4.0 Catchment Modelling

4.1 Introduction

A hydrological and hydraulic model of the Waru/Haisman catchment has been developed to estimate the stormwater discharges and areas most prone to flooding, with and without development arising from the proposed plan change.

The model was developed using the United States Army Corp of Engineers (USACE) software HEC-HMS.

The two scenarios initially modelled are:

- Existing land use
- The land fully developed assuming a plan change allowing 5000m^2 lot sizes in the rural residential zone.

The model is not intended to provide a detailed analysis of the stormwater network but rather to show the key differences of land use changes.

4.2 Hydrological Model

Catchment runoff has been modelled using the modified SCS[1] method as detailed in the Auckland Regional Council Technical Publication TP 108 [5]. The methodology has been modified to reflect the different geology and rainfall patterns in the Gisborne District.

4.2.1 Precipitation

TP108 specifies a 24 hour design storm applicable to the Auckland region. The design storm shows how the rainfall intensity of a typical storm varies over a 24 hour period, and can be scaled by the predicted rainfall depth depending on location. The hyetograph shape is based on the statistical analysis of several storms in Auckland and may not directly translate to the Gisborne region, and therefore has been modified.

Statistical analysis of the storms typical has not been completed and no such design storm exists for the Gisborne region. Consequently, a synthetic hyetograph has been constructed using the rainfall data assembled in HIRDS[2].

Figure 4.1 shows the synthetic 24 hour hyetograph for a predicted 1 in 50 year rainfall event. A hyetograph for the 1 in 10 year event has also been developed (Related Doc. No. 31208, Waru-Haisman CMP Rainfall Data).

[1] US Soil Conservation Service, now know as the US Natural Resources Conservation Service
[2] High Intensity Rainfall Design System developed by National Institute of Water and Atmospheric Research.

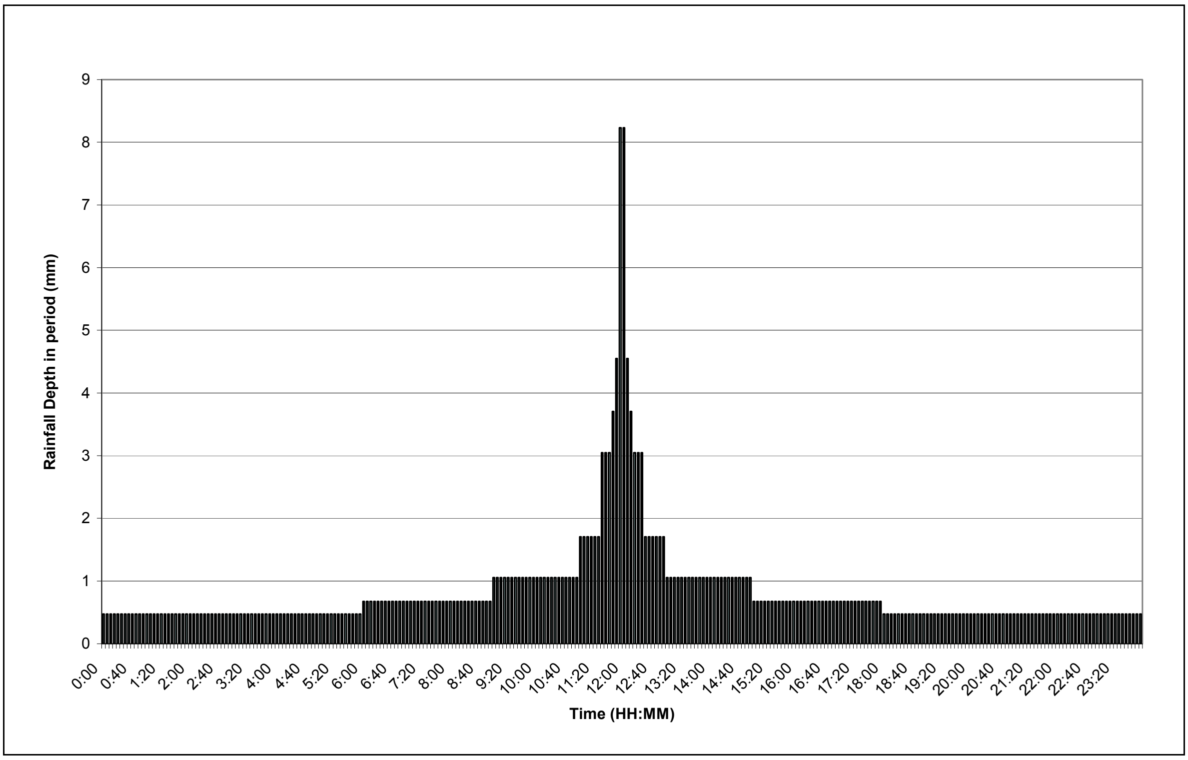


Figure 4.1 : 1 in 50 year 24 hour synthetic rainfall

4.2.2 Climate Change

Climate change in the Waru/Haisman catchment has been considered using the Climate Change Effects and Impact Assessment Guidelines developed by the Ministry for the Environment [6].

The current climate change projections for the Gisborne region are for an annual mean temperature increase of 0.2–1.4°C by the 2030s, and 0.6–3.8°C by the 2080s. Rainfall patterns are also expected to alter as a result of climate change.

From the Ministry for the Environment Climate Change Guidelines, it is inferred that although the annual mean rainfall in Gisborne is expected to *reduce* (up to 17% by 2030s, and up to 34% by 2080s), a warmer atmosphere will increase the potential for extreme rainfall events to occur more often.

The screening assessment procedure detailed in the guidelines has been used to allow for the increased likelihood of extreme rainfall events and is shown in Table 4.1. The projected rainfall depth developed from this screening assessment has been applied to the rainfall data used in the model.

Using the maximum projected temperature increase in the climate change analysis would lead to a very conservative design due to the uncertainty of extrapolating the effect of human activity on climate change 70 years into the future. A more appropriate solution, as used here, is to allow for the average projected temperature increase and to incorporate flexibility into the physical works to allow for changes in the future if they are required.

The climate change projections to the 2080s have been used as it is consistent with the expected life spans of new homes and any new drainage infrastructure installed.

Table 4.1 : Screening Assessment to allow for climate change in extreme rainfall events

Rainfall return interval/ Duration	***Average projected temperature increase by 2080's (°C)[3]***	***Percentage adjustment per °C[4]***	***Percentage increase by 2080's***	***Current rainfall depth (mm)[5]***	***Projected rainfall depth in 2080's (mm)***
1 in 10 year/24 hr	2.2	6.2%	13.64%	144.5	164.2
1 in 50 year/ 24 hr	2.2	6.6%	14.52%	208.8	239.1

4.2.3 SCS Curve

The SCS curve number is a measure of the predicted runoff for a given rainfall intensity. It is comparable to the runoff factor "C" in the Rational Method (used to calculate catchment runoff) and is dependent on the soil type, impermeable area and land cover.

SCS curve numbers have been calculated for pre-development conditions for each of the subcatchments by identifying land use from aerial photographs and weighting the relevant SCS curve number by area.

