Leppington Precinct - Flooding Assessment

April 2013

NSW Department of Planning and Infrastructure

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Approved by: R Leslie ....

Signed: Rob Leslie ....

Date: 30 April 2013 ....

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DISCLAIMER: Flood results have been based on the TUFLOW model developed by WMA Water (2011). PB has used this model on the assumption that it has undergone peer review and subsequent approval by Camden Council.

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1. Introduction

PB has been engaged by the Department of Planning and Infrastructure to prepare a flood assessment for the Leppington Precinct in the South West Growth Centre. This assessment forms part of a set of water management studies which also includes a riparian corridor study and an integrated water cycle management strategy for the Leppington Precinct.

The flooding assessment is intended to model and map a range of extreme flood events up to and including the Probable Maximum Flood (PMF) and to identify potential areas of flood risk within the Leppington Precinct. This assessment forms part of the planning process for development of the precinct, and its main purpose is to identify flood prone lands and to determine the flood planning level before significant development occurs, thereby ensuring that potential flood impacts and flood damage under extreme events are minimised for the developed precinct.

The flooding assessment should provide sufficient information so that the risks and associated costs of flooding on the community are minimised through the design of the development and so that future floodplain risk management measures will maintain floodways and educate the community on the potential risks.

This flood assessment takes information from the Council's floodplain risk management study and presents and adds to this information to inform the precinct planning process. At this stage of planning there is no consultation with the general public but all relevant governing authorities are to be consulted.

This flooding assessment has reviewed and considered a range of development controls and guidelines applicable to future development within the precinct. The assessment also establishes the flood planning level and defines the extent of flood prone lands. The assessment therefore provides information that will guide the planning process in minimising flooding impacts.

1.1 Precinct overview

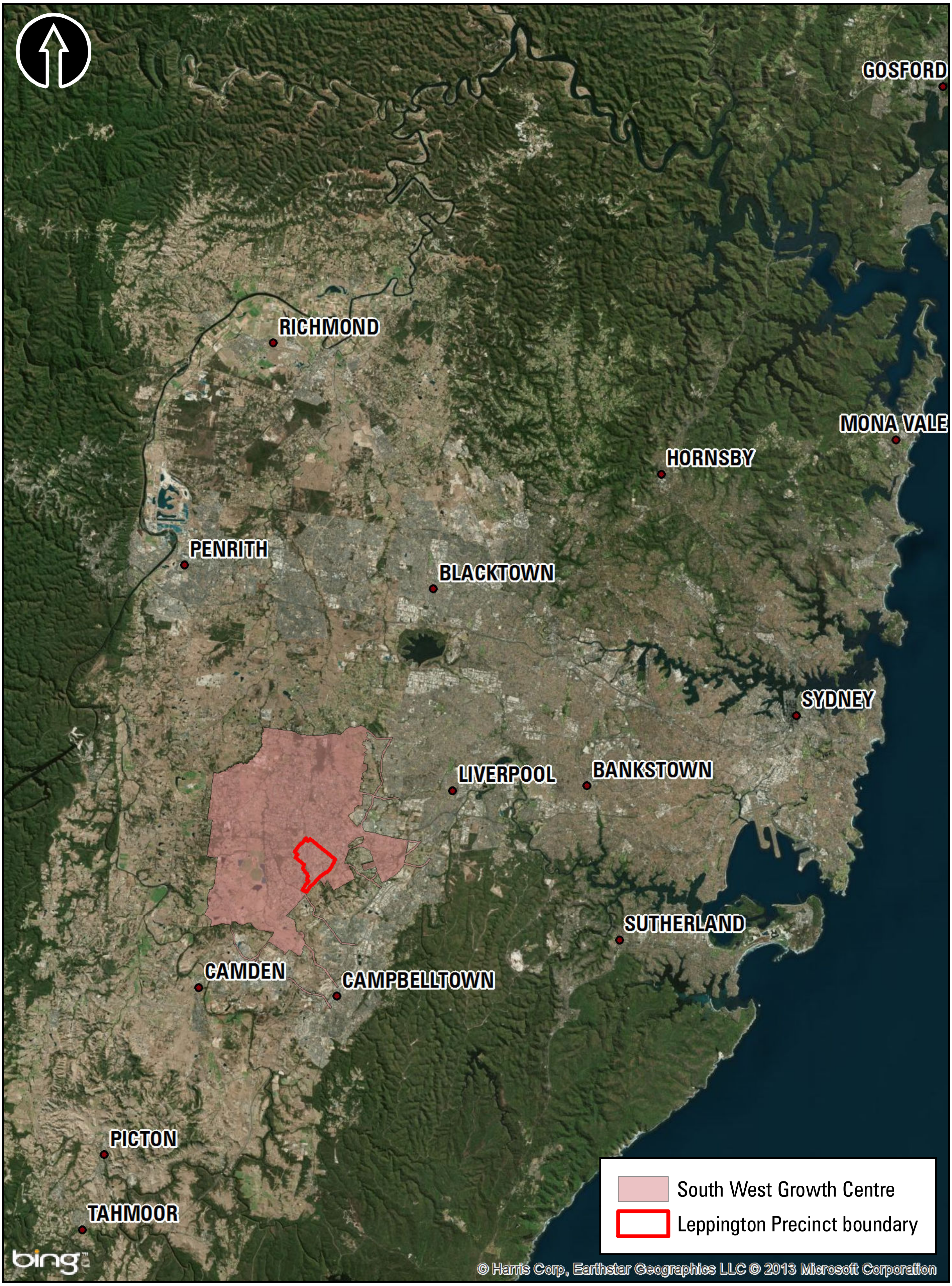
The NSW Government established the South West and North West Growth Centres to sustainably prepare for and manage Sydney's growth over the next 25 to 30 years (DPI, 2012a). It has been identified that 770,000 new homes will be needed and nearly 30% of these will be in new release areas.

The Leppington Precinct, in the South West Growth Centre, was released for precinct planning in November 2011. The Precinct is entirely within the Camden Local Government Area. Precinct planning is the process of co-ordinating and developing the delivery of services to the land such as water, power, roads, transport, parks and community services. The Department of Planning and Infrastructure (DPI) works with Camden Council and other State Government Agencies during precinct planning to decide the future zoning and development controls for the precinct. During the precinct planning process statutory approvals are also obtained so that they do not need to be obtained later on in the development process.

The Leppington Precinct is located approximately 7km south-west of Liverpool and contains the existing suburb of Leppington. The Leppington Precinct is traversed by two watercourses, Kemps and Scalabrini Creeks which eventually drain into South Creek a tributary of the Hawkesbury River. It is these two creeks that are the focus of this flooding assessment. Figure 1.1 shows the Leppington Precinct in relation to Sydney.

The precinct currently comprises small rural holdings, farming lands, market gardens and some residential areas. The proposed re-development of this land provides an opportunity to identify and preserve the local watercourses and riparian areas so that they provide a positive contribution to the overall health of the Hawkesbury Nepean catchment.

The flooding assessment is one component of the overall planning process that will be used to inform the development of a Draft Indicative Layout Plan (ILP) for the Leppington Precinct.



