Waitohu Stream study

Potential flood damages

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1. Introduction

The Waitohu Stream, flowing from the Tararua Ranges to the Tasman Sea just north of Otaki (Figure 1), is a dynamic stream with a history of flooding and erosion problems. It has a catchment of 54km^2 and the steepest average slope of the Kapiti Coast rivers (WRC, 1994). Under the mandate of the Soil Conservation and Rivers Control Act 1941, erosion and flood mitigation work has been undertaken in the Waitohu Stream by the Flood Protection Group of Greater Wellington (the Wellington Regional Council) and its predecessor authorities (most notably, the Manawatu Catchment Board prior to 1989) since the inception of the Otaki Scheme in 1955.

Greater Wellington is undertaking a Waitohu Stream Study, a component of which is an assessment of potential flood damages.

The study is primarily focussed upon the Waitohu Stream, and only considers the tributary streams insofar as they impact upon the main Waitohu Stream. For the Damages Assessment, the Greenwood Boulevard area and the Mangapouri floodplain upstream of Convent Road have not been included.

The floodplain thus covered by this assessment is largely rural, with small semi-rural pockets of residential buildings at the Stream mouth (Otaki Beach) and Convent Road. Given the low level of development, the assessment has not been as detailed as Flood Protection has previously initiated (e.g. WRC, 1992 and AEI, 1992). Rather, a more qualitative approach has been used, identifying assets at risk. The assessment is a desk-top exercise, drawing on other past studies.

Figure 1 Waitohu Stream Location

2. General land use

The study area is rural or semi-rural. The predominant landuses are dairying, grazing (beef or dry stock) and lifestyle blocks (including small scale grazing). There are also smaller areas of horticultural, forestry and residential land uses. Figure 2 summarises the predominant land uses for each land parcel in the floodable area. This has been compiled from the Agribase database (AgriQuality New Zealand (2001)) – in turn from MAF farm census information – and updated with the assistance of some landowners and from aerial photography. However, Figure 2 should be regarded as indicative rather than definitive. No information is available for several parcels, and these have been left bank in Figure 2.