SCS curve numbers for post development conditions have initially been calculated by assuming that development will occur in a similar manner to existing 1 hectare rural residential lots, and that the catchment will be entirely developed. That is, each lot will contain:

- A primary dwelling of 280 m^2
- A self contained secondary dwelling of 80 m^2
- A garage/workshop of 60 m^2
- Paved living areas of 240 m^2
- Driveway of 100 m^2
- Contribution to shared accessways (right-of-ways) of 60 m^2

Therefore, the average impervious area coverage for a 5,000 m^2 lot is calculated to be 16%.

It is anticipated that no new legal roads will be created as part of development in this catchment. Access to additional lots will be via shared right-of ways. A contribution of impervious area from each lot to the right of way has been allowed for in the calculations.

In addition, it is assumed that runoff from all impervious surfaces and water tank overflows will be required to be channelled directly into the drainage system. No allowance for on-site detention has been allowed for in the initial analysis.

A full list of the SCS curve numbers for each of the subcatchments can be found in Related Doc. No. 31212, Waru-Haisman Catchment Data.

[3] From Climate change Impact and Assessment Table 2.3
[4] From Climate change Impact and Assessment Table 5.2
[5] From High Intensity Rainfall Design System (HIRDS) v2

4.2.4 Spatial Data

Contour data for the site has been taken from the airborne Lidar survey performed in 2005. Where this information is not available, the contours on 1:50,000 topographical maps have been used.

Dimensions and grades of the major drainage network have been taken from their original as-built drawings and any subsequent maintenance drawings. Where necessary these have been augmented with survey data and information gleamed from site inspections.

Minor drainage channels and cross sections of overland flowpaths have been extracted from the Lidar data.

4.2.5 Model Runs

The four model runs initially conducted were:

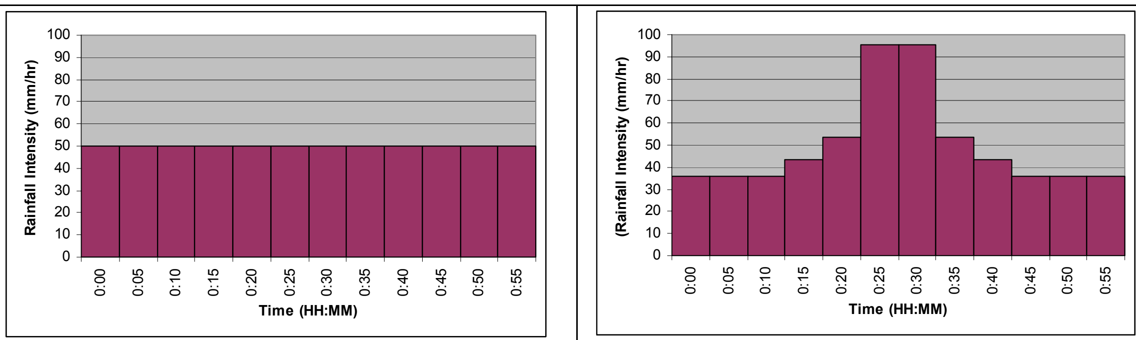
- 10 yr rainfall, pre-development land use
- 10 yr rainfall, post-development (unrestricted) land use
- 50 yr rainfall, pre-development land use
- 50 yr rainfall, post-development (unrestricted) land use

4.3 Model Calibration and Validation of Results

The model has been validated by comparing the results with the runoff predicted using the Rational Method.

The calculated error between the peak flows predicted by the model and the rational method in the Haisman catchment and Waru catchment were 4.1% and 14.9% respectively. In both cases the peak flows predicted using the rational method was lower than those predicted using the computer model.

An explanation for the difference is reported in the NZIE Guidelines for the Hydrological Design of Urban Stormwater Systems [7]. One of the assumptions used in the Rational Method is that the rainfall is uniformly intense over the time of concentration of the catchment (Figure 4.2a). The occurrence of a uniform intensity over any appreciable period is rare, and the peak runoff is more likely to be determined by the effect of a short duration peak(s) in rainfall. The SCS method uses a more realistic hydrograph, and accounts for a short duration peak in rainfall (Figure 4.2b). In essence, the Rational Method will tend to underestimate the peak flow and the effect becomes more pronounced as the time of concentration for the catchment increases. Considering the above, a difference of up to 15% is sufficient to validate the model.



(a) Rational Method

(b) SCS Method

Figure 4.2 : Comparison of assumed rainfall patterns for (a) Rational Method and (b) SCS Method. Note that both represent a rainfall depth of 50 mm over a 1 hour period.

4.4 Model Results

Peak stream flows as predicted from the initial model runs are shown in Tables 4.2 and 4.3 for the Waru and Haisman Streams respectively.

Table 4.2 : Predicted peak stream flows for the Waru Stream

Location	***10 year Storm***		***50 year Storm***	
	Pre-Development (m³/s)	***Post- Development (unrestricted) (m³/s)***	***Pre- Development (m³/s)***	***Post- Development (unrestricted) (m³/s)***
Maclaurin Rd culvert	20.56	20.56	36.98	36.98
Maclaurin Drain junction	31.07	31.37	55.80	56.01
Back Ormond Rd Bridge	32.16	32.60	57.73	58.12
Into Taruheru River	32.16	32.60	57.73	58.12

Table 4.3 : Predicted peak stream flows) for the Haisman Stream

Haisman Stream				
Location	***10 year Storm***		***50 year Storm***	
	Pre-Development (m³/s)	***Post- Development (unrestricted) (m³/s)***	***Pre- Development (m³/s)***	***Post- Development (unrestricted) (m³/s)***
Back Ormond Rd culvert	11.31	12.57	20.13	21.69
Haisman Rd culvert	18.65	20.05	32.92	34.58
Into Taruheru River	18.65	20.05	32.92	34.58

4.5 Discussion of Initial Model Results

The results show that the flow in the Waru Stream will increase by less than 2% when fully developed as per the proposed plan change. The flow in the Waru Stream is dominated by the runoff from the steep upper catchment. The plan change will not alter the land use in the upper catchment; consequently the increase in flow in the Waru Stream is minor.

The effect of allowing more intense development in the Haisman catchment is more pronounced. The peak flow rate into the Taruheru River from the Haisman Stream is expected to increase by 8%.

Allowing unrestricted rural residential development in this catchment, without managing the stormwater runoff, would see a significant increase in the both the total volume of runoff and the peak discharge into the Taruheru River. This will affect a number of downstream properties adjacent to the Taruheru River that are known to be prone to flooding, by increasing the frequency of house flooding, and the depth of any flooding.

An adverse affect such as this is not considered acceptable and there is a need to manage stormwater runoff from the catchment by either (a) controlling how development occurs by limiting the amount of impervious area permitted, or (b) providing detention and storage areas to reduce the peak discharge from the catchment.

4.6 Further Model Runs

Three further model runs were conducted to determine the most effective way to manage runoff from the catchment. Each of these are described below

4.6.1 Minimum Development

Minimum development is the option that would permit the minimum amount of site coverage with impermeable surface whilst allowing the area to remain functional as a residential area.

Each lot will contain:

- A primary dwelling/garage of 200 m^2
- Paved living areas of 150 m^2
- Driveway of 75 m^2
- Contribution to shared access ways (right-of-ways) of 60 m^2

4.6.2 Moderate Development

Moderate development is an intermediate option allowing for 13% site coverage with impervious surfaces.
Each lot will contain:

- A primary dwelling of 280 m^2
- A self contained secondary dwelling of 80 m^2
- Paved living areas of 150 m^2

- Driveway of 100 m²
- Contribution to shared accessways (right-of-ways) of 60 m²

4.6.3 Stormwater Detention and Storage

This option incorporates a detention pond to store runoff in the Haisman catchment.

