Manukau City Council

Puhinui Stream

Flood Mapping

Final Report

November 2003

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Appendices

1. Executive Summary

Scope of Study

GHD Limited was commissioned by Manukau City Council (MCC) to undertake stormwater modelling of the Puhinui Stream. The catchment covers an area of some 2000 hectares and is roughly bounded by Redoubt Road and Hill Rd in the east, Browns Road and Kerrs Road in the south and Manukau City centre through to Plunket Ave in the north. The overall catchment is shown on plan 51/18582/E0 in Appendix A.

The objective of the modelling was to confirm the flood level profile for the Puhinui Stream and main tributaries for a variety of storm events and to map the extent of flooding for the existing year 2000 scenario and for the future ultimate development scenario.

The scope was subsequently extended to include a desktop study to identify flood prone areas in the rest of the "unmodelled catchment".

Background

The existing Catchment Management Plan for the Puhinui Stream was carried out in 1992 by MCC. There has been significant development within the catchment since that date.

In addition, the proposed SH20 to SH1 road link currently under design follows an alignment through the lower Puhinui Stream catchment area. As part of this project, a number of changes to the potential floodplain of the Puhinui Stream are expected to occur. These include the construction of water quality and detention ponds, new bridge / culvert crossings over the main Puhinui stream and its tributaries and re-alignment of the stream adjacent to Roscommon Road.

Modelling Methodology

A hydrological and hydraulic model of the Puhinui Stream and its major tributaries was created using specialised computer software. The details of this work are captured in a modelling report.

Historical rainfall and runoff data for the Puhinui Stream Catchment was used to calibrate the models developed for this study. This process involved adjusting model parameters (within reasonable bounds) until an acceptable fit between recorded flood flows and levels and modelled flood flows and levels had been achieved.

The resulting 'calibrated' model was then used with design rainfall events to predict the 1% and 2% AEP (Annual Exceedance Probability) storm event. These are also referred to as the 50 and 100 year return period flows or the ARI (Annual Recurrence Interval). Water level profiles along the Puhinui Stream were derived for both the existing and ultimate development scenarios. This approach generally provided a high level of confidence for predicted stream flood levels and flood extents within the confines of the main stream channel.

Model Results

Flood levels in the Puhinui Stream for the 1% and 2% AEP design storms (TP 108) with both existing and future development scenarios are set out in a separate modelling report.

In general, it was found that most key structures across the Puhinui Stream would have sufficient freeboard in a 1% AEP design storm event with the exception of the Plunket Ave Bridge and the NIMT railway culvert. Remedial measures at these latter structures are recommended if the catchment is to be developed to its ultimate potential.

For the ultimate development scenario, modelled flood levels were generally above those predicted by the 1992 MCC Catchment Study. This was expected, due to a number of issues including more intensive development and the SH 20 to SH 1 link, that were not taken into account in the 1992 study.

Flood Mapping

A series of flood maps have been produced. These are attached as Appendix A.

These show the predicted extent of flooding for the existing development scenario (2000) and for the ultimate development scenario assuming that the TNZ SH 20 to SH 1 motorway link project has been constructed.

The flood mapping was developed for all of the Puhinui catchment. The mapping was carried out using different methodology depending upon its location within the catchment. An engineering judgement was made as to the potential for flood risk and areas were assigned one of the following four categories:

- **Zone 1**. Areas confirmed by modelling and detailed topographical survey that are predicted with a high level of confidence to become inundated from a 1% AEP design event for either the existing or future development scenarios.
- **Zone 2**. Areas confirmed by modelling and from MCC GIS contour data that are likely to become inundated from the above storm events. The flood mapping of these areas have a medium level of confidence.

  Additional areas identified in the MCC Fitzroy (Papatoetoe) comprehensive flood management plan as being inundated have also been included in Zone 2 as part of earlier work by others.