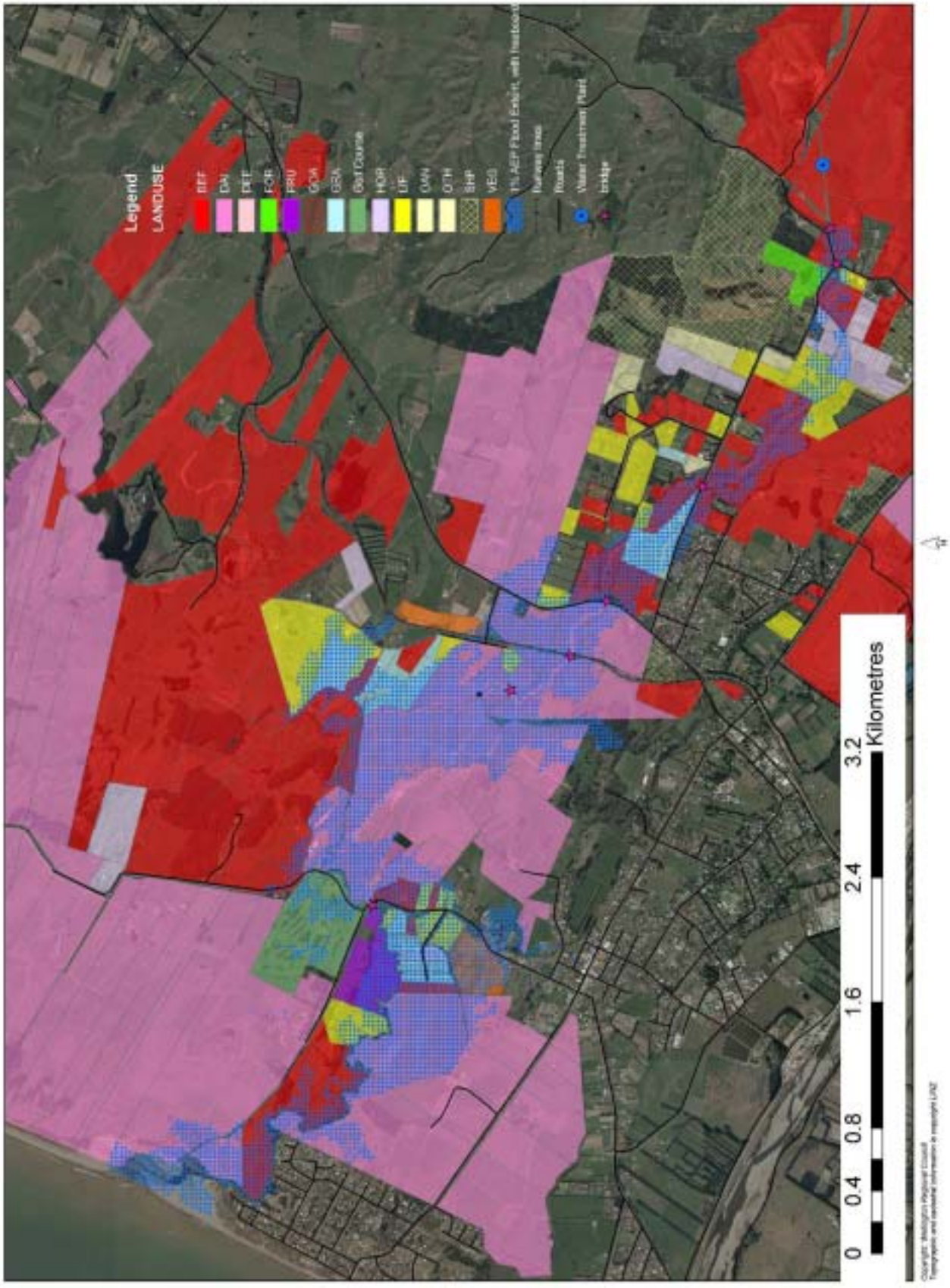

Fig 2 Land Uses and Key Infrastructure Location (Refer to Appendix I for key to landuses)

3. Historical damages and losses in the Waitohu catchment

Records of actual flood damage in the Waitohu floodplain are sparse. No records exist of quantified flood damage to residential dwellings, rural land or other privately owned assets. Nonetheless, various items of correspondence in the past from Waitohu landowners to Greater Wellington give qualitative descriptions of flood costs.

Some repair costs have been documented for infrastructural assets, as described in the "History of the Management of the Waitohu Stream". The more significant of these include the following:

- March 1990 flood: Scour at Waterworks Bridges ($3400)[1], Ringawhati Abutment scour ($2000), Waitohu Valley Road abutment repairs ($39,600)
- 1996 flood: Ringawhati Abutment scour ($10,000)
- November 1998: Replacement of "Phillips" bridge (privately owned bridge downstream of the railway bridge). Repairs to State Highway 1 bridge.
- 1999 flood: Ringawhati Abutment scour
- 2004 flood: Ringawhati Abutment scour

4. Flood extent

Various flood scenarios have been modelled, as reported in the Hydraulic Modelling Report. That report also contains flood extent maps for the scenarios. The 1% Annual Exceedence Probability (AEP)2 flood extent, including 300mm freeboard, has been reproduced as an overlay in Figure 2 above.

A summary of the approximate area of various land use classes flooded in each scenario is given below in Table 1. Note that these areas are approximate only.

[1] With the exception of the Waitohu Valley Road bridge repair cost quoted, these figures are those charged by WRC to KCDC, and exclude any other costs (e.g. staff costs) directly incurred by KCDC. The figures are also in terms of dollars of the day.

[2] By definition, there is a 1% chance of getting a 1% AEP flood or a larger flood in any one year. This is more commonly known as a "1 in 100 year flood" or more simply as a "100 year flood". Likewise, for example, there is a 50% chance of getting a 50% AEP flood (a "2 year flood") or larger in any one year.

