11. Tony Oliver
Flood Issues for Kaiapoi

BEFORE THE CANTERBURY REGIONAL COUNCIL HEARING PANEL

UNDER	of the Resource Management Act 1991
	AND
IN THE MATTER	of a hearing by the Canterbury Regional Council Hearing Panel on submissions on Proposed Change No.1 to the Canterbury Regional Policy Statement Chapter 12A (Development of Greater Christchurch) including Variations 1, 2, 3 and 4.

STATEMENT OF TONY OLIVER
AS PART OF THE OFFICER REPORT UNDER SECTION 42A OF THE RESOURCE MANAGEMENT ACT 1991

1 My full name is **Anthony (Tony) Kenneth Charles Oliver**.

Code of Conduct for Expert Witnesses

2 I acknowledge that I have read the code of conduct for expert witnesses contained in the Environment Court's Practice Note dated 31 March 2005. I have complied with it when preparing my written statement of evidence and I agree to comply with it when I give any oral evidence.

Qualifications and Experience

3 I am employed by the Canterbury regional Council as a Principal Hazards Analyst (Floods).

4 I have a Bachelor of Engineering Degree (Canterbury) and a New Zealand Certificate in Engineering (Civil). I am a member of the Institution of Professional Engineers New Zealand and the New Zealand Hydrological Society.

5 I have had over 30 years experience in water engineering, working in central and local government and private consultancy, both in New Zealand and the United Kingdom. This experience includes water resource engineering, hydrologic and hydraulic analyses, flood mitigation investigations and design, hydrologic and hydraulic computer modelling, and floodplain management planning.

6 At the Canterbury Regional Council my work entails investigating flooding issues throughout Canterbury and includes floodplain management planning, hydrologic and hydraulic investigations, including computer modelling, and giving advice on flood hazards. Recent relevant work I have undertaken includes river and floodplain modelling of the Waimakariri and Ashley Rivers and associated floodplains. I have also developed a number of floodplain management strategies in conjunction with the relevant communities and District councils. I have also provided expert evidence at a number of District and regional Council hearings, as well as, Environment Court hearings.

7 Prior to joining Environment Canterbury in 2001, I was employed at Christchurch City Council for ten years. There I investigated potential flooding on the main rivers and waterways, floodplains, and ponding areas throughout the city. This work also entailed a substantial amount of hydrologic and hydraulic computer modelling.

Ambit of my evidence

8 In my evidence I will discuss historical flooding in Kaiapoi, the current flood hazard in Kaiapoi, the potential impact of new development on flooding, and floodplain management. This evidence is within my area of expertise.

Facts Relied Upon and Formation of Opinions

9 The data, information, facts and assumptions I have considered in forming my opinions are set out in the part of the evidence in which I express my opinions.

10 The reasons for the opinions expressed are set out in the part of my evidence in which I express my opinions.

11 I have not omitted to consider material facts known to me which might alter or detract from the opinions I have expressed.

12 The literature or other information and material that I have used or relied on in forming my opinions is set out in that section of my evidence or otherwise provided as an annexure.

Background

13 Kaiapoi is located near the confluence of the Kaiapoi and Waimakariri Rivers (refer Figure A1 in Appendices). The town, built mainly on marine deposits, is particularly low-lying. Approximately 50% of the existing and potential urban area is less than 2.0 m above mean sea level (msl).

14 To reduce the threat to Kaiapoi from tidal inundation and flooding from the Waimakariri River, stopbanks have been constructed on the Kaiapoi and Waimakariri Rivers. Kaiapoi is also located at the base of the Ashley River fan (floodplain).

Historical flooding

15 Records since early European settlement indicate that flooding in Kaiapoi has always been a problem. Floodwaters from the Waimakariri River, in particular, resulted in the Kaiapoi settlement being flooded a number of times in the 1850s and 1860s. This culminated in the extreme event of 1868, when the Waimakariri River broke out to both the north and the south, entering central Christchurch. Flooding to the north resulted in parts of the Kaiapoi settlement on Kaiapoi Island, being flooded to depths of nearly two metres.