  The reason for the reduced level of confidence is that the contour data supplied has an interval of 2 m and is thus unsuitable for accurate flood level mapping. We would expect most of the areas assigned Zone 2 to be inundated from the particular storm event under consideration however the extent of inundation needs further investigation.
- **Zone 3**. Areas identified by the desktop study and confirmed from walk over / drive over that have a possibility of being inundated are classed as Zone 3.
- **Zone 4**. Those large areas of industrial / commercial land in the flatter portions of the Puhinui catchment where a drive over / walk over survey has been unable to

identify the overland flow path areas but where potential for overland flow is identified have been classified as Zone 4.

Discussion

The discussion section of the modelling report addendum goes through a number of the assumptions used in the modelling process and the applicability and sensitivity of these assumptions. In particular, this section of the report looks at possible options for improvement of the model accuracy.

Recommendations

The report recommends:

- That Council's current requirement of 800 mm of freeboard above advised flood levels for formed stream channels are continued. The report also recommends that consideration be given to the potential risk of blockage for some structures when determining freeboard requirements for new developments.
- That caution be exercised when using flood hazard data in areas where accurate ground survey was not undertaken. The report notes that a greater degree of confidence in flood extents in these areas could be obtained by further modelling and flood mapping using more accurate ground or aerial survey.
- The Ford Weir Bridge is also shown to be under capacity for the 1% AEP design storm flood event.
- That the existing Plunket Bridge and Ford Weir Bridge have capacity problems associated with the current cross sectional waterway for the larger flood events. The report recommends that further work be undertaken on the structures and the stream channel to improve the capacity of the channel upstream and downstream.

2. Introduction

2.1 Scope of Study

GHD Limited was commissioned by Manukau City Council (MCC) to undertake stormwater modelling of the Puhinui Stream catchment area. The catchment covers an area of some 2,050 hectares and is roughly bounded by Redoubt Road and Hill Rd in the east, Browns Road and Kerrs Road in the south and Manukau City centre through to Plunket Ave in the north. The overall catchment is shown on plan 51/18582/E1 in Appendix A.

The objective of the modelling was to confirm the flood level profile for the Puhinui Stream for a variety of storm events and to map the extent of flooding for the existing (year 2000) and the ultimate development scenario.

2.2 Background

The existing Catchment Management Plan for the Puhinui Stream was carried out in 1992 by MCC. This study was used as the basis of an application for a Comprehensive Catchment Discharge Consent in 1995, which was granted the same year.

Since 1992, there has been significant development within the catchment. This includes

- Residential subdivision in the upper Puhinui catchment
- Construction of the Everglade Pond (also called Pond 18)
- The Telstra Saturn - Pacific Arena development (currently under construction) and
- Further commercial development within the lower catchment.

This ongoing development has resulted in significant changes in the catchment characteristics. Furthermore, the proposed SH20 to SH1 road link currently under design follows an alignment through the lower Puhinui Stream catchment area. As part of this project, a number of changes to the potential floodplain are expected to occur. These include

- Construction of water quality and detention ponds,
- New bridge/culvert crossings over the main Puhinui stream and its tributaries and
- Re-alignment of the stream adjacent to Roscommon Road.

The main objective of this current study is to provide Manukau City with an updated hydraulic model of the Puhinui Stream for the modified catchment and updated flood hazard maps. This will assist with managing future development within the catchment.

2.3 Previous Studies

The area under consideration in this study has been the subject of previous investigations as outlined below.

- The *Puhinui Stream Catchment Comprehensive Flood Management Study* was completed by MCC in 1992. This study looked at the greater Puhinui Stream and estimated flows and flood levels along the stream profile. Peak flows were estimated in a hydrological model called RORB, while HEC-2 was used for hydraulic modelling.
- In 1995 Beca Carter Hollings and Ferner (BCHF) undertook a study to identify opportunities for the implementation of stormwater treatment devices in the Puhinui Stream catchment area. Twenty sites were identified and evaluated in terms of cost and efficiency.
- Manukau Consultants Ltd undertook a study in 1999 to model in more detail the Upper Puhinui Stream (Mill Road to the Botanical Gardens), to assess the impacts of existing versus ultimate development and to specifically determine the effect of changes in development potential due to District Plan amendments. Sediment deposition and scour potential within the Upper Stream were also considered. The study found that the likely increase in flood flows due to District Plan changes would be insignificant, but recommended construction of two water quality dams to reduce the impacts of already permitted development.