Landuse	Flood Scenario					
	50% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.5% AEP
Dairying	64	97	112	128	136	141
Grazing & Beef	37	55	63	75	81	89
Lifestyle	8	13	16	24	26	26
Deer	0	0	0	0	0	0
Sheep	0	0	0	0	0	0
Fruit	5	7	7	8	8	8
Horticulture	0	0	1	1	1	1
Vegetables	3	4	4	9	10	11
Residential	0	0	0	1	1	1
Goat	0	0	0	0	0	0
Forestry	0	0	0	0	0	0

Table 1 – Area (ha) of Land Use Activities Inundated in Various Flood Scenarios (excluding freeboard)

5. Flood losses

5.1 Residential

Previous studies for other floodplains (e.g. AEI, 1992) have used "stage-damage" curves (i.e. flood damage to residential buildings and contents defined as a function of water depth above floor level) to estimate total residential losses (excluding intangible losses, themselves not insignificant). Such curves however are based on average losses, for representative houses.

Such an approach has not been taken for this Waitohu Study, however, as so few houses are floodable that the results would be skewed by the use of representative house approach. Instead, a more simple analysis has been undertaken: the number of houses potentially affected by flooding has been derived. Table 2 lists the houses predicted to be surrounded by floodwaters. Note that further houses may be affected by, for example, loss of access during a flood event or damage to garages etc.

Where floor levels are known, these are compared to predicted flood levels in Table 3. (The feasibility of raising several houses in the wider Otaki floodplain considered at risk of inundation was assessed in a previous investigation (Connell Wagner, 1996)).

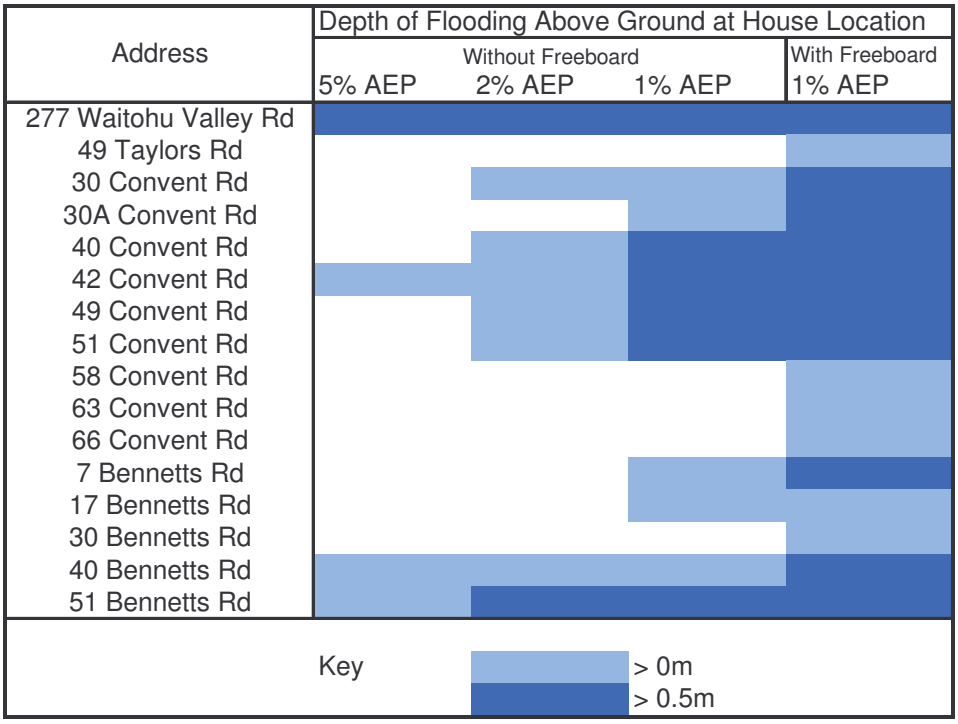

Table 2 – Houses Surrounded by Floodwaters (Not necessarily within the house)