The pond has been sized to comply with the water quantity and quality requirements of Auckland Regional Council Technical Publication TP 10 [8] and has the capacity to hold runoff from up to a 1 in 10 year storm without overtopping. Suitable spillways can be designed to discharge larger flood events in a controlled manner.

Land use is assumed to be as described in Section 4.2.3, with 16% coverage for 5,000 m² lots.

4.6.4 Model Results

Peak Stream flows as predicted from each of the three model runs are shown in Tables 4.4 and 4.5 for the 1 in 10 year and 1 in 50 year events respectively. The pre-development flows calculated previously have been included for comparison.

Table 4.4 : Predicted peak stream flows (m^3/s) for a 1 in 10 year storm

Waru Stream				
	Pre-Development (m^3/s)	***Minimum Development (m^3/s)***	***Moderate Development (m^3/s)***	***Stormwater detention (m^3/s)***
Maclaurin Rd culvert	20.56	20.56	20.56	20.56
Maclaurin Drain junction	31.07	31.27	31.32	31.37
Back Ormond Rd bridge	32.16	32.47	32.52	32.60
Into Taruheru River	32.16	32.47	32.52	32.60
Haisman Stream				
	Pre-Development (m^3/s)	***Minimum Development (m^3/s)***	***Moderate Development (m^3/s)***	***Stormwater detention (m^3/s)***
Back Ormond Rd culvert	11.31	12.19	12.43	12.57
Haisman Rd culvert	18.65	19.53	19.84	18.65
Into Taruheru River	18.65	19.53	19.84	18.65

Table 4.5 : Predicted peak stream flows (m^3/s) for a 1 in 50 year storm

Waru Stream				
	Pre-Development (m^3/s)	***Minimum Development (m^3/s)***	***Moderate Development (m^3/s)***	***Stormwater detention (m^3/s)***
Maclaurin Rd culvert	36.98	36.98	36.98	36.98
Maclaurin Drain junction	55.80	55.94	55.96	56.01
Back Ormond Rd bridge	57.73	58.02	58.02	58.12
Into Taruheru river	57.73	58.02	58.02	58.12
Haisman Stream				
	Pre-Development (m^3/s)	***Minimum Development (m^3/s)***	***Moderate Development (m^3/s)***	***Stormwater detention (m^3/s)***
Back Ormond Rd culvert	20.13	21.25	21.53	21.69
Haisman Rd culvert	32.92	33.99	34.35	32.94
Into Taruheru River	32.92	33.99	34.35	32.94

4.7 Catchment Modelling Conclusions

The results of the catchment model have shown that allowing rural residential development will have only a marginal effect on the stream flows in the Waru Stream. Allowing 16% site coverage will result in only a 2% increase in peak discharge into the Taruheru River. The expense of a catchment-wide flood detention solution is not warranted for such a slight increase in flow. Positive flood attenuation results can be achieved by encouraging on-site methods such as small wetlands or rain gardens within each lot or within clusters of lots.

The increase in flow in the Haisman catchment is more significant with an increase in peak flow of up to 8% predicted, if development is allowed to the maximum extent possible.

Both the options to reduce the runoff from the catchment (1: reducing the amount of impervious area within each lot and 2: constructing a catchment wide stormwater detention pond) have been shown as feasible options in minimising the impact of development on the drainage system, streams and downstream receiving waters.

However, neither option is a recommended solution.

The marginal benefit obtained by reducing the amount of impervious area is outweighed by the type of development the rural residential zone attracts, where large homes proliferate. Placing overbearing restrictions on how the land may be used is more than likely to deter potential land purchasers.

A catchment wide detention pond will be required to cover an area of nearly 1 hectare if it is designed in accordance with the ARC design guidelines [8]. At current market prices this will require at least $300,000 of land to be purchased. Although it may be possible to stage construction, (i.e. begin with a smaller pond, and increase it as more development occurs) this option still places a large financial burden on the land owners and ratepayers.

The preferred option would be to encourage low impact design on each individual lot. Each property would be required to demonstrate at the time consent is applied for, that a method to minimise the impact of the development will be achieved by either use of wetlands, ponds and dispersing of rainwater that has been collected from hard surfaces. The Waitakere City/Rodney District Council Low Impact Design Manual [9] should be used as a basis for evaluating consent applications

More discussion on the best methods to control stormwater and flooding issues can be found in the following sections.

5.0 Other Effects

5.1 Community Consultation

Extensive consultation was carried out with residents in the block of land bound by Cameron Road, Nelson Road and Hansen Road. Although this is outside of the Haisman/Waru catchment area, it has been subject to intense rural residential development and the issues identified are likely to be directly transferable.

The consultation consisted of meeting with groups of landowners and discussing stormwater issues directly relating to them. The main issues are summarised below.

5.1.1 Existing Infrastructure Inadequate

The existing stormwater infrastructure consists of a system of open drains and culverts that were constructed by either the East Cape Catchment Board or the Roading Authority.

These systems were designed and constructed for use in a rural productive environment, e.g. pasture, cropping and permanent horticulture. Upgrades to these systems were not completed as the land use changed to rural residential.

The effects are seen as twofold:

i. The increase in impervious area results in increased runoff reaching the drains

ii. Flooding is less acceptable and more visible in a residential area due to the value of property, the number of people at risk and the potential risk to property damage.

5.1.2 Obstruction of Overland Flowpaths

Drainage in the rural environment is very reliant on naturally existing overland flowpaths or watercourses, due to the large distances between formally constructed drains.

In an urban environment construction, usually in the form of a raised building platform, raised driveways or levelling of land, can unintentionally obstruct these watercourses causing localised ponding or diversion of the flow.

Small open drains may also become filled in over time. This can occur where the drain is maintained privately, and garden waste and other fill is dumped into it. To prevent this the preferred option to manage small open drains is to have them piped.

5.2 Stream and Drain Maintenance

Maintenance of the public drains and streams undertaken by Rivers and Land Drainage operational staff is focussed on maintaining hydraulic efficiency. Work includes:

- vegetation clearance
- weed spraying
- excavation of silt deposited in drains.

Collapse of the stream banks is an ongoing issue in this catchment requiring major remedial works. This instability can be due to:

- excavating too deep into sand layers which are easily eroded by stream flow
- excessive spraying and removal of vegetation of the stream banks
- draw-down failure of the banks following a storm event
- poor design resulting in overly steep channel grades and bank slopes.

5.3 Ecology

The maintenance works which have been aimed at increasing the hydraulic efficiency of the stream has often resulted in the destruction of habitat and stream life.

The Waru Stream is one of the few remaining waterways on the Poverty Bay flats with a relatively undisturbed aquatic habitat. Any future stream works will need to ensure that the ecology of the area is protected or enhanced, such as prohibiting piping of the Waru Stream and encouraging ecologically sensitive maintenance procedures.

5.4 Previous Flooding

Floodspread maps held by Gisborne District Council show that flooding in the catchment is known to have occurred in July 1985 and March 1988 (Cyclone Bola). Analysis of the rainfall shows that these events approximate a 1 in 50 year event in the Waru/Haisman catchment.