3. Discussion

3.1 Modelling of the Puhinui Stream

A computer hydraulic model was created of the main Puhinui Stream channel and some of the major tributaries using Mike 11 software from DHI. The details of this work are included in a modelling report.

The outputs of the modelling include floodwater surface profile for the 1% and 2% AEP design storm event for both the existing and future development scenarios

When a comparison is made between the 1% and 2% AEP events, the flood level difference is less than 200 mm except for upstream of the structure at Plunket Ave and at the railway culvert.

When these flood levels are translated into extent of flooding for flood mapping purposes the extents of the 1% and 2% AEP events are generally within 1 m of each other. As such only the 1% AEP event flood level mapping has been carried out.

3.2 Flood mapping

Flood mapping for the 1% AEP event for the existing and ultimate development scenario are shown in Appendix A. The extent of flooding derived from the modelling is shown on the drawings as for the main Puhinui Stream channel between the lower end of McLaughlins Road near the stream outlet up to the Botanical Gardens.

The extent of flooding predicted by the MIKE 11 model was modified to include the higher than predicted flood levels at key bridges, as determined by hand calculations.

At some locations it was found that the predicted flood plain, as determined from the MIKE 11 model and as modified above, extended beyond the public land surveyed for this study. To give an estimate of the likely extent of flooding in such cases, the digital terrain model (DTM) created from the survey was extended using data from the Council GIS 2.0 m contour data set.

The extent of flooding was determined using MOSS, a three-dimensional land modelling software program, with the water surface profile for each flood event superimposed over the land model. The flood hazard mapping drawings in Appendix A also show the extent of the survey undertaken for this study.

Confidence levels for flood hazard areas shown on the plans were developed for:

- *High level of confidence* – areas where flood extents lie within the public reserve and within the area surveyed for this study.
- *Low level of confidence* – areas where flooding extends beyond the public reserve and beyond the area surveyed for this study.

In addition, the level of confidence in areas with steep topography is greater than in areas with flat topography. As part of a review of study outputs the brief was extended to include flood mapping for the entire Puhinui Stream, catchment. This is set out in section 3.3 below.

3.3 Additional Flood Mapping

The original scope of services was extended to include flood mapping of all of the Puhinui Stream catchment area.

3.3.1 Methodology

The following methodology was used to flood map the stream catchment.

- Each sub-catchment was identified and where necessary subdivided again into small catchment areas.
- The subcatchment areas were identified and the rational formula used to determine the difference between the 20% AEP and 1% AEP flow.
- The 20% AEP flow is assumed to be taken by the pipe network. 1% AEP flow is assumed to fill the pipe with the balance as overland flow.
- The MCC GIS system was used to devise likely flow paths for all of the catchment. As this is based upon a large contour internal (2 m), the accuracy was not good and field walk over was needed to confirm the overland flow path routes.
- A desktop study was done to determine overland flow volumes and a site drive over / walk over was used to confirm the potential flow path width and location. Only those properties visible from the street were inspected. Back lots and larger industrial lots were not inspected.
- Modelling and surveying were specifically not required by Manukau City Council
- An engineering judgement was made as to the potential for flood risk and areas were assigned under one of the following categories:
    - **Zone 1**. Areas confirmed by modelling and detailed topographical survey that are predicted with a high level of confidence to become inundated from a 1% AEP year event for either the existing or future development scenarios.
    - **Zone 2**. Areas confirmed by modelling and from MCC GIS contour data that are highly likely to become inundated from the above storm events. These areas have a medium level of confidence.
    - Additional areas identified in the MCC Fitzroy (Papatoetoe) comprehensive flood management plan as being inundated have also been included in Zone 2
    - The reason for the reduced level of confidence is that the contour data supplied has an interval of 2 m and is thus unsuitable for accurate flood hazard mapping. We would expect most of the areas assigned Zone 2 to be inundated from the particular storm event under consideration however the extent of inundation needs further investigation.
    - Zone 3. Areas identified by the desktop study and confirmed from walk over / drive over that have a reasonable possibility of being inundated are classed as Zone 3.