Floor Level	Address	Flood Level (m above datum)		
		Without Freeboard		With Freeboard
		2% AEP	1% AEP	1% AEP
5.25	30 Convent Rd	5.13	5.47	5.77
5.80	30A Convent Rd	5.10	5.45	5.75
5.09/5.57	40 Convent Rd	4.95	5.28	5.58
5.59	7 Bennetts Rd	5.05	5.45	5.75
4.92	17 Bennetts Rd	4.37	4.50	4.80
2.94	28A Moana St	2.53	2.53	2.83
2.57	3 Kowhai St	Not flooded from Waitohu		
2.41	5 Kowhai St	Not flooded from Waitohu		

Table 3 – Flood Levels at Houses with Known Floor Levels

5.2 Social disruption

The flood damage assessment carried out for the Otaki (AEI, 1992) has a good description of the social impacts of flooding and the vulnerability of various sectors of the community to flood losses. Although the smaller scale flooding of the Waitohu would not have the effect on the community that an Otaki event would, effects such as psychological impacts and health risks described in the Otaki report would apply equally to individuals in the Waitohu floodplain. Of course, a major flood in the Waitohu catchment is likely to coincide with an Otaki flood, exacerbating the impact on Waitohu residents.

5.3 Rural losses

Overplotting the flood extent maps onto the land use map provides an estimate of the area of each land use activity that would be inundated, as in Table 1. Note that, with the exception of the horticulture area, the streambed has been included in these areas. The horticultural land that is in fact streambed has been removed from the table as the losses per inundated hectare are large, and the total losses would otherwise therefore be misleading. For other land uses, the area concerned is small or the losses per hectare are less significant.

Flood losses in rural areas are not a simple function of inundation depth. Duration is relevant; provided areas can be drained quickly, losses can be minimised. However, different land uses have different duration thresholds – pasture can withstand a longer duration of inundation than kiwifruit, for example.

The silt content of floodwaters is also important. More damage is incurred when silt and debris are deposited, than when floodwaters are clear.

A further consideration is the season within which a flood occurs. For example, for dairying, "per cow production in autumn is approximately half that of spring [so that loss of production would be less] and farmers have more options to meet a feed deficit." (Hedley, 2001).

Notwithstanding these factors, an estimate of potential flood losses has been made based upon the area of inundation, as follows. The estimate should only be regarded as indicative, giving the order of magnitude of possible losses. It should not, for example, be used for any benefit-cost analysis.

The estimates draw primarily upon three previous studies:

- That by the Ministry of Agriculture and Fisheries (Forbes (1989)) for the Opotiki area, as updated by Hedley (2001). Losses are given as a function of inundated area alone.

- A more recent desk-top study by AgFirst Consultants (2004), for the Whakatane area. This gives losses as a function of season (summer or winter), depth and inundated area. In applying the data to the Waitohu catchment, the average of the winter and summer values has been assumed (as they will be equally likely).

- That carried out by AEI (1992) for the Otaki area, including the Waitohu floodplain. Only the data for market gardening (vegetables) has been used in this current study. Losses are given as a function of inundated area.

It may be possible to update flood loss estimates further once any reports on the 2004 flood damage in the Manawatu, Wanganui, Wairarapa and Bay of Plenty areas are completed, but at the moment information is insufficiently detailed and not directly applicable to the Waitohu.

Note that these flood loss assumptions are less likely to be applicable in smaller flood events. Floodwaters would drain more quickly and depths of flooding will be less. Thus the estimated flood damage figures have only been applied to floods of 2% AEP or larger.

5.3.1 Dairying

Figure 2 clearly shows that dairying is the predominant land use on the Waitohu floodplain.

Hedley estimated loss of production to be 15% in the season of the flood, and 5% in the following season. The average production for the Kapiti District has been taken as 838 kg milksolids (MS) per hectare (LIC, 2002). (The 2002/03 figure was lower due to drought conditions (MAF, 2003).)

Payouts for milksolids vary from year to year, with a high in 2001/02 of $5.32/ kg MS but only $3.59/ kg MS the following year. Forecasts predict that payouts will steadily rise again to $5.13/ kg MS by 2007/08 (LIC, 2003). In this current exercise, a payout of $4.50/kg MS has been assumed.