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Leppington Precinct Flood Assessment

Figure 1.1
Locality Plan

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1.2 Relevant legislation and policies

The major legislation, policies and guidelines that informed this flooding assessment are discussed below.

1.2.1 Flood Risk Management Policy, Camden Council, 2006

The Flood Risk Management Policy establishes flood risk management planning and development procedures for all flood prone land within the Camden Local Government Area (LGA). Flood prone land is land susceptible to flooding by the PMF event. The policy outlines development controls and guidelines that Camden Council has established to minimise damage to properties and development on flood prone land.

1.2.2 Camden Growth Centres Development Control Plan, Department of Planning and Infrastructure, 2011

This development control plan (DCP) sets out planning and design controls and environmental objectives used for assessing development applications. This DCP will apply to the Leppington Precinct once precinct planning has been completed. Controls specific to Leppington will be added as a schedule to the DCP.

The DCP sets out Precinct wide planning outcomes that apply broadly to all Precincts that are listed in the schedules of the DCP. From a flooding perspective, the objectives for planning new subdivisions are:

- to manage the flow of stormwater from urban parts of the Precinct to replicate, as closely as possible, pre-development flows
- to define the flood constraints and standards applicable to development in the Precincts
- to minimise the potential of flooding impacts on development
- to incorporate best practice stormwater management principles and strategies in development proposals.

Flood controls relevant to planning new subdivisions are listed in Section 2.3 of the DCP and should be addressed in relation to existing site characteristics.

The DCP provides a Flood Planning Level (FPL) which is the combination of flood levels and freeboards selected for planning purposes. The FPL is used for general planning control purposes such as floor levels of buildings, reliable safe flood access for evacuation and electrical installations. The FPL contained in this policy has been adopted for the Leppington Precinct which is the 100 year Average Recurrence Interval (ARI) flood level plus 500mm freeboard.

1.2.3 Floodplain Development Manual, NSW Government, 2005

The Floodplain Development Manual was prepared in accordance with the NSW Government's Flood Prone Land Policy. The objective of the Flood Prone Land Policy is to reduce flooding impacts and flood liability on individual owners and occupiers of flood prone property and to reduce private and public losses resulting from floods.

The purpose of the Floodplain Development Manual is to provide guidance to local councils during the development and implementation of detailed local floodplain risk management plans in order to produce effective floodplain risk management outcomes. The manual identifies the need to consider the full range of flood sizes up to and including the PMF when developing floodplain risk management plans; to recognise flood risk on a strategic basis; to manage not only riverine flooding but local overland flooding and to promote the preparation and adoption of local flood plans that address flood response and recovery. The manual clearly sets out the floodplain risk management process undertaken by local councils.

A number of sections of this manual have been used for this assessment when evaluating provisional flood hazard, provisional hydraulic category and emergency response planning for floods.

1.2.4 Practical Consideration of Climate Change in Floodplain Risk Management, Department of Environment and Climate Change, 2007

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Bureau of Meteorology (BOM) are currently undertaking research on climate change impacts with the objective of estimating rainfall intensities for a range of events under current climatic conditions (1960-2000) and under increased greenhouse gas concentrations for future conditions (2030 and 2070). This document outlines current advice on how to incorporate climate change impacts into flooding assessments.

This document also provides guidance on the evaluation of climate change impacts and their significance. Management options and strategies that should be considered are also outlined in the document.

This document is the basis of the climate change assessment undertaken for this flooding assessment.

1.2.5 State Environmental Planning Policy (Sydney Region Growth Centres), NSW Government, 2006

The State Environmental Planning Policy (SEPP) (Sydney Region Growth Centres) 2006 is the legal instrument that establishes the planning rules and objectives for the Growth Centres. The aims of the Growth Centres SEPP (in conjunction with amendments to the regulations under the Act relating to precinct planning) include: to co-ordinate the release of land; to enable the Minister to designate land as ready for development; to provide planning for the growth centres; to provide controls for sustainability of land and controls for development; and to provide for the orderly and economic provision for infrastructure.

The SEPP and the EP&A Amendment Regulation 2006 provide the statutory planning framework for the Growth Centres and establish the broad planning controls required to oversee the development of the Growth Centres. These instruments outline the statutory role of Structure Plans, Infrastructure Plans and the Development Code.

1.2.6 Growth Centres Development Code, Growth Centres Commission, 2006

The Growth Centres Development Code (Growth Centres Commission 2006) sets out the 'planning rules' to guide new development from the initial staging for release, to the design of a Precinct, to how a neighbourhood will look on the ground. The Development Code outlines the process by which precinct plans can be developed, including the requirements on these plans for physical, transport and social infrastructure. The Development Code details requirements for employment, residential, school and leisure land uses and plays a key role in ensuring that Precinct Plans for each precinct address the provision of schools, housing, town centres, shops, parks and industrial areas in a manner that reflects the broad objectives of the SEPP, Regulation, Structure Plans and Infrastructure Plan.

1.2.7 Floodplain Risk Management Study and Plan, Camden Council, in progress

Camden Council advised that a floodplain risk management study and plan (FRMS&P) is currently underway with an expected delivery date of the draft study in mid-2013.The FRMS&P will provide detailed flood results for the Leppington Precinct including:

- Definition of design flood behaviour including proposed development (i.e. an updated model compared to WMA 2011)
- Interim development controls to address the South West Growth Centre scheduled for public exhibition in March of 2013
- Flood Planning Area (FPA)
- Flood Planning Levels (FPLs)
- True hazard mapping
- Final Hydraulic Categories based on Council agreed criteria
- Flood Control Lot Selection for subsequent S.149 certificate notification
- A review of pertinent Council policy and recommendations in regard to suggested changes to the policy, where considered appropriate; and
- State Emergency Services (SES) classification mapping.

1.2.8 Other

Other relevant legislation and policies that were considered for the flooding assessment are listed below:

- Camden Council Section 94 Plan for the Leppington North Precinct – the Leppington Precinct will have a similar outline in its Section 94 Plan
- South West Growth Centre Structure Plan (edition 3) and supporting plans and studies on the DPI Growth Centres website
- Flood Risk Management Guide, Department of Environment Climate Change and Water, 2010
- Hawkesbury Nepean River Health Strategy 2007
- State Environment Planning Policy (Growth Centres) 2006
- *Environment Protection and Biodiversity Conservation Act 1999*

2. Flood investigations

2.1 Previous studies

This flooding assessment is based on the hydrodynamic model and results produced for the *Upper South Creek Flood Study* (WMA Water, 2011), which was adopted by Camden Council in November 2011. The following section summarises the flood modelling and assessment undertaken by WMA Water.

2.1.1 Upper South Creek Flood Study, WMA Water, November 2011

The Upper South Creek Flood Study (WMA Water, 2011) was undertaken for Camden Council as part of the State Government's Floodplain Risk Management Planning process. The first step of this process is a Flood Study in order to define design flood behaviour and also to create a model suitable for quantifying flood risks and assessing management measures.

The WMA Water (2011) flood study covered the upper South Creek catchment of south-west Sydney. The South Creek catchment forms part of the larger Hawkesbury-Nepean catchment. The South Creek catchment also includes Rileys Creek, Kemps Creek, and Scalabrini Creek.