The extent of flooding during these two events has been used for the Flood Hazard Overlays in the District Plan where rules introduce minimum floor heights for dwellings and control earthworks that may divert floodwaters or cause erosion or aggradation.

5.5 Insurance

Insurance is an important consideration when managing the catchment. Information about the risk of flooding needs to be freely available to both homeowners and the insurers.

A lot of the Waru/Haisman catchment was not affected by either the 1985 or 1988 flood events, and has not been designated as a flood hazard zone in the District Plan. However, it would not be appropriate to say that this land is not at risk from inundation, particularly considering the proposed change to land use.

It is necessary to investigate the effect on flooding that, allowing increased residential development may have, to ensure that homeowners' are aware of any natural hazard risks and are able to make informed decisions on the amount of insurance required.

This information would also be important for Civil Defence and Emergency Management Planning purposes.

5.6 Catchment Management

There has been a noticeable demand for an increased level of service for maintenance of public drains as the rural residential area has grown.

This is driven by the greater expectations from a residential environment over a rural production area. The key differences are:

- Aesthetics – drainage needs to be compatible with a residential environment and greater control over vegetation growth is required.
- Safety – consideration needs to be given to the safety of people particularly around deep drains
- Access – drainage needs to be located where access for maintenance can be achieved.

The recommended way to manage the increased expectations would be to form a new drainage district to cover the rural residential area.

6.0 Catchment Issues

The preceding sections of this report have identified a number of issues specific to the Waru/Haisman catchment that need to be managed. Each of these issues is discussed below.

6.1 Flooding

Issue Identified	***Outcome Required***
○ Stream flooding	✓ Minimise the effect of stream flooding on residential development ✓ Minimise/mitigate effects of flooding downstream
○ Lack of public infrastructure	✓ Provide each property with the means to appropriately manage and dispose of excess stormwater ✓ Upgrade and maintain public and private drainage
○ Blocking of overland flowpaths	✓ Retain the capacity of overland and secondary flowpaths
○ Localised ponding	✓ Control residential development in low lying areas

6.2 Contaminant Discharge

Issue Identified	***Outcome Required***
○ Wastewater Discharge	✓ Minimise the impact of onsite waste water treatment and disposal on streams
○ Contaminants from human activity	✓ Minimise the contaminants discharged into the receiving environment

6.3 Erosion

Issue Identified	***Outcome Required***
○ Upper catchment erosion	✓ Encourage sustainable use of upper catchment land

6.4 Receiving Environment

Issue Identified	***Outcome Required***
○ Habitat and biodiversity	✓ Maintain and improve watercourses of high ecological value ✓ Remove obstacles to fish passage in streams of high ecological value

7.0 Management Options and Evaluation

7.1 Evaluation Methodology

In this section management options are presented for each of the issues identified previously. These options are not mutually exclusive and it may be that a combination of options may be best, or that different options are best applied in different parts of the catchment.

As required by Section 77 of the Local Government Act 2002, each of the options has been assessed by considering:

(a) the benefits and costs of each option in terms of the present and future social, economic, environmental, and cultural well-being of the district or region; and

(b) the extent to which community outcomes would be promoted or achieved in an integrated and efficient manner by each option; and

(c) the impact of each option on the local authority's capacity to meet present and future needs in relation to any statutory responsibility of the local authority; and

(d) any other matters that, in the opinion of the local authority, are relevant

The six high level community outcomes referred to in (b) above are:

- Vibrant Communities
- Connected Communities
- Prosperous Communities
- Safe and Healthy Haven
- Positive Leadership
- Fair and Active Democracy

7.2 Issue: Stream Flooding

7.2.1 Overview

The drains and streams in this catchment have been shown to have a limited capacity and flooding is to be expected. The appropriate management solution will need to address both the potential flooding within the catchment and mitigate or minimise any downstream effects.

A statutory requirement exists in the Building Act 2004(First Schedule, E1 – Surface Water) for Council to ensure that buildings and siteworks are constructed in a way that protects people and other property from the adverse effects of surface water. The performance requirement is to ensure that surface water resulting from a 1 in 50 year event does not enter buildings. Objectives 7.3.1 & 7.3.2 and Policy 7.4.1 of Chapter 7 of the District Plan also relate.

7.2.3 Options

Option 1 – Designate Flood Hazard Zones

One option is to accept extra generated runoff from increased development as a necessary by-product of development. Areas of land that are vulnerable to flooding would be identified in the

District Plan as a natural hazard. Rules would be provided that would require minimum floor heights for habitable dwellings to be achieved and restrict structures that endanger lives or increase aggradation or erosion as a result of flooding, or divert floodwaters.

Cost: $25,000 for professional services, consultation and District Plan change.

Option 2 – Construct Flood Defences

Flood defences (i.e. stopbanks or levees) would be constructed to retain floodwaters within the stream width. Stopbanks may be constructed along the entire stream length to protect the entire catchment, or around clusters of dwellings, or around individual dwellings.

Cost: $800,000 for design and construction.
$10,000 per year for additional maintenance

Option 3 – Improve Capacity of Existing Streams/Drains

The capacity of the existing drains, streams and rivers would be improved by increasing the cross-sectional area, decreasing the friction of the channel, or by regrading the stream beds. An assessment for work that is required would need to be done both within the catchment and downstream as far as the Turanganui River mouth.

Cost: $600,000 for design and construction
$20,000 per year for additional maintenance

Option 4 – Limit the Amount of Additional Runoff

The catchment modelling in Section 4 of this report has shown that minimising the percentage of impervious surfaces (roofs, driveways, paved areas etc) is effective in reducing the peak discharge rate and the total volume of stormwater runoff from the catchment to acceptable levels. This can be achieved directly through District Plan rules that restrict the site coverage or lot size, or indirectly by encouraging smarter design with “clustering” and shared hard surfaces.

Cost: nil

Option 5 – Provide Stormwater Detention

Stormwater detention areas would be constructed to store floodwaters and release it at a suitable flow rate.

At-source detention can be achieved using water tanks to collect and store runoff from roofs. Rainwater tanks become full during sustained periods of wet weather and their storage capacity cannot be relied upon. Tanks also collect runoff from elevated surfaces (roofs). Runoff from other impervious surfaces such as driveways and paved living areas cannot be directed into tanks under gravity.

A catchment-wide stormwater detention solution can be achieved by constructing a dedicated detention pond or wetland area.

Cost: $500,000 for design, land purchase and construction
$5,000 per year for additional maintenance

7.2.3 Evaluation

Option	Benefits in Terms of Present and Future Well-Being	Costs in Terms of Present and Future Well-Being	Community outcomes achieved or promoted	Statutory Responsibility
Designate flood hazard areas	***Social:*** None identified. ***Cultural:*** None identified. ***Economic:*** Providing flood hazard overlays is a low cost solution. No physical works are required. ***Environmental:*** None identified.	***Social:*** Flooding will remain a visible issue. ***Cultural:*** None identified. ***Economic:*** Some land may be unsuitable for residential development due to flooding, or maybe subject to an increased frequency of flooding, reducing land values. ***Environmental:*** The effect of flooding on land downstream of the catchment will not be mitigated.	• Safe and healthy haven • Positive leadership	Building Act 2004, First Schedule E1.3.2 will be achieved by requiring minimum floor heights for new habitable buildings.
Construct flood defences	***Social:*** None identified. ***Cultural:*** None identified. ***Economic:*** Flood defences provide a definite solution to known flooding issues, increasing land value. ***Environmental:*** None identified.	***Social:*** Flood defences create a physical barrier between communities. ***Cultural:*** Physical works will be required within the cultural heritage alert overlay. ***Economic:*** Benefit/cost ratio for a small catchment such as this will be very low. ***Environmental:*** Disturbance to the land and high value habitat will be required. The effect of flooding on land downstream of the catchment will not be mitigated.	• Safe and healthy haven • Positive leadership	Building Act 2004, First Schedule E1.3.2 will be achieved by designing flood defences to convey a 1 in 50 year storm without overtopping.