Thus the predicted production loss for inundated areas is estimated at 838 x $4.50 x (15% + 5%) = $754/ha, using the method of Hedley.

In addition to loss of production, costs are incurred in off-farm grazing, additional feed, regrassing, fence repairs, weed spraying and soil reaeration. Hedley estimated these would average $1178/ha, for a slightly more intensive stocking ratio than the Kapiti average. Assuming a figure of $1000/ha for the Waitohu, total dairy losses would be approximately $1750/ha.

In the event of a flood and resulting loss of production, there will be some saved expenses (e.g. labour costs, feed costs and milking shed electricity costs). These do not appear to have been allowed for in Hedley's analysis.

Accordingly, the total dairy losses should be reduced. For this study, although no assessment of saved expenses has been carried out, net dairy losses have been assumed to be $1500/ha.

Applying data from the AgFirst study (which give losses as a function of depth) gives similar results to those derived from Hedley's work. (Tables 4 and 5).

5.3.2 Dry stock grazing and beef and sheep farming

It has been assumed that the total flood losses in the areas of dry stock grazing are as Hedley estimated for the Opotiki area – i.e. $669/ha (after correcting an error in Hedley's analysis). It has also been assumed that beef and sheep farming losses are of a similar amount per hectare. (Revenue from sheep and cattle farming is similar, per hectare, according to MAF figures for the Manawatu area (MAF, 2004)).

As with dairy losses, applying the AgFirst data to this study gives similar results to those of Hedley

5.3.3 Fruit

The principal fruit crop in the Waitohu floodplain, as shown in Figure 2, is kiwifruit. Hedley estimated that the total net losses (i.e. allowing for saved expenses) would be $59,080 per hectare in the eastern Bay of Plenty. This assumed a total loss of production in

the year of the flood and 50% in the following year. It also assumed a yield of 8000 trays/ha, whereas the national average is more like 6000-7000 trays/ha (HortResearch, n.d.). For the Waitohu, a figure of 7000 trays/ha has been assumed, leading to a net loss of $51,820/ha.

However, the data from the AgFirst study suggests a much lower loss – up to a maximum net loss of only $18,183/ha.

5.3.4 Lifestyle blocks

Flood losses on lifestyle blocks could include damage to fences and trees, clean up costs and possible livestock loss. For instance, the relatively small flood of 6 January 2005 caused an estimated loss of over $5000 to one affected landowner. However, losses from lifestyle blocks have not been costed in this study, as farming activities on them tend to be less intensive and as there will be a diversity of activities amongst the blocks.

5.3.5 Forestry

It has been assumed that forestry blocks are resilient to flooding and that no losses occur. Some losses due to hill-slope erosion or wind-throw may occur in the upper catchment, but that is beyond the scope of this study.

5.3.6 Vegetables

AEI (1992) estimated market garden losses to be $15,000 per hectare, assuming total ruin of crops. This figure has been adopted here, updated for the change in consumer price index from 1992 to 2004 and rounded to $18,000 per hectare.

5.3.7 Horticulture

Other than fruit growing and market gardening, horticultural land in the area is primarily used for flower growing. Only a small amount of such land is floodable (ignoring the land classified as horticultural that is in fact in the stream bed and is therefore not cultivated). Discussions with the landowner reveal that the crops can withstand some inundation without damage. In the absence of any actual data, losses have been assumed to be the same as for vegetable crops, i.e. $18,000 per hectare.

5.3.8 Other land uses

Areas of other land uses (e.g. deer and goat farming) within the Waitohu catchment are small, and any flood losses have been ignored.

5.3.9 Rural flood loss summary

Two tables are provided below, summarising the rural losses. Table 4 summarises the losses calculated according the method of Hedley for dairy, grazing and kiwifruit losses. Table 5 summarises the losses assuming the method of AgFirst for those losses. (Losses shown for vegetable growing and other horticulture losses have been estimated using only one method).

