

## 4. FLOOD BEHAVIOUR SUMMARY

### 4.1 EXISTING FLOOD BEHAVIOUR

The *Macquarie Park Flood Study* was prepared as the first phase of investigations for this project (Bewsher Consulting, 2010). This Flood Study provides an assessment of flood behaviour under existing catchment conditions. Flood levels, flood velocities and the extent of flood inundation have been determined for floods with different probabilities of occurrence. This helps to determine the magnitude of the flood problem within the catchment, and to identify the main problem areas. It also provides the necessary flood models to examine the effectiveness of undertaking various floodplain management measures within the catchment, which is further examined in this report.

The flood model is comprised of a *hydrologic* model (DRAINS) and a *hydraulic* model (TUFLOW).

The *hydrologic* model determines the runoff resulting from a particular rainfall event. The primary outputs from the model are hydrographs at various locations along the waterways to describe the quantity, rate and timing of stream flow that results from rainfall events. The model covers the entire catchment.

The *hydraulic* model consists of a linked two-dimensional/one-dimensional (2D/1D) model using a 3 metre grid. The hydraulic model simulates the movement of floodwaters through the waterway reaches, storage elements and hydraulic structures. The model calculates flood levels and flow patterns and also models the complex effects of backwater, roughness, overtopping of embankments, waterway confluences, bridge constructions and other hydraulic structures across the study area.

Data from two historical floods in November 1984 and February 1990 was compiled, with the flood models generally reproducing the observed flood regimes (see Bewsher Consulting, 2010 for a summary of public submissions). However, the rainfall and water level data sets were of insufficient quality to permit formal calibration against those events.

Design floods are hypothetical floods used for floodplain management studies. Design floods with the following Average Recurrence Intervals (ARIs) were modelled: 5 year, 20 year, 50 year, 100 year and the probable maximum flood (PMF) (see the glossary for definitions). Design floods are modelled by applying design rainfall totals which are derived from *Australian Rainfall and Runoff* (2000). The 2 hour duration storm defined the critical durations for the Mars, Shrimptons, Industrial, Porters and Lane Cove catchments while the 9 hour storm was critical for the Lane Cove River. The downstream boundary condition was derived from a rating curve.

Flood modelling produced a grid of results at 3 metre intervals over the study area. These results include flood levels, flood depths, and flood velocities at regular time intervals throughout the flood simulation. The peak values are recorded and can be interrogated at any point within the study area using a GIS database, such as MapInfo.

Maps showing the extent of flood inundation, flood depths and flood level contours are presented in the *Macquarie Park Flood Study* report (Bewsher Consulting, 2010). This provides Council with the necessary information to specify minimum building floor levels and other controls for future development.

## 4.2 FLOOD RISK AND OVERLAND FLOW PRECINCTS

### 4.2.1 Introduction

Floodplain management is all about managing the risk of flooding across the floodplain. In doing so, it should be recognised that different parts of the floodplain are subject to different degrees of flood risk.

It is important not to confuse 'flood risk' with 'flood hazard' or 'provisional flood hazard'. The terms 'hazard' and 'provisional hazard' are defined in the 2005 *Floodplain Development Manual* and relate to the magnitude of a *specific* flood. For example, a site may experience high hazard conditions in a 100 year flood and low hazard conditions in a 5 year flood. On the other hand, flood risks (as used to define land use planning precincts) do not relate to a single flood, but rather to all floods.

### 4.2.2 Flood Risk Precincts

Flood risk precincts consider the probabilities and consequences of flooding over the full spectrum of flood frequencies that might occur at a site. When expressed in mathematical notation:

$$\text{Flood Risk} = \int_{\text{all floods}} \text{Probability} * \text{Consequence}$$

where *probability* is the chance of a flood occurring, and *consequence* is the property damage and personal danger resulting from the site's flood characteristics. Note that in carrying out this assessment, the existing land uses and any private warning/evacuation plans at the site are ignored, and typical residential land uses and the normal public warning/evacuation plans are assumed.