WMA Water (2011) reviewed and considered a number of previous flood studies undertaken for the local area. These studies included:

- South Creek Flood Study (DWR, 1990)
- South Creek Floodplain Risk Management Study – Volumes 1 and 2 (DWR 1991)
- Austral Floodplain Risk Management Study and Plan (Liverpool City Council, 2003)
- South Creek Floodplain Risk Management Study and Plan (Liverpool City Council 2004)

Various information and useful data such as surveyed flood marks, loss models, cross sections, etc. were taken from these studies and used in the Upper South Creek Flood Study.

2.1.1.1 Hydrology and hydraulics

Although the report describes the development and use of an XP-RAFTS hydrologic model to generate inflow hydrographs for the TUFLOW hydraulic model, Camden Council advised that the hydrological modelling method was later revised to input of design rainfall applied directly to the TUFLOW hydraulic model grid.

Design rainfalls were calculated using the Bureau of Meteorology's (BOM) intensity-frequency-duration (IFD) tool for Bringelly and are presented in Appendix A. An areal reduction factor was not used and therefore design event rainfall was uniformly distributed across the catchments.

WMA Water (2011) used TUFLOW to undertake the hydraulic modelling. TUFLOW is a 1-dimensional / 2-dimensional (1D/2D) hydrodynamic model able to simulate free-surface flows occurring from floods and tides. TUFLOW is able to accurately represent overland flow paths as well as main channel flow with the main channel being represented by a 1D network or 2D surface. The WMA Water TUFLOW model was based on a 10m grid cell size created with digital elevation model (DEM) sampling at 5m centres. This grid size allowed for detailed resolution of important hydraulic features such as roads and reservoirs. Cross-sections from a previous MIKE-11 hydraulic model were also used to extend the representation of South Creek, although this area is outside of the Leppington Precinct.

Two scenarios were modelled by WMA Water - "existing" and "semi-developed". The "Existing" scenario is the study area in its current state excluding development work carried out to date on the Oran Park and Turner Road sub-division developments. The "Semi-developed" is the same as "Existing" but includes Oran Park and Turner Road fully developed. However, since the Turner Road and Oran Park sub-divisions are in the upper catchment of South Creek, only the existing model runs are relevant for Kemps Creek and Scalabrini Creek. A number of sensitivity tests were also undertaken, including a climate change assessment. The results of the sensitivity tests have been examined in Section 3.6.

2.1.1.2 Limitations

It has been assumed that the direct rainfall approach has also been calibrated and validated, as the Flood Study Report (WMA Water, 2011) discusses the calibration and validation process of the XP-RAFTS model.

It was also noted that the Flood Study naming of "Bonds Creek" is inconsistent with a number of other reports and catchment figures (Cardno, 2011 and Perrens Consultants, 2003). The creek modelled to the east of Kemps Creek is Scalabrini Creek, whereas Bonds Creek is to the east of Scalabrini Creek.

The flood assessment undertaken for the downstream precincts Austral and Leppington North Precincts used a different TUFLOW model developed by Cardno (July 2011). This assessment was undertaken before the release of the WMA Water study (Nov 2011). For this reason, flood extents and hazard mapping may not match up exactly along the border between the two precincts at the interface of the different modelling studies.

2.2 Flood assessment

The Flood Study (WMA Water, 2011) simulated a range of extreme flood events up to the PMF but did not model low order flood events. The purpose of this flood assessment was to complete the suite of flood modelling scenarios so that low order events could be used for precinct planning such as the top of bank determination in the riparian corridor assessment. This section summarises the additional flood modelling and re-runs for Kemps and Scalabrini Creek based on the modelling undertaken by WMA Water.

2.2.1 Modelled scenarios

The WMA Water Flood Study did not simulate the 2 and 5 year ARI events. To add to the suite of modelling scenario results, additional model runs were undertaken for this flooding assessment, as listed in Table 2.1. Only the existing case was modelled for this flood assessment.

Table 2.1 Additional model runs

ARI	Scenario
2 year	Existing case
5 year	Existing case
100 year	Existing case with climate change – 10% increase in rainfall intensity
100 year	Existing case with climate change – 20% increase in rainfall intensity
100 year	Existing case with climate change – 30% increase in rainfall intensity

2.2.2 Hydrology and hydraulics

The methodology followed by WMA Water was adopted for the hydrology calculations for this flood assessment. New direct rainfall files were created based on the same design rainfalls using the BOM's IFD tool for Bringelly (see Appendix A).

The WMA Water flood study identified that the 2 hour duration was the critical duration for Kemps and Scalabrini Creek and therefore the 2 hour temporal pattern was used to distribute the design rainfall depths from the WMA Water study. The 2 hour temporal pattern for Zone 1 from Table 3.2 Volume 1 of Australian Rainfall and Runoff (Engineers Australia, 1987) was used to distribute the total rainfall over the same timesteps as the WMA Water input files.

The 20 year ARI event was used as a check for the new direct rainfall calculation and verified the temporal pattern calculation. See Appendix A for additional direct rainfall calculations undertaken and the check undertaken for this flooding assessment.

2.2.3 Assumptions

The following assumptions were adopted for the additional model runs by PB:

- The critical duration for the 2 year ARI, 5 year ARI and climate change runs was assumed to be the 2 hour storm which is the critical duration for all storm events modelled by WMA Water for Kemps and Scalabrini Creek existing case runs.
- Direct rainfall files for the 2 year and 5 year ARI events were developed using the same BOM rainfall intensities presented in the WMA Water Flood Study (2011).

2.2.4 Verification

PB was able to carry out verification of the new model runs by comparing the 100 year ARI results grid from WMA Water (2011) and the PB model results for the same event. "Single precision" and "double precision" model runs were undertaken and compared to the WMA Water results grids. Single and double precision runs relate to the number of bytes used to store floating point values when the computer is running the simulation. Single precision will give about seven digits of precision and double precision about 16. Differences in results based on single or double precision are more prominent if the site is further away from sea level or is calculating runoff using direct rainfall. On comparison, it was confirmed that double precision matched closest to the WMA Water results. TUFLOW recommends that double precision be used for direct rainfall models. Based on the flood height 100 year ARI grid, when comparing the modelled flood heights the results were very similar (generally within -1mm to 2mm with some scattered cells within 8mm). Small differences were observed and are likely to be due to slight differences in model stability, slight difference in model builds etc.

2.3 Climate change assessment

CSIRO and BOM are currently undertaking research on climate change impacts in order to estimate rainfall intensities for a range of events under current climatic conditions (1960-2000) and under increased greenhouse gas concentrations for future conditions (2030 and 2070).

Current advice on how to incorporate climate change impacts into flooding assessments is provided in *Floodplain Risk Management Guideline: Practical Considerations of Climate Change* (DECC, 2007). DECC (2007) states that climate change impacts on flood producing rainfall events show a trend for large scale storms (rainfall totals for the 40 year ARI 1 day storm event) tend to increase by 2030 and 2070. In the Hawkesbury-Nepean catchment the projected change in extreme rainfall is -3% to 12% to the year 2030 and -7% to 10% from 2030 to 2070.