7.2.3 Evaluation (Cont.)

Option	Benefits in Terms of Present and Future Well-Being	Costs in Terms of Present and Future Well-Being	Community outcomes achieved or promoted	Statutory Responsibility
Improve capacity of existing drains, streams and rivers.	***Social:*** None identified. ***Cultural:*** None identified. ***Economic:*** Land protected from flooding may benefit from increased land values. ***Environmental:*** None identified.	***Social:*** None identified. ***Cultural:*** Physical works will be required within the cultural heritage alert overlay. ***Economic:*** Large capital costs are required to make the capacity improvements. On-going maintenance will also need to be funded to ensure the improvements remain effective. ***Environmental:*** Disturbance to the land and high value habitat will be required.	• Safe and healthy haven • Positive leadership	Building Act 2004, First Schedule E1.3.2 will be achieved by increasing the capacity to convey a 1 in 50 year storm without overtopping.
Limit the amount of additional runoff	***Social:*** None identified. ***Cultural:*** None identified. ***Economic:*** Low cost (planning based) solution as no additional physical works are required. ***Environmental:*** Flooding within the catchment and downstream can be effectively managed.	***Social:*** None identified. ***Cultural:*** None identified. ***Economic:*** Limiting the amount of development on each lot may reduce the desirability, and value, of rural residential land. ***Environmental:*** None identified.	• Safe and healthy haven • Positive leadership	Building Act 2004, First Schedule E1.3.2 will be achieved by ensuring that development in the catchment does not adversely effect flooding in the catchment or downstream.

7.2.3 Evaluation (Cont.)

Option	Benefits in Terms of Present and Future Well-Being	Costs in Terms of Present and Future Well-Being	Community outcomes achieved or promoted	Statutory Responsibility
Provide Stormwater detention	***Social:*** None identified. ***Cultural:*** None identified. ***Economic:*** Land protected from flooding may benefit from increased land values. ***Environmental:*** Flooding within the catchment and downstream can be effectively managed.	***Social:*** None identified. ***Cultural:*** None identified. ***Economic:*** Capital costs including land purchase will be required to construct the detention pond. On-going maintenance will also be required. ***Environmental:*** None identified.	• Safe and healthy haven • Positive leadership	Building Act, First Schedule is achieved by designing stormwater detention devices to store floodwater and releasing it at a rate that will not cause flooding.

7.2.4 Conclusion

The management options that provide the most benefit and least cost, while meeting the statutory requirements, are Options 4 & 5, limiting the amount of additional runoff and providing stormwater detention.

One of the key attractions of the rural residential area is that large lot sizes can accommodate large dwellings and supplementary buildings. Modelling has shown that in order to significantly reduce the peak runoff from the catchment, severe restrictions to site coverage will be required (one moderate house and a small living area). Such restrictions by themselves may make the rural residential land less desirable to buyers.

The design of the stormwater detention device is highly dependent on the volume of water needing to be stored, which is in turn dependent on the degree of impermeable area within the catchment. A site coverage limit will be a design parameter for the detention pond.

The recommended option is to provide a District Plan rule to ensure that site coverage (roofs, driveways, paved living areas, and right of ways) within each rural residential lot does not exceed 16%. In addition, each lot is to provide a method that collects all impervious surfaces, and discharges it in a controlled, diffused manner (i.e. a pipe outlet is not acceptable as it discharges a concentrated flow of water, a diffusion device is required). Reference [9] should be the basis for evaluating each development until Gisborne District Council develops its own specific design manual.

7.3 Issue: Lack of Public Infrastructure

7.3.1 Overview

The existing stormwater infrastructure was designed for a rural production environment and at present has neither the reach nor capacity to accommodate a fully developed rural residential zoning. An appropriate management strategy will be required to ensure that stormwater runoff from impervious surfaces can be disposed of from any new development without adverse effects on the environment.

A statutory requirement exists in the Building Act 2004 (First Schedule, E1 – Surface Water) for surface water resulting from a 1 in 10 year event which is collected or concentrated by buildings or siteworks to be disposed of in a way that avoids the likelihood of damage or nuisance to other property. Objective 4.3 and Policies 4.4.3 & 4.4.7 of Chapter 4 of the District Plan relate.

7.3.2 Options

Option 1 – Privately Owned Infrastructure

Infrastructure will be constructed by developers if and when it is required when subdivision consent is applied for. Most infrastructure could be held in private ownership and managed by easements and private agreements.

Cost: Capital construction costs and ongoing maintenance costs are to be met by individual landowners.

Option 2 – Construct Fully Reticulated Piped System

An urban style, fully reticulated pipe network would be constructed to provide a stormwater connection to each property. This would be established soon after the plan change and paid by development contributions and targeted rates.

Cost: $8,000,000 for design and construction

Option 3 – Construct Swale Drains

A network of publicly maintained swale drains could be constructed to dispose of excess stormwater runoff. This is to be established soon after the plan change and paid by development contributions.

Cost: $500,000 for design and construction
$40,000 per year for additional maintenance

Option 4 – On-site Stormwater Disposal

The need to provide a network to collect and dispose of excess stormwater runoff can be eliminated if the water can be disposed of at its source. This would utilise water tanks to store roof runoff to be re-used as household water, or disposal into the groundwater.

Cost: Capital construction costs and ongoing maintenance costs are to be met by individual landowners.

7.3.3 Evaluation

Option	Benefits in Terms of Present and Future Well-Being	Costs in Terms of Present and Future Well-Being	Community outcomes promoted or achieved	Statutory Responsibility
Privately owned drainage infrastructure	***Social:*** None identified. ***Cultural:*** None identified. ***Economic:*** No cost to Council. Infrastructure to be funded and provided by each individual developer. Infrastructure will only be provided as and when it is required. ***Environmental:*** Each house site will be provided with a means to dispose of surface water from impervious surfaces.	***Social:*** Maintenance will be the responsibility of individuals or body corporates. Conflict between neighbours may arise if maintenance work is not sufficient ***Cultural:*** None identified. ***Economic:*** Council may be required to resolve any disputes. Funding for any physical works and staff time is a consideration. ***Environmental:*** Success of the drainage scheme is largely in the hands of developers and land owners. Expertise of council staff will not be fully utilised.	• Safe and healthy haven • Positive leadership • Prosperous communities	Building Act 2004, First Schedule E1.3.1 will be achieved by providing each lot with a point to dispose of stormwater from impermeable surfaces, and conveying the water to a suitable disposal point.
Construct a reticulated pipe drainage network	***Social:*** Stormwater will not be a visible issue. ***Cultural:*** None identified. ***Economic:*** Underground pipes allow for more of the land to be usable and are more aesthetically appealing. May contribute to increased land values. ***Environmental:*** Each house site will be provided with a means to dispose of surface water from impervious surfaces.	***Social:*** Perception of the rural residential area may change from rural to “large-lot urban”, altering the amenity value. ***Cultural:*** Physical works will be required within the cultural heritage alert overlay. ***Economic:*** A piped stormwater system is expensive to construct and fund. It may also increase a demand for other urban services (sewer and water) to be extended into the area. ***Environmental:*** Piped systems generally operate with a higher water velocity, making transport of sediment and contaminants to the receiving environment easier.	• Safe and healthy haven • Positive leadership • Prosperous communities	Building Act 2004, First Schedule E1.3.1 will be achieved by providing each lot with a point to dispose of stormwater from impermeable surfaces, and conveying the water to a suitable disposal point.