As per the *Eastwood and Terrys Creek FRMS&P*, which has been adopted by Council, the areas within the Macquarie Park study area subject to the most significant inundation have been categorised into three different grades of flood risk, namely 'high', 'medium' and 'low'. This same categorisation has been applied to a number of other catchments throughout NSW, and is consistent with the categorisation of other natural risks, such as bush fire risk. It allows different development controls to be applied in different parts of the floodplain, recognising both the type of development proposed and the flood risk where the development is to be located.

After a review of the probabilities and consequence of flooding over all flood frequencies, the 'high', 'medium' and 'low' flood risk precincts were mapped as described below, and are shown on **Figure 4.1**.

- ▶ **High Flood Risk Precinct** includes all areas of the floodplain which would be provisionally high hazard in a 100 year flood (based on Figure L2 of the *Floodplain Development Manual*). In addition to including the 100 year provisionally high hazard areas in the high flood risk precinct, other parts of the floodplain are also included where:
  - (a) in a 100 year event, significant evacuation difficulties exist (e.g. islands surrounded by provisionally high hazard conditions);
  - (b) in floods rarer than a 100 year event, the potential for significant or extreme consequences exist which are not otherwise apparent from consideration of only the 100 year flood or more frequent flood events. Some events that may result in these consequences (depending on their scale) include catchment diversions, areas subject to overtopping of levees and embankments, areas subject to severe

bank or bed erosion, or other conditions that can lead to unusually high depths, velocities or otherwise produce very dangerous flood conditions. Whilst the probabilities of these events might be low, the consequences can in some cases be extreme and thus produce a high risk.

- ▶ Medium Flood Risk Precinct is the remaining area inundated in a 100 year flood event, not defined as the 'high' flood risk precinct. For reasons similar to those discussed above under (a) and (b), it is possible for some otherwise 'low' flood risk areas to be elevated to 'medium', when the flood conditions warrant it, though this is rarely required.
- ▶ Low Flood Risk Precinct comprises all remaining areas of the floodplain (defined as the limit of inundation in a PMF) but not identified as either a high flood risk or medium flood risk precinct, and where the risk of damages is low for most land uses.

#### **4.2.3 Overland Flow Precinct**

Areas of shallow overland flow that are distant from watercourses have been excluded from the flood risk mapping described above. These properties have been identified in a separate Overland Flow Precinct and are also shown on **Figure 4.1**.