DECC (2007) recommends that low, mid and high level rainfall intensity increases be investigated to assess changes in flood behaviour – this equates to a 10%, 20% and 30% increase in rainfall intensity. In line with these guidelines, the previous WMA Water (2011) study has assessed 100 year ARI flood levels at key road crossing locations within the Kemps Creek and Scalabrini Creek catchments.

The results of the climate change assessment are presented and discussed in Section 3.6.

2.4 Summary of key flood risks and hazards

This section summarises the modelling and mapping undertaken by WMA Water and the additional modelling and mapping of lower order events undertaken for this flood assessment. Table 2.2 summarises the suite of modelling that has been undertaken to date for Kemps Creek and Scalabrini Creek.

Table 2.2 Suite of modelled scenarios for Kemps and Scalabrini Creeks used for this assessment

ARI	Scenario	Source of results
2 year	Existing	Undertaken by PB for this flood assessment
5 year	Existing	Undertaken by PB for this flood assessment

ARI	Scenario	Source of results
20 year	Existing	WMA Water (2011)
50 year	Existing	WMA Water (2011)
100 year	Existing	WMA Water (2011)
100 year	Existing with climate change – 10% increase in rainfall intensity	Undertaken by PB for this flood assessment, WMA Water (2011)
100 year	Existing with climate change – 20% increase in rainfall intensity	Undertaken by PB for this flood assessment, WMA Water (2011)
100 year	Existing with climate change – 30% increase in rainfall intensity	Undertaken by PB for this flood assessment, WMA Water (2011)
200 year	Existing	WMA Water (2011)
500 year	Existing	WMA Water (2011)
PMF	Existing	WMA Water (2011)

Figure 2.1 shows that the 2 year ARI flood extent is confined mainly within the main channel. The 2 year ARI flood extent is quite narrow for both Kemps Creek and Scalabrini Creek. The 2 year ARI flood extent is widest at the lower ends of the precinct and where the creeks intersect with Bringelly Road. The 2 year ARI flood extent of Scalabrini Creek upstream of Bringelly Road at the northern boundary of the Leppington Precinct is approximately 90m wide. There is an open flat area to the east of the Bringelly Road crossing where the 2 year ARI flood spills out of bank. The 2 year ARI flood extent of Kemps Creek is also at its widest at approximately 90m where it crosses Bringelly Road.

During the 20 year ARI flood shown in Figure 2.2, flows are out of bank in the lower reaches of Kemps and Scalabrini Creek. Flooding in some of the first order streams is not present for the 20 year ARI. The 20 year ARI flood extent for Scalabrini Creek is widest at the lower reaches measuring approximately 150m; and Kemps Creek measuring approximately 160m at the mid-lower reaches where there is a large patch of existing vegetation.

The 100 year ARI flood extent in Figure 2.3 follows a similar pattern to the 20 year ARI extent. The WMA Water (2011) study states that, whilst depths have changed slightly, the flood extents for the 20 year and 100 year ARI events are similar.

For the PMF event shown in Figure 2.4, all first order streams form part of the continuous flood extent. Flooding occurs out of bank for both Kemps and Scalabrini Creek and is nearly double the width of the 20 year ARI flood extent, measuring approximately 300m for Kemps Creek and for Scalabrini Creek.