7.3.3 Evaluation (Cont.)

Option	Benefits in Terms of Present and Future Well-Being	Costs in Terms of Present and Future Well-Being	Community outcomes promoted or achieved	Statutory Responsibility
Construct a network of swale drains	***Social:*** The rural amenity value is retained. ***Cultural:*** None identified. ***Economic:*** Swales are a cost effective solution to conveying stormwater where there is land available. ***Environmental:*** Swales operate with a slower velocity than piped systems, allowing sediments and contaminants to settle rather than being transported to the receiving environment. Each house site will be provided with a means to dispose of surface water from impervious surfaces.	***Social:*** Stormwater remains a visible issue and a potential source of conflict between neighbours. ***Cultural:*** None identified. ***Economic:*** Construction costs will need to be funded by the community. Maintenance costs are higher for swale drains than for a piped system. The land on which the swales are constructed is not able to be used for any other purpose. ***Environmental:*** Swales have the potential to become dumping grounds which would limit their effectiveness.	• Safe and healthy haven • Positive leadership • Prosperous communities	Building Act 2004, First Schedule E1.3.1 will be achieved by providing each lot with a point to dispose of stormwater from impermeable surfaces, and conveying the water to a suitable disposal point.
On-site stormwater disposal	***Social:*** None identified. ***Cultural:*** None identified. ***Economic:*** Costs to construct an onsite stormwater disposal will be the responsibility of individual land owners. ***Environmental:*** Stormwater can be managed within the catchment, without causing injurious effect to land downstream. Land disturbance to high value habitat is not required.	***Social:*** None identified. ***Cultural:*** None identified. ***Economic:*** Cost of fixing the stormwater problem would be significant should onsite disposal be shown to be ineffective. ***Environmental:*** The effectiveness of onsite disposal is severely reduced when the water table rises, as has been shown in previous winters. It will also contribute to wastewater effluent from disposal fields rising to the surface and becoming a health risk.	• Safe and healthy haven • Prosperous communities	Building Act 2004, First Schedule E1.3.1 will be achieved by allowing each to dispose of surface water within its own boundaries without affecting neighbouring properties.

7.3.4 Conclusion

Handing the responsibility for maintenance of a community drainage scheme to individuals or body corporates can lead to problems that may eventually require Council intervention to resolve. Maintenance is best achieved by utilising the expertise of Council staff, particularly where a drain benefits a number of properties.

The high construction cost precludes a piped stormwater system from the bulk of the drainage network. Pipes will be useful where the potential for open drains to become filled in exists.

The recommended management option is to construct a network of swale drains to provide a connection point for stormwater disposal to each property. As subdivision occurs each developer will be required to pay a development contribution for the extension of the drainage network to ensure that each new lot is provided with a point to discharge stormwater.

If it is identified that the potential effectiveness of a swale drain will be reduced over time (either by the potential for it to be filled in, or being of a very shallow grade or cross sectional area) Council may require it to be piped.

The responsibilities for maintenance of all drains that provide benefit to two or more properties should be vested in Council and all such drains and pipes should be constructed to Council standards.

The use of on-site stormwater disposal (soakage pits) remains an option available to developers but its use should be restricted to soils with high hydraulic permeability and where high water tables will not induce problems with wastewater effluent fields.

7.4 Issue: Blocking of Overland Flowpaths

7.4.1 Overview

Obstructions in overland flowpaths (natural watercourses or secondary flowpaths) by levelling land, raised building platforms or raised driveways can divert surface water and cause unexpected ponding.

There is a need to control development and construction to ensure that the overland flow paths are retained.

A statutory requirement exists in the Building Act 2004(First Schedule, E1 – Surface Water) for Council to ensure that buildings and siteworks are constructed in a way that protects people and other property from the adverse effects of surface water. The performance requirement is to ensure that surface water resulting from a 1 in 50 year event does not enter buildings.

Objectives 5.3.1 & 5.3.3 and Policies 2, 4 & 5 in Chapter 5 of the District Plan relate.

7.4.2 Options

Option 1 – Do Nothing

Essentially retaining the current practices, Council has minimal involvement in identifying and retaining overland flowpaths, natural hollows and watercourses as part of the subdivision process.

It would be left to the developers and residents to use "common sense" to retain natural watercourses and flowpaths. Where a problem does arise, Council has appropriate mechanisms in the District Plan pertaining to diversion of catchments which may be enforced if necessary.

Cost: Nil

Option 2 – Identify and Designate Overland Flowpaths

The analysis of contour plans in conjunction with on-site visits could be used to determine the likely places where water naturally collects and flows. These could be marked on the structure plan as features that need to be protected where development is to take place.

This may be undertaken as a Council initiative for the whole of the catchment, or as a requirement in subdivision applications for the developer to complete.

Cost: $25,000 for professional services and District Plan change.

Option 3 – Education

Many of the problems that have occurred with blocked flowpaths or watercourses have occurred because the landowners or developers have not been aware of the consequences. One way to overcome this may be to provide education to the general public in the form of a best practice guide, or to advertise that Council has expertise in these areas that can be utilised.

It is noted that education by itself is not a solution to this issue.

Cost: $5,000 for professional services and printing costs.

7.4.3 Evaluation

Option	Benefits in Terms of Present and Future Well-Being	Costs in Terms of Present and Future Well-Being	Community outcomes promoted or achieved	Statutory Responsibility
Do nothing	***Social:*** None identified. ***Cultural:*** None identified. ***Economic:*** No capital or maintenance costs are required. ***Environmental:*** None identified.	***Social:*** The issue of flooding is not resolved and remains a potential source of conflict. Managing disputes with bylaws and plan rules is reactive rather than providing a proactive solution to a known problem. ***Cultural:*** None identified. ***Economic:*** Costs will be incurred by Council to administer the bylaws and plan rules. ***Environmental:*** Potential for obstructing overland flowpaths still exist, which may result in buildings being flooded.	Nil	Building Act 2004, First Schedule E1.3.2 will not be achieved.
Identify and designate overland flowpaths	***Social:*** Buildings and communities will be constructed in safe locations. ***Cultural:*** None identified. ***Economic:*** Dwellings can be sited outside of potential flood zones, reducing insurance and flood repair costs. ***Environmental:*** Keeping overland flowpaths clear will enable flood waters to pass while minimise damage and nuisance to land and buildings.	***Social:*** None identified. ***Cultural:*** None identified. ***Economic:*** Land located within the overland flow paths may be unsuitable for residential development, lowering its value. The flood study will also need to be funded by the community. ***Environmental:*** None identified.	• Safe and healthy haven • Positive leadership • Prosperous communities	Building Act 2004, First Schedule E1.3.2 will be achieved by ensuring buildings are constructed outside of the 1 in 50 year flowpaths.