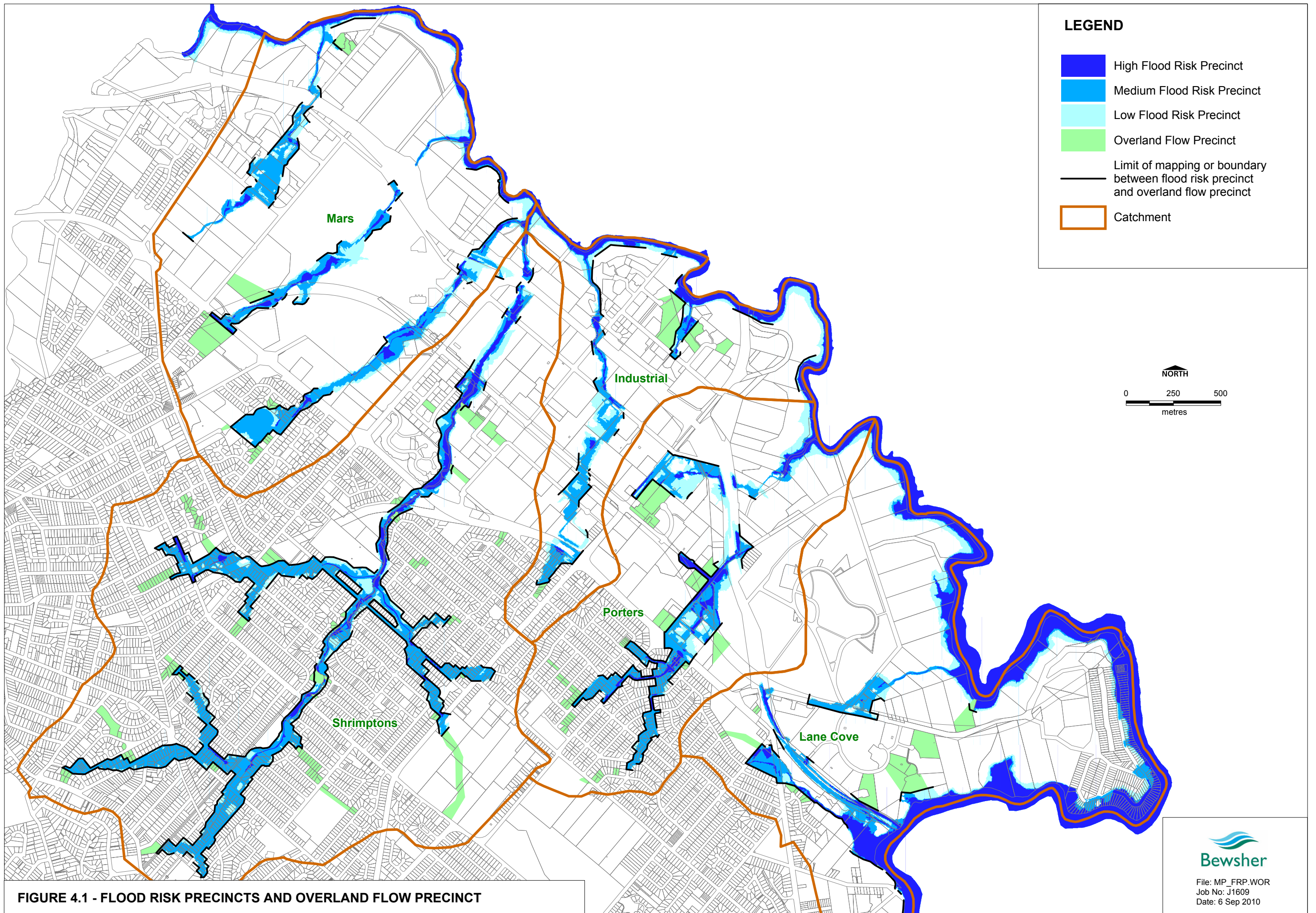
The depth of inundation in these areas will typically be less than 0.3 to 0.5m but more than 0.1 to 0.2m in a 100 year flood. Velocities in these areas are mild and the combination of depth and velocity is unlikely to present a safety danger to able-bodied adults or to cause significant erosion problems. These areas would normally be classified as 'low' provisional hazard under the *Floodplain Development Manual*. Where depths in an upslope road sag point exceed 0.3m, downstream allotments affected by shallow flooding have also been included in the Overland Flow Precinct area.

Note that shallow inundation may still occur in areas beyond the Overland Flow Precinct where depths would typically be less than 0.1 to 0.2m. These areas are not classified as being within either a Flood Risk Precinct or an Overland Flow Precinct and would include areas referred to as 'Local Drainage' under the *Floodplain Development Manual*.

#### **4.2.4 Floodways**

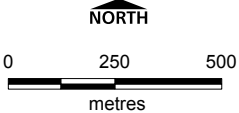
The merit of mapping floodways in the Macquarie Park study area has been considered. Floodways are defined as areas of significant flow that, even if partially blocked, would cause a significant redistribution of flood flow. In the previous *Floodplain Development Manual* (NSW Government, 1986), floodways were delineated on the basis of the product of flood depth and velocity being greater than 1.0 in the 100 year flood. In the case of the current study area, generally all such areas have been identified to be in the high provisional hazard area in the 100 year flood, and therefore have been incorporated into the high flood risk precinct.