16 The New Zealand Rivers Commission report in 1921 discussed the flood hazard to which Kaiapoi had been subjected to *"in addition to these floods (of 1868 and 1887, emanating from the Waimakariri) Kaiapoi has been inundated by local floods from the Eyre and Cust Rivers, and also by flood overflows from the Ashley River. As a rule floods in the Eyre, Cust and Ashley Rivers do not synchronise with those of the Waimakariri, but this happened in 1868 and 1905."*

17 Numerous floods were reported in the latter half of the 19th century, but the largest appears to be the February 1868 event. The Ashley River "broke its banks" flooding Rangiora and floodwaters extended all the way to Kaiapoi. Two children were drowned near Rangiora and *"Kaiapoi suffered severely with water up to 5 ft 6 inches (1.7 m) in some streets, and almost every shop and house was invaded with consequent heavy losses…"* the flooding of Kaiapoi was due to the overflows from the Cust, Eyre and Ashley Rivers, and flooding from the Waimakariri River.

18 Further significant floods were recorded in the early 20th century, particularly March 1902, June 1905 and May 1923. The 1923 flood was reported as *"the most disastrous since 1868… A large amount of damage was done to Kaiapoi, and Rangiora was similarly affected… Between Kaiapoi and Southbrook the country is a sea of water, in some places up to the tops of the fences… the main road from Flaxton to Southbrook was transformed into a river of water from fence to fence…"* Kaiapoi was again flooded as a result of a breakout from the Ashley above Rangiora. *"Rangiora suffered some local (surface) flooding but Kaiapoi was inundated. Two hundred families were evacuated from their homes and the Revell family marked a new flood level at their home fifteen inches above the 1868 mark"*

19 Despite the completion of a stopbanking scheme on the Ashley River in 1938, a flood in March 1941 resulted in the Ashley River *"breaking its banks in four or five places."* The stopbanks were again breached in 1945, 1951 and 1953. These events all caused widespread flooding and major flood damages, and evacuation of people from their homes. In the 1953 flood event, Waikuku and Woodend Beach were flooded and floodwaters flowed through the Pines and Kairaki. Floodwaters from the Ashley also caused the Cam to overflow its banks and threatened the low-lying Camside area of Kaiapoi. A photo of flooding in Kaiapoi in 1995 is shown in Figure A2. There has been a number of reasonably large river flows in the Ashley River since 1953. Although the stopbanks have been close to breaching/overtopping a number of times, there have been no breakouts onto the floodplain since that time.

20 Overflows from the Waimakariri River in 1926, 1936, 1950 and 1957 have been limited to the Clarkville area (west of the motorway) and the Courtenay Stream area (east of the motorway). There are no reports of these floods entering the existing Kaiapoi urban area.

21 The most recent flood event in July 2008 resulted in significant flooding immediately to the west of Kaiapoi, but only minor surface flooding in parts of Kaiapoi. These floodwaters were a result of local surface runoff and overflows from the Cam River. Rainfall from the Canterbury Regional Council recorder in the Cust catchment, to the west of Kaiapoi, was in the order of a 10 - 20 year return period.

River control works

22 To mitigate flooding to rural and urban areas the Canterbury Regional Council maintain river control schemes, including stopbanks and erosion control measures on the Waimakariri, Ashley, Kaiapoi, Cam and Cust rivers.

23 The stopbanking system (1960 scheme) on the Waimakariri River is designed to contain a flow of approximately 4700 m^3/s (currently estimated to be approximately equivalent to a 450 year return period event). However, there is still a risk of stopbank failure at flows below the design flow, due to lateral erosion or piping (seepage under the stopbanks). Further erosion protection measures, however, are planned to reduce the threat of failure below the design level. However, even when these works are completed, the Waimakariri River will still pose a potential threat to Kaiapoi in extreme events.

24 Improvements to the Cam River flood control works were completed in the 1980s and the design standard is based on a 50 year return period or 2% AEP (Annual Exceedence Probability) event. Overflows, however, have occurred since these works were completed, which compounds flooding immediately to the west of Kaiapoi and potentially can enter Kaiapoi.

25 The Cust River / Main Drain also has a stopbanking system, designed to contain a 50 year return period or 2% AEP flood event. Overflows across rural land would eventually enter the Kaiapoi River, but is unlikely to be a hazard, on its own, to the Kaiapoi urban area.