7.4.3 Evaluation (Cont.)

Option	Benefits in Terms of Present and Future Well-Being	Costs in Terms of Present and Future Well-Being	Community outcomes promoted or achieved	Statutory Responsibility
Education	***Social:*** Landowners are empowered to make correct decisions. ***Cultural:*** None identified. ***Economic:*** Education is a cost effective way of increasing the awareness of stormwater management. ***Environmental:*** Education can provide developers and land owners with the knowledge to make decisions that minimise will not induce or worsen flooding.	***Social:*** The issue of flooding is not resolved and remains a potential source of conflict. ***Cultural:*** None identified. ***Economic:*** The cost to provide the education will need to be funded by the community. ***Environmental:*** Education alone does not provide a solution to the issue.	• Safe and healthy haven • Positive leadership	Does not directly meet the requirements of Building Act 2004, First Schedule E1.

7.4.4 Conclusion

The "do nothing" is not a suitable management strategy. The evaluation has shown that it provides no benefit, apart from requiring to funding. None of the Community outcomes are promoted, and the statutory requirement under the Building Act is not achieved.

The recommended management option is to undertake a flood study to locate the overland flowpaths during a 1 in 50 year event. District Plan rules can then be established to require consent to alter land levels, or to otherwise provide an obstruction within the designated flowpath.

Education, by means of an informative pamphlet is also an effective way to inform developers and landowners why it is important that overland flowpaths are preserved.

7.5 Issue: Wastewater Discharge

7.5.1 Overview

The interaction between stormwater runoff and wastewater is an important consideration. If stormwater is not managed appropriately, it can inundate septic tanks from surface flooding, or reduce the efficiency of effluent disposal fields due to a high water table.

A statutory requirement exists in the Health Act 1956 Section39 for every dwelling built to be provided with a suitable means to dispose of refuse water in a sanitary manner.

7.5.2 Options

Option 1 – Reticulated Wastewater System

A limited reticulated waste water system has been considered to service properties between Back Ormond Road, Hansen Road and Haisman Road. The land is flat with poor draining soils. It was identified that this land would be unsuitable for development down to 0.5 hectare lots without constructing a reticulated system to dispose of wastewater offsite.

Cost: $6,000,000 for Capital construction costs

Option 2 – On-site Wastewater Disposal

Wastewater will be collected and broken down in septic tanks. Liquid effluent will be disposed onsite through filtration beds located on each lot. More advanced solutions, such as aerated WWTP are also an acceptable solution.

Cost: Capital construction costs and ongoing maintenance costs are to be met by individual landowners. Typical costs range between $10,000 and $20,000 per dwelling.

7.5.3 Evaluation

Option	Benefits in terms of present and future well-being	Costs in terms of present and future well-being	Community outcomes promoted or achieved	Statutory Responsibility
Reticulated wastewater system	***Social:*** None identified. ***Cultural:*** None identified, ***Economic:*** None identified. ***Environmental:*** Effluent is transported off-site away from the residential population and will be treated at the proposed wastewater treatment plant before disposal into the ocean.	***Social:*** None identified. ***Cultural:*** Cultural issues will be managed in the resource consent for the waste water treatment plant. ***Economic:*** Financing of the construction costs will be borne by Council. As each new dwelling is constructed a financial contribution will be required for connection into the system. Current growth projections are low, meaning it will take 25+ years for the entire cost of the project to be recovered. Provision of a reticulated wastewater system may increase the demand for water reticulation also to be provided. ***Environmental:*** More wastewater will be disposed of into the ocean.	• Safe and healthy haven • Positive leadership	Health Act 1956, S39 will be achieved.

Option	Benefits in terms of present and future well-being	Costs in terms of present and future well-being	Community outcomes promoted or achieved	Statutory Responsibility
On-site wastewater treatment and disposal	***Social:*** None identified. ***Cultural:*** None identified. ***Economic:*** Construction and maintenance costs will be borne by individual land owners. Construction is only required as new dwellings are constructed. ***Environmental:*** No additional effluent will be disposed in the ocean.	***Social:*** None identified. *Cultural:* None identified. *Economic:* The efficiency and effectiveness of each onsite wastewater treatment and disposal system will need to be monitored. *Environmental:* Wastewater will be disposed within a residential population. A potential exists for the untreated effluent to enter the groundwater and surface water. Controls are required to ensure best practice design is used, adequate lot size is provided and sufficient land drainage is available.	• Safe and healthy haven • Positive leadership	Health Act 1956, S39 will be achieved provided that best practice design in followed, and adequate land drainage is provided to remove surface water.

7.5.4 Conclusion

A decision has been made by Council's Environment and Policy Committee that it is not economic to construct a reticulated wastewater system in the rural residential area.

To ensure that onsite treatment and disposal systems will be effective each lot should be provided with a connection point to drain surface water that will enable cut-off drains to be constructed around disposal beds if required.

A qualified professional will also be required to undertake a site specific design to determine the appropriate system, location and the size of the disposal field that is required.

7.6 Issue: Upper Catchment Erosion

7.6.1 Overview

Erosion in the upper catchment (i.e. the hill country) results in sediments being transported and often deposited in the streams of the lower catchment.

Reducing the amount of sediment in the stream has a positive impact on the life supporting capacity of the streams and the degree of maintenance required to retain flow capacity.

7.6.2 Options

Option 1 – Existing Land Use Controls

Existing controls on the use of land in the upper catchment have been prescribed in the District Plan. The rules and policies promote sustainable use of the land that aim to minimise erosion and thus the amount of silt discharged into the lower catchment.

7.6.3 Conclusion

Soil erosion in hill country is a well known issue in the Gisborne region due to its unique geology and climate. Gisborne District Council, through its Soil Conservation Division, has an established set of rules for sustainable management of erosion prone land.

For the purpose of this catchment management plan it is considered that the effort and expertise in forming these rules has resulted in the most appropriate management practices for hill country, including the upper part of the Waru/Haisman catchment.

Details of the rules that control land use in hill country can be found in Chapter 6 of the Gisborne District Council Combined Regional Land Use and District Plan.

8.0 Proposed Management Strategy

8.1 Flooding

- Coverage of each site, including roofs, driveways, hardstand areas, shared accessways and any other structure is not to exceed 16% of the total area of each lot.
- Each development is to demonstrate that low Impact Design Principles [8], [9] have been considered prior to the construction of each dwelling or subdivision. Runoff from all hard surfaces is to be collected and dispersed within each lot or group of lots in a manner that is a) not a concentrated flow and b) does not exceed the peak runoff as calculated for conditions prior to development occurring.

8.2 Lack of Public Infrastructure

- In existing flood hazard areas, each new lot shall be provided with a discharge point into a network of Council owned and maintained swale drains.
- Council will require the developer to pay a development contribution for the extension of the drainage network. The land for the drainage network will be vested in Council or an appropriate easement arranged.
- Where, in Council's opinion, a drain will be difficult to access for maintenance, or be difficult to maintain, Council will require the drain to be piped with a suitably sized conduit.
- Soak pits are not a permitted solution for the discharge of stormwater, unless it can be established by a qualified professional that the soil conditions are suitable to ensure no adverse effects on the receiving environment.
- District Plan rules and the Engineering Code of Practice need to be updated to reflect this and to be consistent with the statutory requirements.