- Zone 4. Those large areas of industrial / commercial land in the flatter portions of the Puhinui catchment where a drive over / walk over survey has been unable to identify the overland flow path areas but where potential for overland flow is identified have been classified as Zone 4.

3.4 Remedial Works

3.4.1 Plunket Ave Bridge

We recommend that consideration be given to further work be done to improve the hydraulic profile of the stream such that potential nuisance flooding is reduced on Plunket Avenue and Cavendish Drive. Possible options include:

- Improving the cross section downstream of Plunket Ave by removal of bed and bank material built up from accretion and non-consented filling.
- Leave the low flow channel but improve the flow characteristics of the high flow channel. This can be achieved by
    - Cross section modifications to enlarge the cross section profile,
    - Improvement of roughness by the construction of a paved walkway.
    - Maintenance of the vegetation to reduce friction
    - Removal of non-consented filling and removal of stream debris (i.e. shopping trolleys and car bodies)

  The above measures could achieve a downstream reduction in flood levels of 100 mm to 150 mm. This would result in a corresponding reduction in upstream flood levels, i.e. upstream of Plunket Ave.
- Increasing the cross sectional area under Plunket Bridge (suggest by 7 m^3 per meter each side of the low flow channel). The roughness of the stream channel either side of the low flow channel could also be improved by changing the grassed vegetation to hardfill / concrete or similar material. This could lower the flood level by a further 100 mm to 120 mm.
- Improve the hydraulic characteristics of the bridge soffit. The existing entry is rough with a pipeline on the upstream side of the upstream bridge 'I' beam. A further reduction in flood level would be gained by this, however this improvement would be unlikely to exceed 50 mm - 80 mm.
- Improvements to the rail culvert (see below)

3.4.2 NIMT Railway

Possible options for the reduction of flood levels between Plunket Ave and the existing railway culvert include:

- *Increase intake capacity* - this could be achieved by modifying the shape of the culvert soffit to a rounded entry. This is not required yet but should be undertaken

to cater for increased flows resulting from further development up to the ultimate development scenario.

- *Enlarge high flow channel downstream of the railway* – this would assist in lowering flood levels both below and above the railway culverts.
- *Upstream Detention* - Creation of upstream detention areas would reduce downstream peak flows and therefore flood levels.

3.4.3 Future Work

This study quantified the extent of flooding in the main Puhinui Stream channel and selected major tributaries. Flooding of additional tributaries was not part of the agreed original scope of work for this study and therefore further work will be required to quantify flood levels in these areas. Areas where such work may be undertaken include:

- Adjacent to the new motorway works near Roscommon Road and upstream into the commercial and residential land around Puhinui Road;
- The Milburn Quarry site off Wiri station Road;
- The tributary leading past the Frucor site on to Wiri Station Road;
- Further up this same tributary on Ash road;
- On private land immediately downstream of Plunket Ave;
- In Puhinui Domain adjacent to Brett Ave;
- Adjacent to the Ford Weir;
- Kerrs Road and the land upstream of Kerrs.

4. Recommendations

There are a number of recommendations that would improve the confidence levels of the computer model predictions. These are set within the discussion section of the modelling report attached as Appendix A.

The following recommendations stand alone separate from the modelling report addendum.

