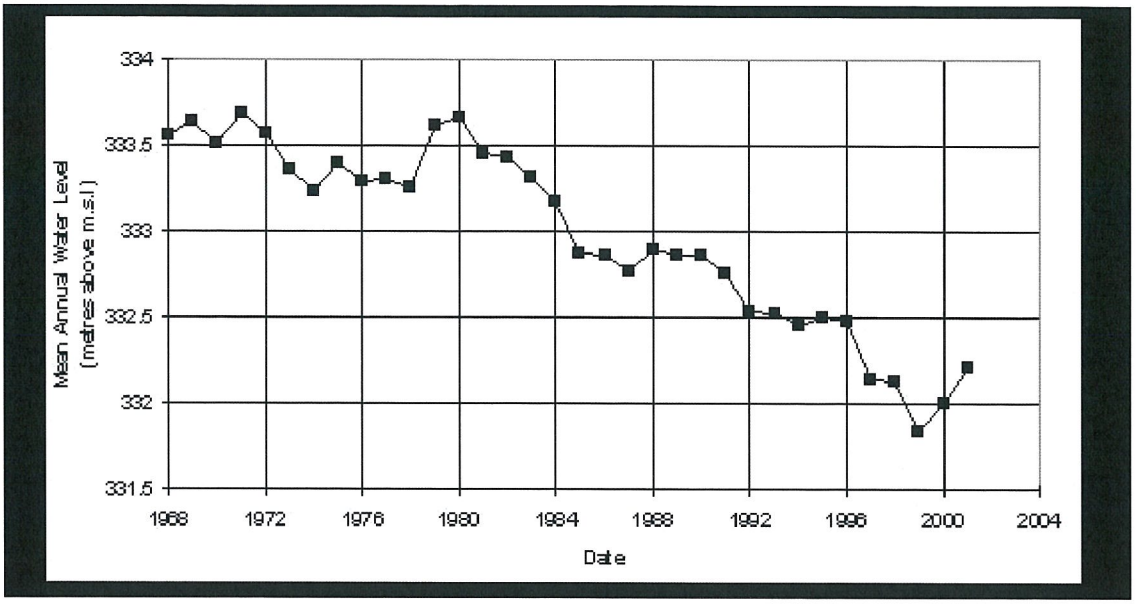


Figure 7 – Change over Time in Mean Annual Water Level at the Bowens Peak Recorder Site

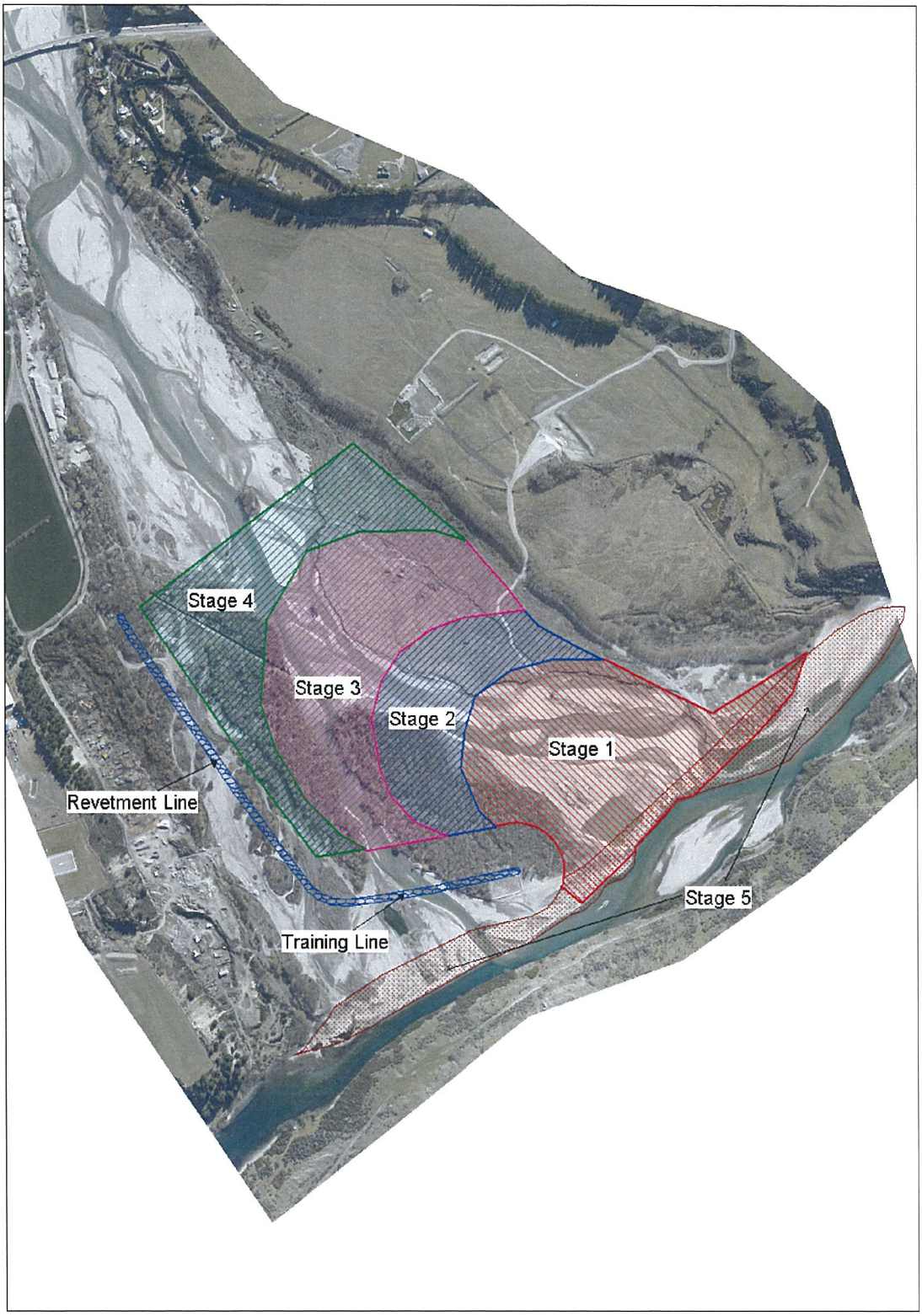


Figure 8 – Gravel Extraction Staging Diagram and Proposed Revetment and Training Line Locations, Shotover Delta.