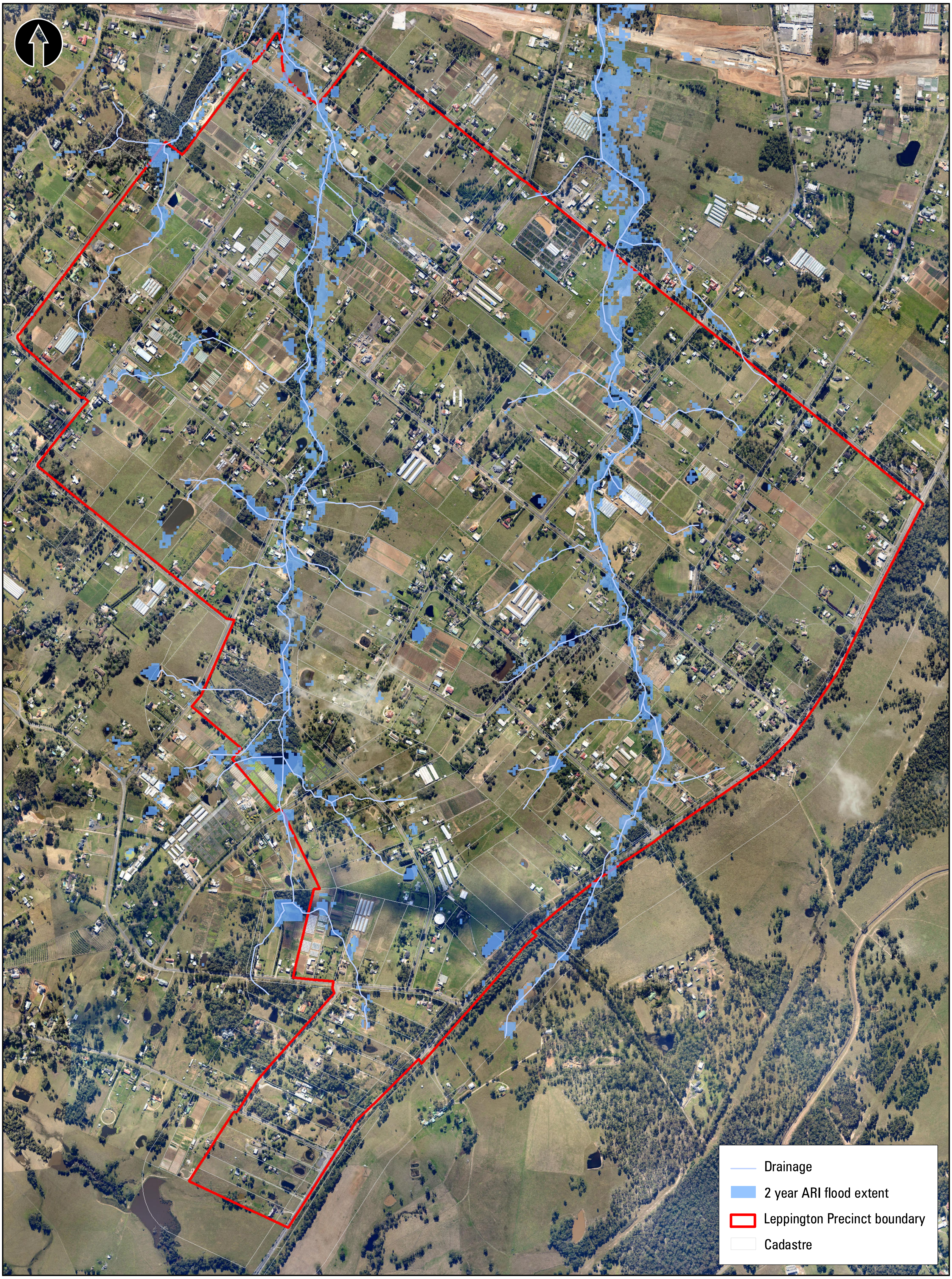

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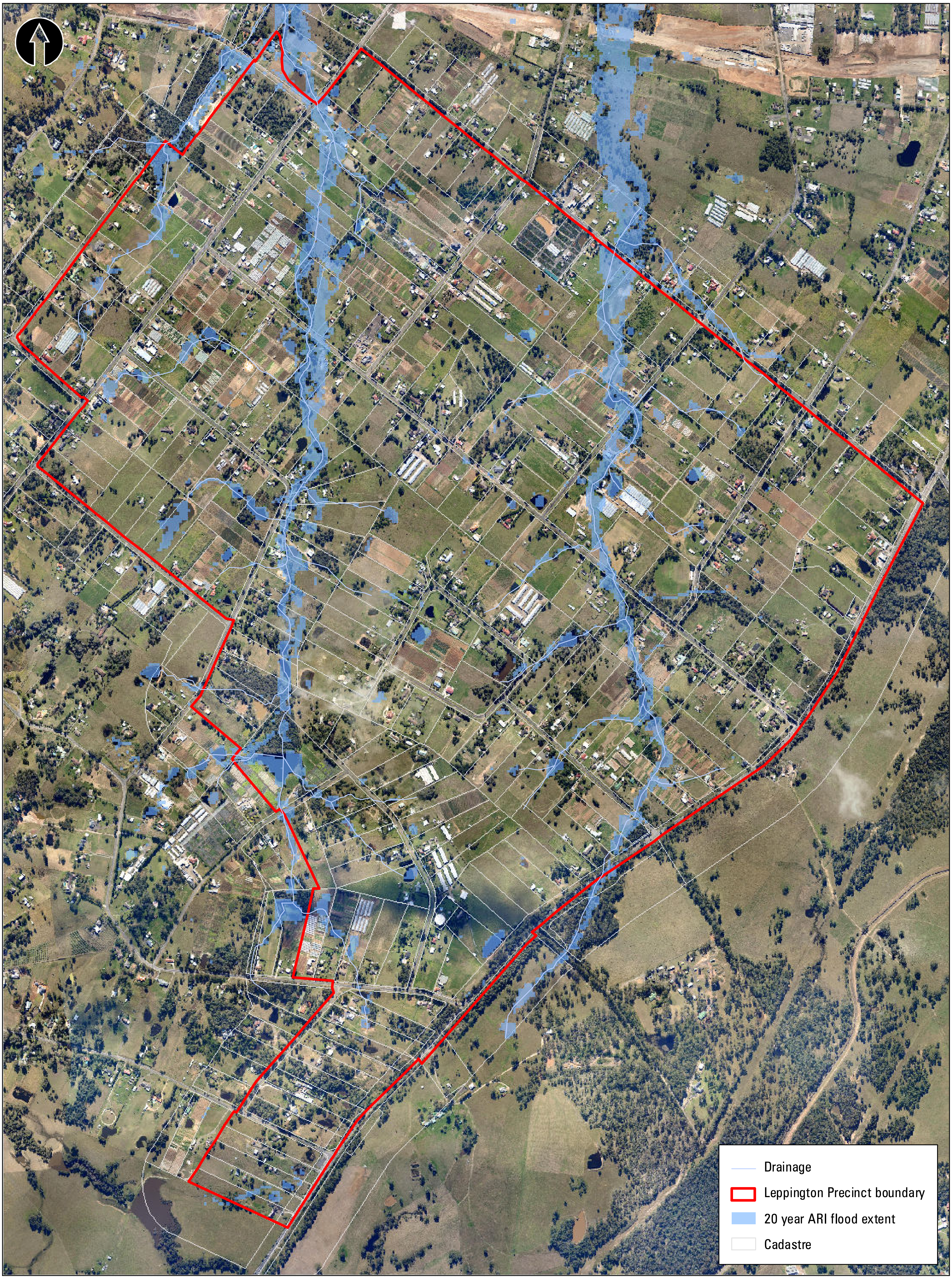
Figure 2.1
2 year ARI existing flood extent



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Leppington Precinct Flooding Assessment

Figure 2.2
20 year ARI existing flood extent

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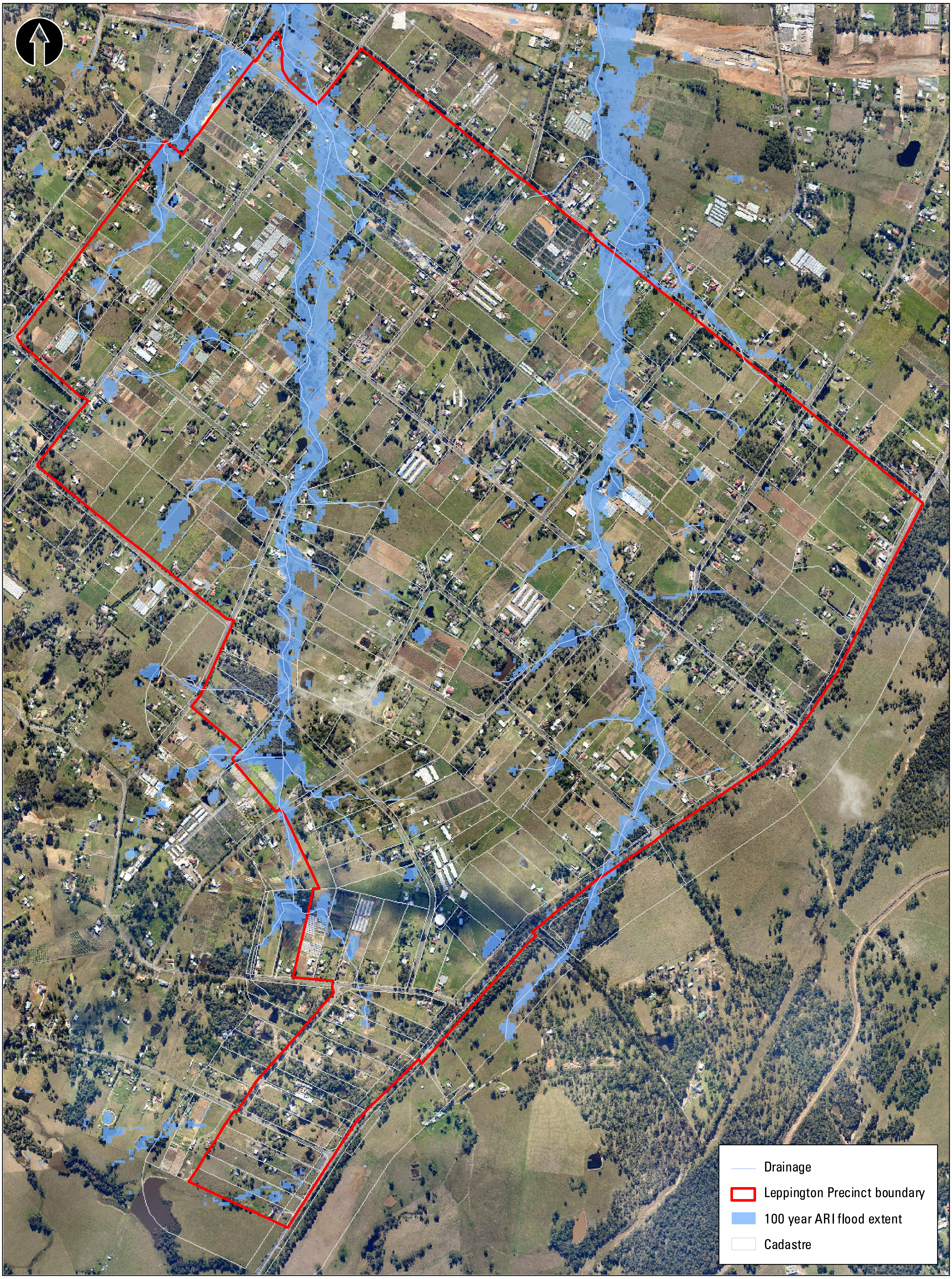

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Figure 2.3
100 year ARI existing flood extent

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Leppington Precinct Flooding Assessment

Figure 2.4
PMF existing flood extent

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3. Flood planning assessment

The flood planning assessment is intended to provide flood compatible development guidelines and prepare the community for a flood emergency. The NSW Flood Prone Land policy recommends following a risk based approach for managing the flood risk. The first step in managing a flood emergency is to prevent the potential hazard resulting from the risk, then preparation, followed by a response to the emergency and finally recovery.