The proposed planning controls in Council's DCP prohibit all new development (apart from recreational or non-urban uses) within the high flood risk precinct. Any 'concessional development' (for existing property) is permissible only upon the conditions that an engineer's report certifies that the development will not increase flood affectation elsewhere, and that safe evacuation is possible. For this reason, it was concluded that a separate exercise to control development within floodways would add little practical value.



**LEGEND**

- High Flood Risk Precinct
- Medium Flood Risk Precinct
- Low Flood Risk Precinct
- Overland Flow Precinct
- Limit of mapping or boundary between flood risk precinct and overland flow precinct
- Catchment



**FIGURE 4.1 - FLOOD RISK PRECINCTS AND OVERLAND FLOW PRECINCT**



File: MP\_FRP.WOR  
Job No: J1609  
Date: 6 Sep 2010

## 4.3 CLIMATE CHANGE SENSITIVITY TEST

### 4.3.1 Background

There is increasing evidence that the temperature of the earth's atmosphere and oceans has increased over the last century, and that the accumulation of greenhouse gases in the earth's environment will accelerate this process in future years. Australian average temperatures are projected to rise by 0.6 to 1.5°C by 2030 and by between 2.2°C to 5.0°C by 2070, should global greenhouse gas emissions continue to grow at rates consistent with past trends (CSIRO/BOM, 2010).

Climate change could affect flood behaviour in the Macquarie Park study area catchments through:

- (i) increased sea levels (only for the Lane Cove River catchment); and/or
- (ii) increased severity of flood producing storms or other weather systems.

From 1870 to 2007, the global average sea level rose by 20cm, with an increased rate from 1993 to 2009 (CSIRO/BOM, 2010). Sea levels are expected to continue rising throughout the 21<sup>st</sup> century and there is no scientific evidence to suggest that sea levels will stop rising beyond 2100. In October 2009, the NSW Government released the *NSW Sea Level Rise Policy Statement* (DECCW, 2009), which lists sea level rise planning benchmarks of increases above 1990 mean sea levels of 40cm by 2050 and 90cm by 2100. The *Flood Risk Management Guide* (DECCW, 2010) and the *NSW Coastal Planning Guideline* (DoP, 2010) require that these planning benchmarks be considered in relation to flooding.

The impact of climate change on rainfall is a topic of greater uncertainty. The *Practical Consideration of Climate Change Floodplain Risk Management Guideline* (DECC, 2007) reports that extreme rainfall (40 year 1 day rainfall total) could increase by 10% for Sydney Metropolitan catchments by 2070.