26 The Kaiapoi River stopanks are mainly designed to contain water “backing up” from the Waimakariri River in the case of high river levels due to very high tides, floods in the Waimakariri River, or both. Drainage systems which discharge into the Kaiapoi

or lower Waimakariri rivers are generally flapgated to prevent water inundating the low-lying land behind the stopbanks.

27 The river control scheme on the Ashley River was designed and constructed in 1976 to contain 2400 m^3/s, which originally was estimated to be the 100 year return period or 1% AEP event. However, based on the current hydrology, 2400 m^3/s is estimated to be smaller than the 50 year return period or 2% AEP event. Recent hydraulic computer modelling, however, shows that for much of its length the Ashley River has a capacity of approximately 3000 m^3/s. This is estimated to be approximately equivalent to a 2% AEP (50 year return period) flow. As discussed below, it is the Ashley River which presents the greatest likelihood of significant overflows and a major flood hazard to Kaiapoi.

Ashley River flood investigations

28 Recent flood investigations (2007/08), including a risk assessment on the Ashley River, has identified a significant risk of stopbanks breaching at or even below the theoretical scheme capacity. It has been estimated there is a 50% chance of a breakout in a 2% AEP (50 year return period) event, i.e. 3000 m^3/s river flow.

29 Flood estimates for the Ashley River were analysed by NIWA (National Institute of Water and Atmospheric Research) in 2002. Recent discussions with NIWA concluded there was unlikely to be much change in these estimates. The estimated design flows for the Ashley River (at Rangiora) are: 3470 m^3/s (1% AEP or 100 year return period); 4050 m^3/s (0.5% AEP or 200 year return period); and 5300 m^3/s (0.2% AEP or 500 year return period).

30 It is therefore obvious with a theoretical design capacity of approximately 3000 m^3/s, major overflows onto the floodplain are likely to occur in large flood events. The majority of these overflows are expected to be to the south of the Ashley River. Hydraulic computer modelling recently undertaken by myself, and peer reviewed by the Danish Hydraulic Institute (New Zealand office), shows extensive flooding across the floodplain. These overflows eventually enter the Kaiapoi River and the lower probability events result in significant flooding to Kaiapoi.

31 The computer modelling of the Ashley River floodplain (approximately 190 km^2) I have recently undertaken uses a ID/2D hydrodynamic numerical model (Mike Flood). The model links the Ashley River breakouts with the floodplain and includes the Kaiapoi River and other waterways, which eventually return the overflows to the

Waimakariri River and the sea. The floodplain topography has been obtained by a recent LiDAR (Light Detection and Ranging) survey, obtained from an aerial laser survey. This survey provides a very detailed and relatively accurate description of the ground topography.

32 Incorporating other parameters into the model, including floodplain roughness, the two-dimensional component of the model calculates water levels, depths, flood extent and flow speeds across the floodplain.

33 Flood modelling simulations have been undertaken for the 1%, 0.5% and 0.2% AEP (i.e. 100, 200 and 500 year) events for both existing land use and a number of development scenarios in the Kaiapoi River. Breakouts from the Ashley River could be from a number of locations, however the most likely locations are those where freeboard on the stopbanks is minimal, historic locations, and overflow paths identified from a floodplain geomorphology investigation. It is these locations which have been used in the computer modelling investigations. Apart from some potentially small breakouts to the north side of the Ashley River, breakouts to the south generally flow down the fan and eventually end up in the low-lying areas around and in Kaiapoi, before eventually draining to the Kaiapoi and Waimakariri rivers.

34 The predicted flooding and maximum depths across the floodplain are shown in the appended plans, A4 – A9. It needs to be noted that these maps show flooding only from the Ashley River. There is also likely to be significant local surface runoff which will contribute to the overall flooding.

35 Figures A4 and A5 which show the potential flooding (from the Ashley River) in the 1% AEP (100 year return period) event, predicts significant flooding to the north-west of Kaiapoi, especially in the area known as the "Flaxton Swamp", but limited shallow flooding (200-300 mm) in Kaiapoi urban area.