The preceding chapters have identified the key risks and hazards associated with flooding for the Leppington Precinct. This chapter draws upon the Flood Study and further flood assessment information as well as the climate change assessment to develop a set of guidelines that will firstly prevent the flood hazard and secondly prepare the community for the flood emergency.

The prevention flood risk management measures proposed include setting the minimum flood planning levels for all residential buildings and zoning the land to ensure only suitable development is placed in areas predicted to be at risk of flooding. Filling of the land to provide more land above the flood planning level is also considered as a means of preventing the flood risk.

To prepare the community for the flood emergency it is important to understand the magnitude of the hazard. The assessment will document the flood hydraulic and hazard zones for the precinct and consider how potential climate change will affect flood risk within the precinct.

It is not possible to completely eliminate flood risk within the precinct, as that would result in a large reduction in developable land area. It is therefore essential that a response plan (a flood emergency management plan) be developed to enable management of the flood emergency with an acceptable level of residual risk.

All of these measures are described and discussed in more detail below with a summary of the key flood planning guidelines provided at the end of the chapter and in accompanying maps.

3.1 Flood planning levels

3.1.1 Background

The flood planning level (FPL) is a development control level that is defined as the flood level for a specified flood event (usually a design flood event) plus a suitable freeboard allowance. The intent of the FPL is to manage the risk of flooding for future development and in some cases to set the design level for mitigation works to manage existing flood risks.

The chosen flood event for the FPL depends on a complete understanding of the flood risk for an area across a range of flood events. The 100 year ARI is typically chosen as the flood event for the FPL for residential development.

Freeboard is intended to provide an allowance for uncertainties in the flood level estimate. Types of uncertainties include hydraulic model input data uncertainties, differences in water levels across the floodplain that are of a local nature and cannot be estimated by the model, increases in water level due to wave action across the flood surface, changes in rainfall pattern due to a non-static climate and the cumulative effect of subsequent infill development of the floodplain (NSW Government, 2005).

3.1.2 Adopted Leppington Precinct flood planning level

In accordance with the Camden Growth Centres Development Control Plan (Department of Planning and Infrastructure, 2011) and to ensure consistency across the south west growth centres it is proposed that the adopted FPL be the 100 year ARI flood level plus a freeboard of 500mm. The FPL varies across the precinct to account for the flood surface gradient along the major flow paths. A single freeboard allowance has been adopted across the Precinct but lower freeboard levels can be considered for non-residential and non-critical infrastructure. This can be determined following development and review of the Masterplan for the Precinct.

The flood planning area (land within the FPL) for the Leppington Precinct is presented in Figure 3.1 and Figure 3.2, which includes the 500mm freeboard allowance (grid results dated November 2012 from WMA Water flood assessment were used as the basis for applying the freeboard allowance). The flood planning area will be confirmed during the completion of detailed modelling undertaken for the Camden Council FRMS&P which should be reviewed once available. However, until this more detailed study is available, the FPL presented in Figures 3.1 and 3.2 should be adopted as it is based on the best current available information/modelling for the Kemps and Scalabrini catchments.

Leppington Precinct Flooding Assessment

Figure 3.1
Leppington Precinct Flood Planning Area - northern

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Figure 3.2
Leppington Precinct Flood Planning Area - southern

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Drawing No: 2114850A_GIS_F020_A1	
Author: LR	Date: XX/XX/2011
Editor: XX	Print Date: 5/03/2013
Revision: A1	Review: XX

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3.2 Flood compatible development zones

Appropriate zoning of land is important for managing the flood risk within flood liable land. Zoning land at the beginning of the land development process so that only flood compatible development can occur within particular flood hazard zones can avoid unacceptable flood risks and damages to people and property during a flood event.

Flood compatible development zoning identifies appropriate uses for flood liable land. For instance, high hazard flood storage areas are unsuitable for hospitals and schools but may be suitable for infrequently used recreational facilities such as sports fields.

It is proposed that Camden Council's Development Guidelines Matrix (section 6.3 of the Flood Risk Management Policy) be adopted (see Appendix B). The matrix applies development controls to particular types of development based on the land use and the hydraulic categories. Refer to Section 3.3 for the Leppington Precinct provisional hydraulic and hazard categories.

Flood compatible development zones presented in this report are based on the best available information at the time. Flood compatible development zones and flood hydraulic and hazard categories will be updated/confirmed in the Camden Council FRMS&P (refer to Section 1.2.7) currently in progress. The draft FRMS&P will provide interim development controls to address the South West Growth Centre scheduled for public exhibition in early 2013 and should be consulted for further details relating to flood compatible development.

3.3 Flood hydraulic category and provisional hazard

The understanding of flood hydraulic and hazard categories for a particular floodplain is essential for understanding the flood risks across the floodplain and informing flood risk management and mitigation measures.