Appendix 2. Historical aerial photography

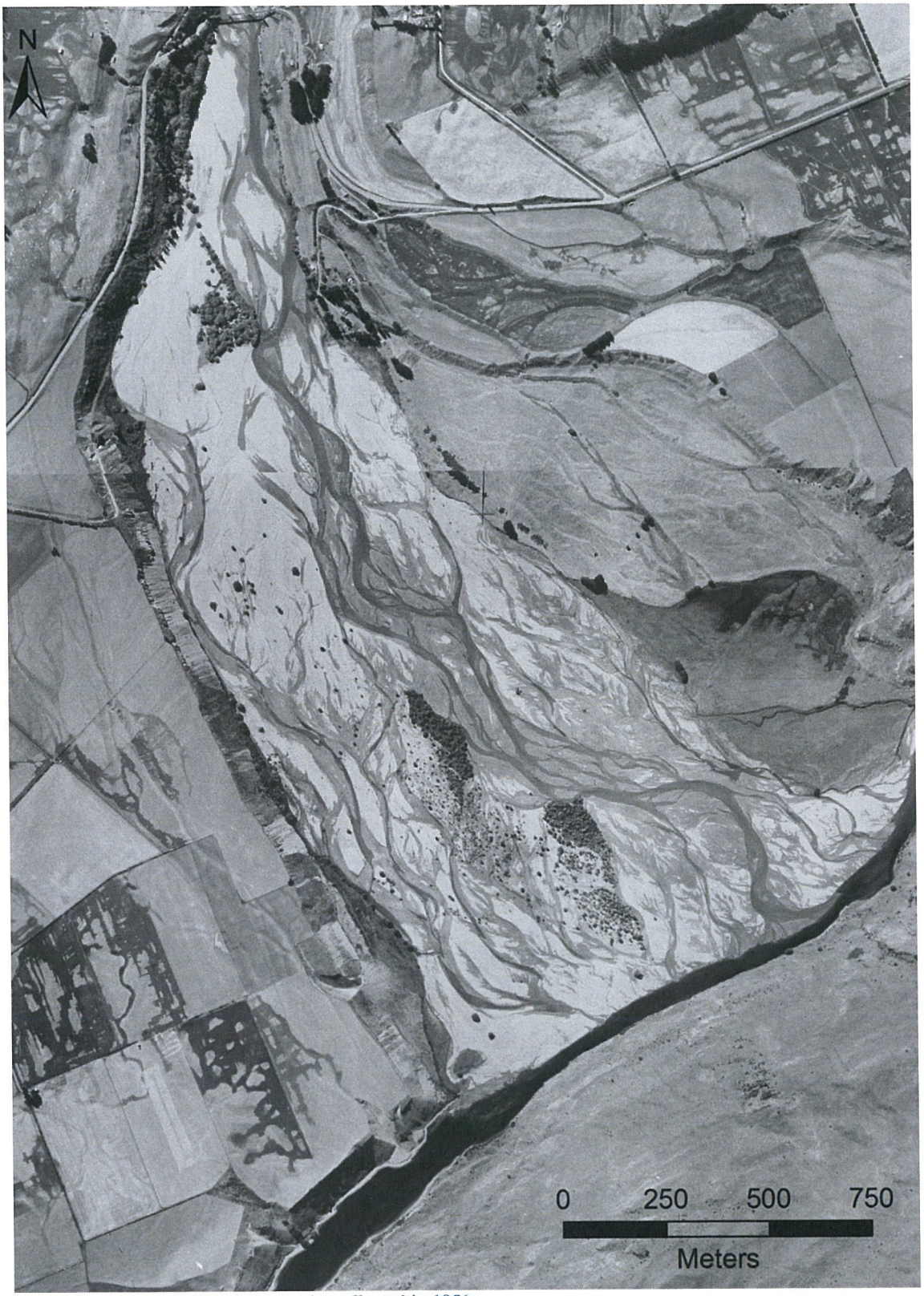


Figure 9. Aerial photography collected in 1956

Figure 10. **Aerial photography collected in 1959**

Figure 11. **Aerial photography collected in 2006**

Figure 12. **Aerial photography collected in 2014**

Appendix 3. Cross-section changes

As stated in the covering letter, the Shotover River is a dynamic environment with changes occurring in the channel locations as well as their morphology. The ORC has a series of cross-sections in the Shotover River which are monitored for changes in bed levels and river morphology (Figure 13). The mean bed level (MBL) of the Shotover River changes over time. Between 1980 – 2014 the upper reaches of the Shotover River delta (ORC cross-section MWD1-MWD5) experienced a decrease in MBL, while the lower reaches (ORC cross-section MWD6 – MWD7) experienced a small increase in MBL. Between 2012 and 2014 the MBL increased between the state highway 6 bridge and the confluence with the Kawarau River, with the exception of MWD5.

Figure 13. Shotover River cross-section locations