4.1 Minimum Floor levels

The MCC District plan rule 9.9.1.2 (c) states that, “Finished ground level for potential building sites areas shall meet the following standards relating to freeboard regarding 1% Annual Exceedance Probability levels: Sites adjoining formed open stream channels – 800mm freeboard”. We would in general concur with this policy.

There has been historical development where land and possibly floor levels do not meet this criterion. In some circumstances it may be possible to relax this criterion for land and parking areas but we would not recommend such an approach for floor levels. Where a less stringent freeboard requirement is permitted as per the above, it is recommended that this be recorded on the Land Information Register (LIR).

4.2 Areas at Risk of Flooding

In the lower Puhinui Stream there are a number of bridges and culverts that cross both the main stream and tributaries. Several of these structures are at risk of blockage should a car, an empty container or debris be washed into the stream channel during peak flood conditions.

These structures include

- Great South Road Bridge just down stream of the SH1 Motorway.
- Kerrs Road Bridge
- Wiri, Lambie and SH20 Armco arch culverts
- Plunket Ave Bridge and
- The NIMT rail triple box culvert

If MCC are to consider any reduction in freeboard below the standard 800mm requirement then we recommend that this be carried out with due consideration of the effects of the structures between SH 1 and the NIMT railway culverts.

Below the NIMT culverts the risk of elevated flood levels above that predicted by the MIKE 11 model reduces somewhat because the waterway for the existing and proposed bridge structures is substantial and risk of blockage potential reduces significantly.

4.2.1 Plunket Ave Bridge

The Plunket Avenue Bridge is at risk of being overtopped in a 1% AEP event. The degree of overtopping is not considered to be significant. However the bridge and adjacent Cavendish Drive are on principal arterial routes (once the Liverpool Nesdale link is open). In accordance with the District Plan, such roads require greater freeboard than is currently available.

A number of stream channel upgrades have been suggested in Section 4.4 to reduce the risk of surface flooding at this location. These works are considered important and we recommend that they be investigated further and the optimum solution determined within the next 5 years.

These could be undertaken in conjunction with the proposed *Puhinui Stream Coast to Inland Walkway Project*.

4.2.2 Ford Weir Bridge

The Ford Weir Bridge is likely to be overtopped in a 1% AEP event. The degree of overtopping is probably significant, however once the recommended Plunket Bridge improvement works are developed the extent of flooding at the Ford Weir Bridge site should be re-addressed.

As an alternative or in conjunction with other works, a reduction in the peak flow would improve the Ford Weir Bridge and Plunket Avenue Bridge flooding problems. Options such as increased upstream detention storage should be included in the range of solutions to be considered.

4.3 Flood Mapping

4.3.1 Extent of Flooding On Main Stream Channel

The extent of flooding shown outside the limits of the ground survey is indicative only. Further survey will be required to confirm the accuracy of flood hazard areas outside the current survey limits for the Zone 2 flood mapping. The flood level profile is known within reasonable accuracy, however the extent of flooding cannot be accurately defined because of inaccurate ground level data.

We understand that Council is considering obtaining a more accurate DTM of the city. This would allow the extent of flooding on private property to be made with a much higher degree of accuracy defined.

4.3.2 Extent of Flooding Elsewhere within catchment

To confirm with a reasonable degree of accuracy the extent of flooding over all the catchment, a full modelling programme of all the pipe work open channels and overland flow paths is required.

This work was not required by Manukau City at this stage. Areas outside of the main stream channel have been classified into various flood risk profile areas.

The purpose of these risk profile areas was to give guidance for planning purposes on flood prone areas and those areas unlikely to have flooding areas.

Areas not classified in any flood hazard zone may still receive some sheet flow but the depth is unlikely to be critical.

Appendix A

Flood Maps

GHD Limited

Level 1 Merial Building
Putney Way
Manukau
T: 64 9 261 1400 F: 64 9 262 8340 E: auckmail@ghd.co.nz

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