36 Figures A6 and A7 show the potential flooding from the Ashley River in the 0.5% AEP (200 year return period) event. This scenario predicts widespread flooding to existing and future Kaiapoi urban areas mainly on the north side of the Kaiapoi River. Flood depths are typically less than 0.5m, although greater in lower-lying areas.

37 The estimated 0.2% AEP (500 year return period) event of 5300 m^3/s is predicted to result in over 40% of the flow spilling onto the floodplain. The majority of this is predicted to be to the south, resulting in significant depths of flooding in and around

Kaiapoi. The Kaiapoi River is at full capacity and banks are overtopped. The majority of the exiting urban area is likely to be flooded, as well as proposed new growth areas. Flood depths to the south of the Kaiapoi River and east of the motorway, including a proposed residential development (Kaiapoi Waters), are predicted to be to be up to 2.5 – 3.0 metres deep. The existing urban area on the north side of the Kaiapoi River is predicted to be flooded in the range of 1 – 1.5 metres, while parts of the proposed growth areas are predicted to be flooded up to 2 metres deep.

38 If the proposed new growth areas around Kaiapoi do proceed, then the floor levels of new buildings will need to be elevated to reduce potential flood damages. The effect of this will be a loss of floodplain storage and some diversion of floodwaters. The increase in flood depth as a result of this is shown in Figure A10.

39 It can be seen from Figure A10 that flood depths in the existing Kaiapoi urban area, north of the Kaiapoi River, generally increase by 0.2 – 0.5 m, and typically about 0.3 m in the 0.2% AEP (500 year return period) event. The potential development to the west of Kaiapoi has a “blocking” effect, elevating flood depths in the order of 0.2 – 0.5 m further west. However, it is understood if this particular development proceeded then roads may be lowered to allow passage of floodwaters. This would help reduce potential adverse effects.

40 Further modelling has also been undertaken to look at the impact of the small isolated development area to the east (east side of McIntosh’s Drain). The modelling indicates that this area, on its own, only has a negligible increase in flood depths on adjacent properties. This low-lying area, however, would be potentially isolated during a major flood event.

Waimakariri River flooding

41 Given the much greater river scheme standard on the Waimakariri River than the Ashley River, the flood hazard to the majority of Kaiapoi from the Waimakariri River is not as high. Overflows from the Waimakariri River, however, have occurred in the past and potentially will occur in the future despite the relatively high standard of “theoretical protection”.

42 A computer model has also been developed for the Waimakariri River and floodplain in much the same way as the Ashley River. This northern floodplain of the Waimakariri River was modelled undertaken by DHI Water and Environment, as

consultants to the Canterbury Regional Council. Potential overflows have been assessed to occur at historical locations and follow historic floodpaths towards Kaiapoi. Predicted depths for breakouts resulting from the 0.5% and 0.2% AEP (200 year and 500 year return period) floods in the Waimakariri River are shown in Figures A11 and A12.

43 Flood depths (up to 2.5 – 3.0 metres) are greatest in the relatively low-lying areas adjacent to the Kaiapoi and Waimakariri Rivers. The proposed new growth area (and consequent filling) south of the Kaiapoi and on the western side of the town is predicted to increase flood depths in the adjacent rural areas by up to approximately 0.2 m in the 0.2% AEP (500 year return period) event.

44 It should be noted that although the figures referred to above indicate potential flooding in the case of a 0.5% AEP (200 year) or 0.2% AEP (500 year) river flood, there is no certainty that the breakout will occur on the north (Kaiapoi) side of the river. The risk assessment for the Waimakariri River indicates approximately 30% chance of a breakout to the north in a 0.2% AEP (500 year return period) flood.

Climate change

45 Predictions for climate change include increased rainfall, and hence runoff during major storm events, and elevated sea levels.

46 NIWA/MFE predictions suggest that a catchment such as the Ashley could receive an additional 15% (approximately) rainfall during storm events by 2090. This would result in additional flooding around Kaiapoi, typically 0.2 – 0.5 m deeper.

47 For the Waimakariri catchment, with its headwaters in the Southern Alps, the increased rainfall and hence runoff is likely to be greater than 15%. The likely increases, however, are currently within the uncertainty of the estimates in the flood hydrology, and no additional modelling has been done specifically for this. It is likely, however, that flood flows will be greater.