It can be seen that the different estimates of kiwifruit production losses lead to significantly different total rural losses. No judgement has been made as to which of the two estimates is the more appropriate.

Only the losses for larger floods have been shown; losses calculated for smaller floods using the above assumptions are likely to be overestimates as ponding times will generally be less, and in the case of livestock farming there will be more options to move stock to flood-free locations within the farm. (For these reasons, as well as the uncertainty regarding kiwifruit production losses, no attempt has been made to quantify the "average annual damage").

		Flood Scenario (Excluding Freeboard)		
Land Use	Damages/ha	2% AEP	1% AEP	0.5% AEP
Dairying	$1,500	$191,922	$204,434	$212,102
Grazing & Beef	$669	$50,226	$53,896	$59,347
Sheep	$669	$3	$6	$17
Fruit	$51,820	$380,446	$384,044	$391,498
Horticulture	$18,000	$18,935	$22,515	$24,852
Vegetables	$18,000	$166,037	$188,333	$193,151
Sum		$807,568	$853,228	$880,967

Table 4 Expected Flood Losses for Various Flood Scenarios (Indicative Only) – Based on Assumptions of Hedley (2001) for Dairying, Grazing & Beef, Sheep and Fruit Losses.

	Flood Scenario (Excluding Freeboard)		
Land Use	2% AEP	1% AEP	0.5% AEP
Dairying	$161,089	$182,086	$198,398
Grazing & Beef	$44,299	$49,204	$54,646
Sheep	$1	$2	$4
Fruit	$28,411	$31,291	$37,677
Horticulture	$18,935	$22,515	$24,852
Vegetables	$166,037	$188,333	$193,151
Sum	$399,837	$450,916	$483,877

Table 5 Expected Flood Losses for Various Flood Scenarios (Indicative Only) – Based on Assumptions of AgFirst (2004) for Dairying, Grazing & Beef, Sheep and Fruit Losses.

5.4 Infrastructure

5.4.1 Roads

Losses relating to roading and bridging falls into two categories – direct damage to the assets and repair costs, and indirect losses to the economy from loss of access (e.g. additional vehicle running costs, cost of time).

As described earlier, parts of the KCDC roading network are vulnerable to flood and erosion damage. The Water Supply, Waitohu Valley Road and Ringawhati Road bridges have at various times suffered abutment damage, although some protection works since have reduced the damage from subsequent floods. Inundation of Convent Road, Bennetts Road, Waiorongomai Road, Taylors Road, Waitohu Valley Road and Ringawhati Road would also restrict or prohibit access during large flood events.

Flooding of State Highway One, north of the Waitohu Bridge, has occurred in the past, and overflow would occur in floods as small as 10% AEP. As well as loss of access, overflow can cause damage to the road surface. The bridge itself has also suffered flood damage, and although protection works have reduced the risk of bridge damage they constrict the waterway under the bridge – at the least creating potential for greater overtopping of the road.

The private road off the southern end of Taylors Road is inundated in relatively small flood events, impacting upon on the operation of the farm, and in larger events the houses along it would be isolated. A replacement bridge was built over the stream after the previous bridge was destroyed in the 1998 floods, and while this new bridge would be less vulnerable again some damage to it would be a possibility in large events.

5.4.2 Rail

As with the road bridges, both direct flood damage to the bridge and resulting indirect losses from disruption to the NIMT would be possible in large flood events. Ongoing minor maintenance and repairs to abutments have been needed from time to time as a result of flood damage.

The bridge also carries signalling information and fibre optic cabling. However, alternative networking options are available for these in the event that the links across the bridge are damaged.

5.4.3 Water supply

Water supply could be disrupted in the event of a flood, particularly to the Waitohu Plateau area (i.e. above SH1). Four bridges carry water supply pipelines (owned either privately or by KCDC assets): Waitohu Valley Road, Ringawhati Road, Water Supply Bridge and Convent Road. If any of the bridges or abutments were damaged, the likelihood of damage to the water supply pipeline is high. (Although to date, when the Ringawhati Road and Waitohu Valley Road bridge abutments have been washed out, the pipelines have remained unbroken, and spanned the washout in some instances. Furthermore the privately-owned pipeline over the Convent Road bridge is less vulnerable, as stream velocities are low in the lower reaches of the Waitohu.) No redundancy in the supply network is present – i.e. if the pipelines were broken, no alternative supply exists.