8.3 Blocking of Overland Paths/Localised Ponding

- In order to show where the overland flowpaths that need to be maintained are located, a flood study showing to establish the extent of 50 year flood is to be undertaken. Such information can be used to ensure that any dwellings are located out of flood prone areas, or that the effect of flooding is mitigated by requiring an elevated floor height.
- Education, via a pamphlet aimed at developers and home builders that shows how to avoid blocking or diverting overland flow, should be undertaken. This is however, not a solution by itself.

8.4 Wastewater Discharge

- All assessments and design of on-site waste water treatment and disposal is to be undertaken by a suitably qualified designer.
- Where necessary, shallow cut-off drains are to be constructed at the perimeter of the disposal fields to ensure that surface water does not pond. The cut-off drains should be channelled into the stormwater management system for each property and discharged in a controlled manner that does not result in a concentrated flow.
- An absolute minimum lot size of 2000m2 is recommended if onsite waste water disposal is to be used.

8.5 Contaminants from Human Activity

- The developer is required to consider as part of their consent application the potential for contaminants to enter waterways, and to provide a means to mitigate if necessary. Such contaminants may include disturbed earth surfaces, soaps and detergents, household waste, garden waste and litter.

8.6 Upper Catchment Erosion

- Any development needs to be in harmony with the established rules and principles contained in Chapter 6 of the District Plan to mitigate the effect of erosion in the upper catchment.

8.7 Habitat and Biodiversity

- All development is to designed to have no adverse effect on the existing habitat and biodiversity on the land and within the streams.

8.8 Evaluation

As a final evaluation on the proposed catchment management strategy the criteria has been reviewed to ensure they are consistent with the legislation, policies, strategies and codes of practice outlined in Chapter 2 of this report. This is outlined in the table below.

Criteria	Achieved?	Comment
Legislation		
Resource Management Act	✓	
Local Government Act 2004 and amendments	✓	
Local Government Act 1977 and amendments	✓	
Soil Conservation and Rivers Control Act 1941	✓	
Land Drainage Act 1908	✓	
Building Act 2004 First Schedule. Clause E1 – Surface Water	✓	
Combined Regional Land and District Plan		
Natural Heritage	✓	
Natural Hazards	✓	
Beds of Lakes and Rivers	✓	
Subdivision	✓	
Rural Zones	✓	
Regional Water Plan	✓	
Engineering Code of Practice	✓	**The existing code of Practice will need to be updated to incorporate some of the recommended management strategies.**

9.0 Conclusions

A catchment study has been undertaken on the Waru and Haisman catchment which lie west of Gisborne City. The study involved analysis of predicted growth of the area, a hydrological model analysis, and critique of known and potential problems including insurance and Civil Defence implications to establish a set of catchment issues. These have then been assessed against the legislation, policies and strategies in place to determine the best method of managing the land. The assessment has been undertaken in a way that is consistent with the decision making requirements of the Local Government Act 2004.

The recommended management strategy is:

Flooding

- Coverage of each site, including roofs, driveways, hardstand areas, shared accessways and any other structure is not to exceed 16% of the total area of each lot.
- Each development is to demonstrate that low Impact Design Principles [8], [9] have been considered prior to the construction of each dwelling or subdivision. Runoff from all hard surfaces is to be collected and dispersed within each lot or group of lots in a manner that is a) not a concentrated flow and b) does not exceed the peak runoff as calculated for conditions prior to development occurring.

Lack of Public Infrastructure

- Where an existing flooding problem is seen to occur, each lot of land is to be provided with a discharge point into a network of Council owned and maintained swale drains.
- As development occurs, Council will require the developer to pay a development contribution for the extension of the drainage network. The land for the drainage network will be vested in Council (or an appropriate easement arranged). Responsibility for the maintenance of the drain will then be vested in Council.
- Where, in Councils opinion, a drain will be difficult to access for maintenance, or be difficult to maintain, Council will require the drain to be piped with a suitably sized conduit.
- Soak pits are not a permitted solution for the discharge of stormwater, unless it can be established by a qualified professional that the soil conditions are suitable to allow this.
- District Plan rules and the Engineering Code of Practice needs to be updated to reflect this and to be consistent with the statutory requirements.

Blocking of Overland Paths/Localised Ponding

- In order to show where the overland that need to be maintained are, a flood study showing to establish the extent of 50 year flood is to be undertaken. Such information can be used to ensure that any dwellings are located out of flood prone areas, or that the effect of flooding is mitigated by requiring an elevated floor height.
- Education, via a pamphlet aimed at developers and home builders that shows how to avoid blocking or diverting overland flow, should be undertaken. This is however, not a solution by itself.

Wastewater Discharge

- All assessments and design of on-site waste water treatment and disposal is to be undertaken by a suitably qualified designer.
- Where necessary, shallow cut-off drains are to be constructed at the perimeter of the disposal fields to ensure that surface water does not pond. The cut-off drains should be channelled into the stormwater management system for each property and discharged in a controlled manner that does not result in a concentrated flow.
- An absolute minimum lot size of 2,000 m^2 is recommended if on-site wastewater disposal is to be used.

Contaminants from Human Activity

- The developer is required to consider as part of their consent application the potential for contaminants to enter waterways, and to provide a means to mitigate if necessary. Such contaminants may include disturbed earth surfaces, soaps and detergents, household waste, garden waste and litter.

Upper Catchment Erosion

- Any development needs to be in harmony with the established rules and principles contained in Chapter 6 of the District Plan to mitigate the effect of erosion in the upper catchment.

Habitat and Biodiversity

- All development is to designed to have no adverse effect on the existing habitat and biodiversity on the land and within the streams.

These principles are to be used to update the Gisborne District Council Engineering Code of Practice and for zone rules in the Gisborne District Council District Plan.

10.0 References

[1] Gisborne District Council (GDC) 2007, *Combined Regional Land & District Plan*. Gisborne District Council, Gisborne.

[2] Gisborne District Council (GDC) 2007, *Regional Water Plan*. Gisborne District Council, Gisborne.

[3] Gisborne District Council (GDC) 2000, *Engineering Code of Practice – Section 3 Stormwater.* Gisborne District Council, Gisborne.

[4] Reid, Colin J 1995, *Taruheru River Modelling*. Report for Gisborne District Council, Gisborne.

[5] Auckland Regional Council (ARC) 1999, *Technical Publication No 108, Guidelines for Modelling Stormwater Runoff in the Auckland Region*. Auckland Regional Council, Auckland.

[6] Ministry for the Environment (MfE) 2004, *Climate Change Effects and Impacts Assessment: A guideline manual for local government in New Zealand*. Ministry for the Environment, Wellington.

[7] New Zealand Institute of Engineers 1979, *A Guideline and Procedure for Hydrological Design of Urban Stormwater Systems*. New Zealand Institute of Engineers, Auckland.

[8] Auckland Regional Council (ARC) 1992, *Technical Publication No 10, Design Guideline Manual: Stormwater Treatment Devices.* Auckland Regional Council, Auckland.

[9] Waitakere City Council (WCC) & Rodney district Council (RDC) 2005, Management of Stormwater in Countryside Living Areas. WCC & RDC, Auckland