48 The mid-range estimate for sea level rise is 0.5 m by 2100. The stopbanking around Kaiapoi will be able to contain the effects of this most of the time. However, when peak flooding (from Waimakariri or Ashley river breakouts or local surface runoff) coincides with high tides, flood depths around Kaiapoi could rise by 0.1 – 0.2 m in some locations. Duration of flooding is also likely to be longer, as outflows from the Kaiapoi River and flapgated drains will be reduced.

Flood hazard management

49 Over the last 20 years there has been an increasing realisation world-wide that full reliance on structural measures, such as stopbanks, to prevent flood damages is unattainable and not cost-effective. Inevitably structural protection measures are overwhelmed by not only greater than design flood events, but also smaller floods. Additionally, complete reliance on structural protection gives a false sense of security and encourages further development on the floodplain. This increases the potential for flood damage.

50 It is noted that flood damage costs in New Zealand have been increasing. This is not due to more frequent or larger flows, but development on floodplains.

51 The current approach to flood mitigation is floodplain management planning which provides a comprehensive long term strategy for managing the flood hazard. It aims to achieve sustainable development in flood-prone areas without imposing unacceptable limitations or costs on future generations.

52 Floodplain management planning, therefore, emphasises a balance between keeping people away from floodwaters, and floodwaters away from people.

53 The Waimakariri District Flood Hazard Management Strategy, based on the above principle, was adopted by the Waimakariri District and Canterbury Regional Councils in 2003. This strategy covers the Waimakariri and Ashley River floodplains within the Waimakariri District.

54 The strategy, which was developed through significant public consultation, includes a mix of structural and non-structural measures. These include:

- maintaining the existing river schemes and channel capacities of 4,700 m^3/s and 3000 m^3/s for the Waimakariri and Ashley rivers, respectively;
- planning measures, including restricting development in areas where there is "extremely likely to be flooding", and providing for elevated floor levels for new dwellings, providing there is no increase in flood risk to other areas;
- improving community education and advice on flood hazards;
- effective emergency management.

55 Complementary with the above measures, the Canterbury Regional Council also advocates the avoidance of development in high hazard areas. This is consistent

with the Resource Management Act 1991 (s316), and more specifically with the Canterbury Regional Policy Statement (Chapter 16, Objective 1).

56 High hazard is defined as, where the depth of floodwaters is greater than one metre or where the product of depth and velocity is greater than one. International research and observations have identified critical depths and velocities which will damage structures and harm people. Resulting hazard categories from low to extreme and the depth/velocity relationship is shown in Figure A13. For example, in ponded water, flood depths greater than about one metre are sufficient to float young children and thus pose a threat to life. Normal vehicle access is prevented by flood depths above 0.3 – 0.5 m, while the maximum depth for rapid access of large emergency vehicles is approximately one metre.

57 A flood hazard category map has been produced for the Ashley River floodplain, based on the 0.2% AEP (500 year return period) event. This map (refer Figure A14) shows that the majority of Kaiapoi, including more than 50% of the proposed new growth area, is within the high hazard category. As Kaiapoi and surrounding areas are in a ponding area, the high hazard category is based on flood depths being greater than one metre.

58 The perception of a 500 year return period event (or 100, 200 year, etc) is that they are very extreme and "will never occur in my life-time". While the probability of these events occurring in any one year is very low, the probability of occurrence over a person's or building's life-time, for example, is relatively high. For example, the 200 and 500 year return period events have a 33% and 12% chance (respectively) of occurring over a 70 year period. A table showing the likelihood of flooding for a range of time periods is shown in Figure A15.

Conclusion

59 Kaiapoi is located in a particularly low-lying area, and drainage is impeded by high tides.

60 Kaiapoi is located on the Waimakariri and Ashley River floodplains.

61 The most significant threat to flooding in Kaiapoi is the Ashley River, which has a much lower "standard of flood protection" than the Waimakariri River.

62 Hydraulic computer modelling (peer reviewed by DHI Water and Environment) indicates that the majority of Kaiapoi and a large portion of proposed new growth areas, fall within a high flood hazard category.

63 Filling on the floodplain for any new development could potentially create an adverse effect on adjacent urban and rural areas.