Other than at the bridges, the water supply line runs some distance above or away from the stream corridor and it would not be expected to suffer damage during floods.

The Waitohu Water Supply Intake has not been used since 2003, with bores now supplying water, so that the supply to Otaki township is now not as vulnerable to flood damage as

would have been the case a few years ago. (Although no decision on whether to decommission the intake has yet been made.)

5.4.4 Other District Council assets/services

No other KCDC assets (stormwater, sewerage) would be affected by Waitohu flooding.

5.4.5 Gas

The natural gas transmission line passes under the Waitohu Stream near its downstream end. No flood damage to the line would be expected (AEI, 1992).

5.4.6 Electricity

Two transmission lines on pylons pass over the Waitohu, near the water supply intake and downstream of Convent Road. The pylons are sufficiently distant from the stream to avoid damage. However some distribution lines run near the stream, for example along Waiorongomai Road and upstream of the Waitohu Valley Road bridge, and erosion damage might be possible in a major flood.

Residents have reported that power was cut to parts of the floodplain during a flood event in the early 1980s.

5.4.7 Telecommunications

Telecom has a fibre optic cable attached to the State Highway One bridge over the Waitohu, and any flood damage to the damage to the bridge could result in damage to the cable. However there is sufficient redundancy in the cable network to be able to reroute the network via alternative links. Obviously there would be some repair costs to the cable over the Waitohu.

No other significant Telecom assets in the Waitohu floodplain are expected to be at risk of flood damage.

5.4.8 Flood Protection assets

No Greater Wellington flood protection assets exist for the Waitohu Stream.

6. Conclusions

Potential flood damage in the Waitohu floodplain is relatively low compared to floodplains of other major streams and rivers in the western Wellington region, due to the current low intensity land use.

Nonetheless, as the floodplain is unprotected, losses occur in medium sized floods. In a more severe flood such as a 1% AEP, some residential flood losses will occur while inundation of high value crops such as kiwifruit and vegetables is estimated to lead to rural flood damages of between $450,000 and $850,000. Affected landowners and residents would likely suffer some psychological and health impacts. Given the proximity of the

Otaki catchment, it is possible that a major flood in that would coincide with a flood in the Waitohu, leading to much wider community disruption.

An unquantified risk of flood and erosion damage to national infrastructure (Stage Highway One, telecommunications, North Island Main Trunk railway), and to local infrastructure (electricity, water supply, roading and bridges) exists. Some flood damage to these assets has indeed occurred in past flood events.

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Appendix I Landuse codes

Codes for Landuses illustrated in Figure 2 (from AgriQuality New Zealand (2001)).

Enterprise Code	Description
API	Beekeeping and hives
ARA	Arable cropping or seed production
BEF	Beef cattle farming
DAI	Dairy cattle farming
DEE	Deer farming
DOG	Dogs
DRY	Dairy dry stock
EMU	Emu bird farming
FLO	Cut flowers and flower seeds
FOR	Forestry
FRU	Fruit growing
GOA	Goat farming
GRA	Grazing other peoples stock
HOR	Horse farming and breeding
LIF	Lifestyle block
NAT	Native bush
NEW	New record – unconfirmed farm type
NOF	Not farmed (i.e. idle land or non-farm use)
NUR	Plant nurseries
OAN	Other livestock (not covered by other types)
OPL	Other planted types (not covered by other types)
OST	Ostrich bird farming
OTH	Other Enterprises not covered
PIG	Pig farming
POU	Poultry farming
SHP	Sheep farming
SNB	Mixed sheep and beef farming
UNS	Unspecified (i.e. farmer did not indicate)
VEG	Vegetable growing
VIT	Viticulture, grape growing and wine
ZOO	Zoological gardens