### 4.3.2 Method

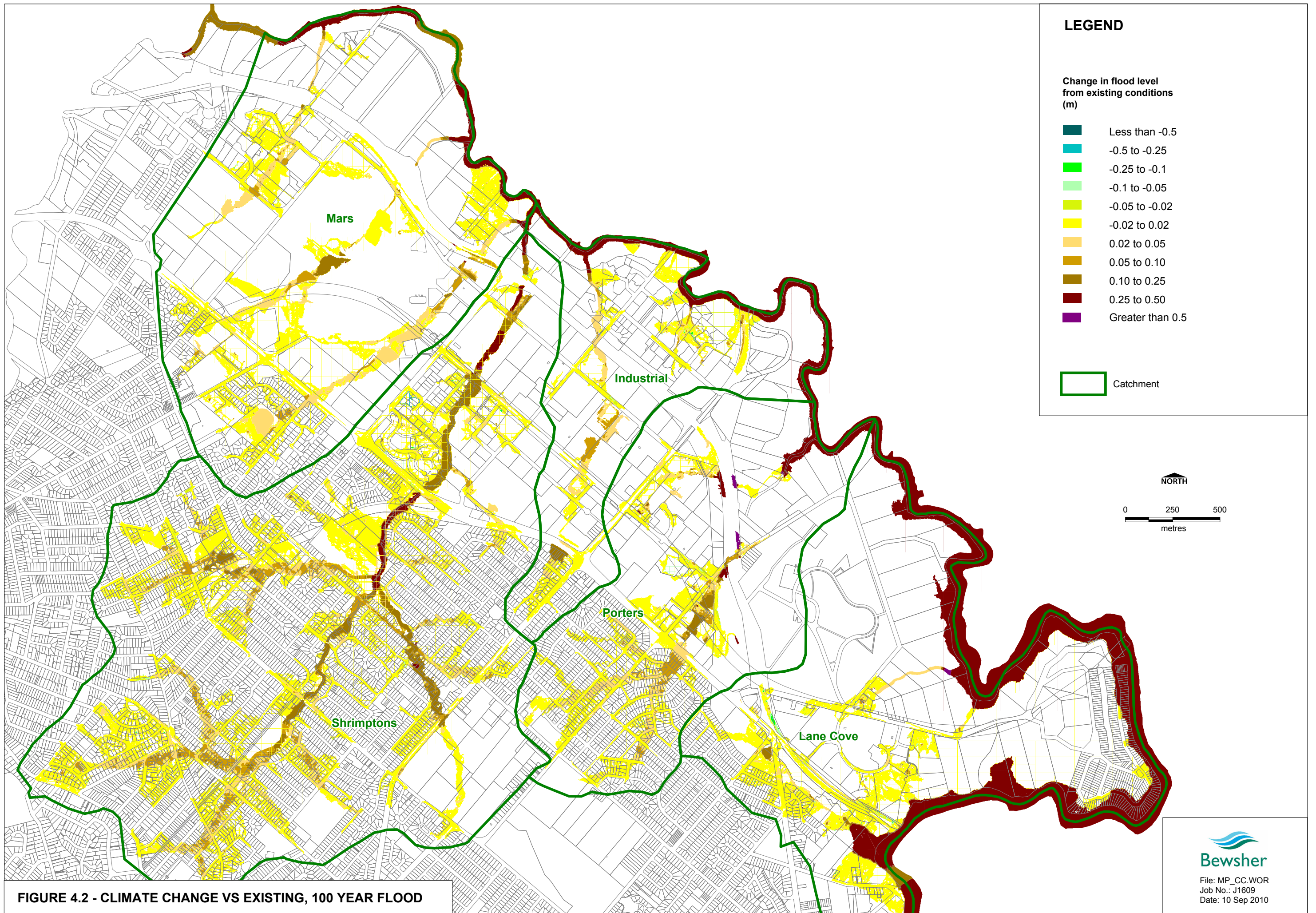
Accordingly, a 100 year ARI climate change sensitivity test model run was conducted following this approach:

- ▶ tailwater rating curve adjusted to reflect the Year 2100 Sea Level Rise planning benchmark, coincident with a 10% increase in rainfall intensities;
- ▶ operation of the four DRAINS models and the three TUFLOW models across the study area; and
- ▶ blocked and unblocked assessments for the 100 year critical duration only, enveloped to give worst case.

### 4.3.3 Results

**Figure 4.2** compares the 100 year ARI climate change flood results to the 100 year ARI existing case. Unsurprisingly, flood levels increase in many areas. Increases of about 0.3m occur along River Avenue, Chatswood West. Some existing flood problems are amplified, including:

- ▶ 0.1m increase at No. 112 Talavera Road
- ▶ 0.1m increase in the Danbury Close sag point;
- ▶ 0.1-0.2m increase in the reach downstream of the North Ryde Golf Club;
- ▶ 0.3m increase in Shrimptons Creek between Kent Road and Epping Road;
- ▶ 0.3-0.4m increase above the culverts running through the Macquarie Centre;
- ▶ 0.15m increase upstream of the Epping Road at Industrial Creek;
- ▶ 0.1m increase upstream of Epping Road at Porters Creek; and
- ▶ 0.3m increase along River Avenue, Chatswood West.



**FIGURE 4.2 - CLIMATE CHANGE VS EXISTING, 100 YEAR FLOOD**



File: MP\_CC.WOR  
 Job No.: J1609  
 Date: 10 Sep 2010