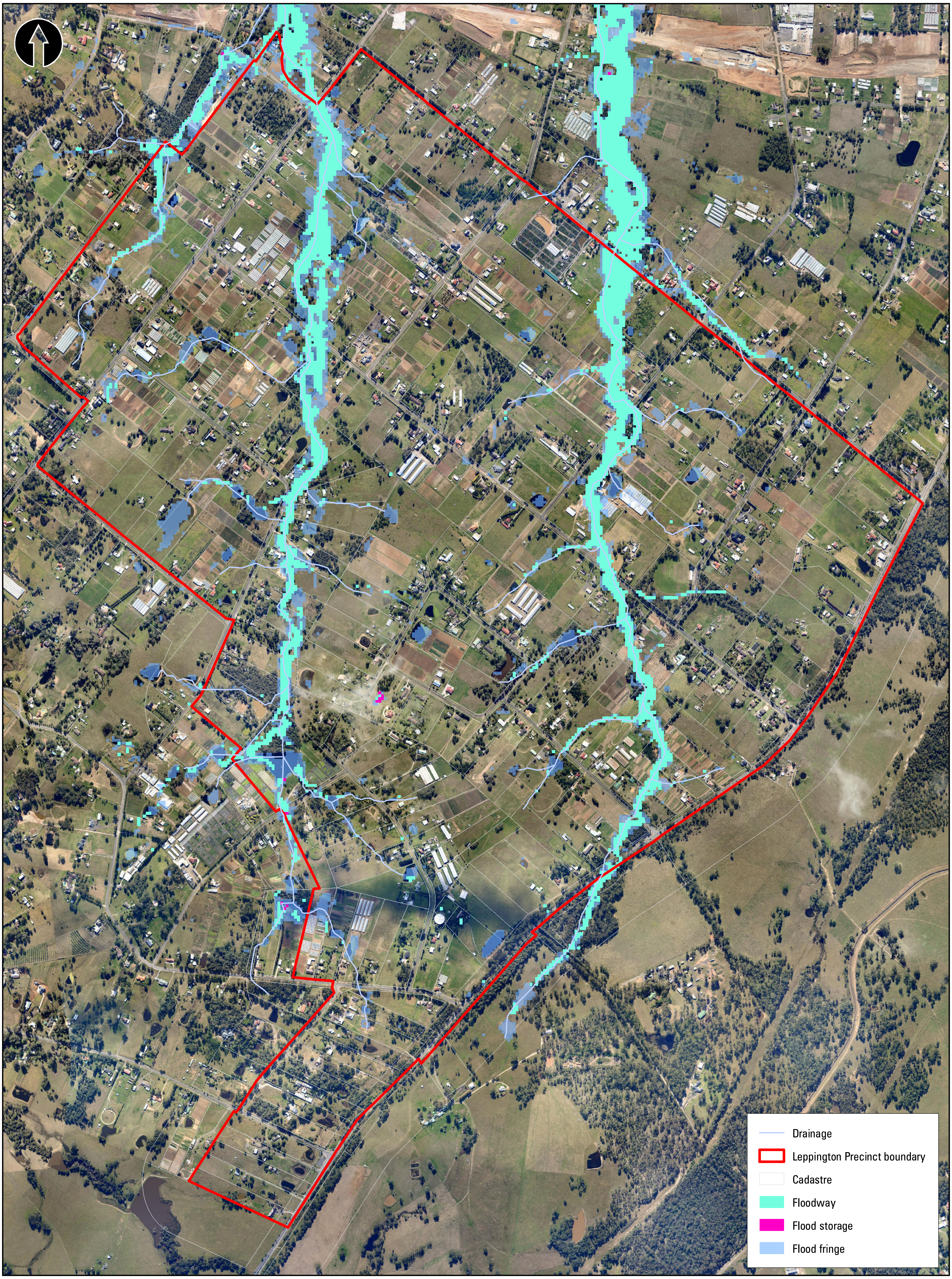
Hydraulic categories are floodways, flood storage and flood fringe and each of these areas is defined as follows (NSW Government, 2005):

- **Floodways** are those areas where a significant volume of water flows during floods and are often aligned with obvious natural channels.
- **Flood storage** areas are those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood.
- **Flood fringe** is the remaining area of land affected by flooding, after the floodway and flood storage areas have been defined.

Provisional hydraulic categories have been mapped for Kemps and Scalabrini Creek for the 100 year ARI event. The categorisation is based on the velocity/depth product approach:

- ***Floodway*** *=* $V*D > 0.25\ m^2/s$ *and* $V>0.25\ m/s$ *or* $V > 1m/s$
- ***Flood storage*** *= depth > 1m and NOT in a Floodway*

The 100 year ARI provisional hydraulic categories are shown in Figure 3.3 (grid results dated November 2012 from WMA Water flood assessment were used as the basis for this figure). It can be seen that the majority of Kemps Creek and Scalabrini Creek within the Leppington Precinct is classified as a floodway. There are some very small areas of scattered flood storage along the mid reaches of Scalabrini Creek.



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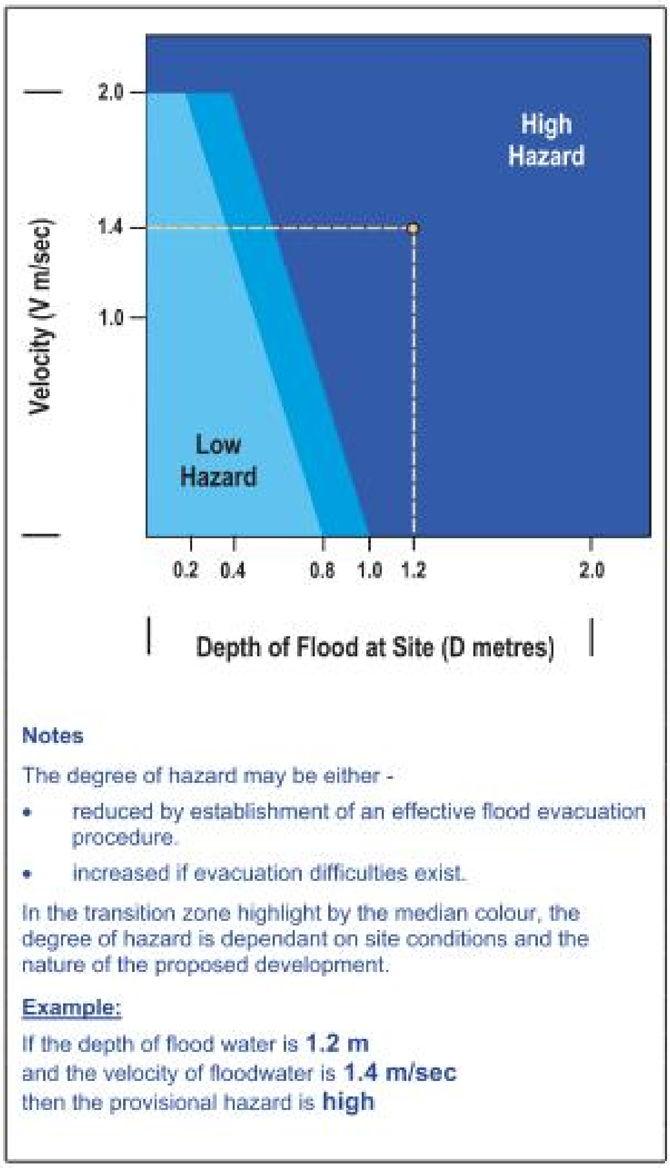
Leppington Precinct Flooding Assessment

Figure 3.3
Provisional hydraulic categorisation100 year ARI

Hazard categories are those that reflect the potential impact of flooding on development and people. The determination of hazard categories involves firstly defining the hydraulic categories and then identifying other risks such as access to higher ground, warning time for the flood event, evacuation options etc. A simple definition of the two hazard categories is as follows (NSW Government 2005):

- **High hazard**: Possible danger to personal safety, evacuation by trucks difficult, able-bodied adults would have difficulty in wading to safety, potential for significant structural damage to buildings.
- **Low hazard:** Should it be necessary, truck could evacuate people and their possessions; able-bodies adults would have little difficulty wading to safety.

Provisional hazard categories are defined by using the following matrix shown in Figure 3.4 below (NSW Government, 2005):



(Source: NSW Government, 2005)

Figure 3.4 Provisional hazard categories

The provisional flood hazard for Kemps and Scalabrini Creeks was mapped as part of this assessment and is shown in Figure 3.5 (hazard output grid results directly from TUFLOW for the PB 100yr DP run were used as the basis for this figure). It can be seen that a majority of the floodplains of the creek systems are classified as low hazard and a majority of the creek channels are classified as intermediate hazard with some scattered high hazard areas.

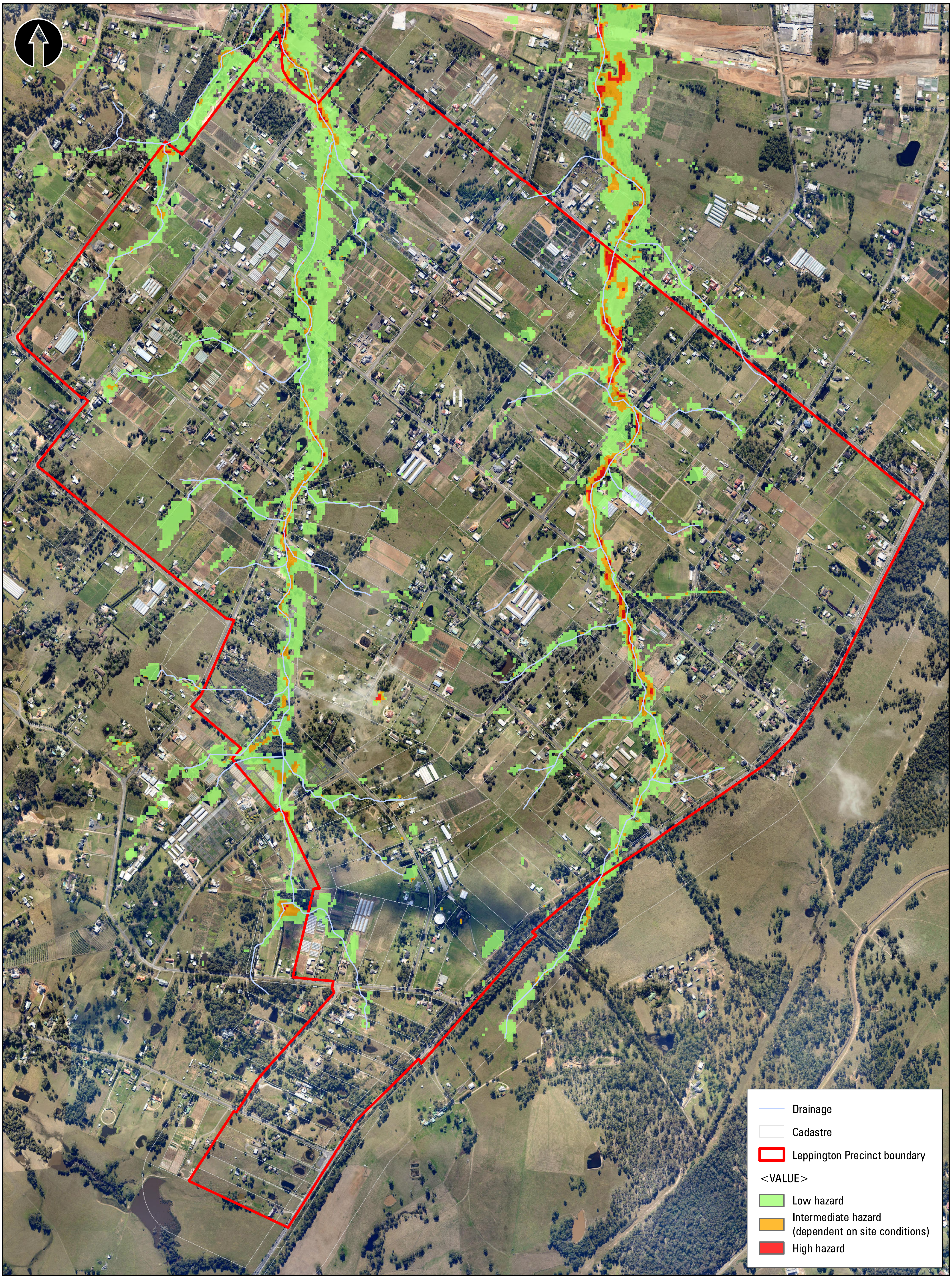
The WMA Water flood study mapped the provisional hazard for Kemps and Scalabrini Creeks. The hazard maps looks very similar with a majority of Kemps and Scalabrini Creeks classified as low hazard with parts of the channel classified as high hazard. This difference could be based on the conservative assumption that areas of intermediate hazard are considered provisional high hazard until otherwise confirmed.

The categorisation is provisional in nature because it is solely based on hydraulic parameters at this stage. Other factors relating to public safety need to be taken into account before the true hazard can be confirmed.

True hazard ratings and hydraulic categories will be presented in the Camden Council FRMS&P currently in progress. Flood parameters that will be used to assess the true hazard of Leppington Precinct include – timing to flood peak, duration of inundation, access to high ground, velocities, flood depths, awareness of flooding, access to essential services during the flood emergency, availability of information and dissemination of information on flooding of the Kemps and Scalabrini catchments and visual awareness of an impending flood event.

It was also found that in Section 3.2 of the *Camden Council Flood Risk Management Strategy* it is stated that “even though hazard categories are broken down into high and low hazard for each hydraulic category, talking all issues into account, particularly the limited warning time and generally rapid rise of water levels in the catchments of Camden local government area, that all areas within the floodplain are considered to be high hazard”.

This hazard rating is not intended to sterilise land for any use. Rather it is intended to highlight that any development that occurs in the floodplain should be planned with due attention to the flood related issues and that strict implementation of flood related development controls is essential for the reduction of flood damages (Camden Council, 2006).



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Editor: GK	Print Date: 5/03/2013
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Projection: Transverse Mercator
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Leppington Precinct Flooding Assessment

Figure 3.5
Provisional hazard 100 year ARI

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3.4 Extent of filling within the flood prone areas

Filling of flood prone land is a preventative measure for minimising and potentially eliminating the flood risk to the raised land. The filling of land affects the temporary storage volume available for the flood waters and may impact the local overland flow paths. The filling of flood prone land should consider these aspects and not result in an increase in flood affectation of any other areas of the floodplain.

Camden Council's Flood Risk Management Policy states that fill operations are not permitted below the 100 year ARI in floodways and flood storage areas. Proposed developments that may involve land forming operations should consider Camden Council's *DCP No, 106 – Land forming operations.*

There is no intention to fill the floodplain in the Leppington Precinct. This is because the floodplain is relatively narrow and development is unlikely to encroach on the floodplain. Also council does not support filing in the 100 year ARI floodplain; only in the flood fringe zone which is very narrow in the precinct. Therefore a flood fill strategy was not developed for the Leppington Precinct.

3.5 Preliminary flood evacuation strategy

3.5.1 Background

A preliminary flood evacuation strategy has been prepared for the Leppington Precinct based on the preliminary sketch of the Draft Leppington ILP of the precinct (Cox, dated 6/6/12, see Appendix C) and on the draft road network produced by AECOM (dated 11/01/13, see Appendix C). Watercourse crossings in the riparian corridor have been identified by AECOM and preliminary sizing and costing was carried out as part of the riparian corridor assessment (PB, 2013).

Camden Council's *Flood Risk Management Policy* states that the current *Australian Rainfall and Runoff* (EA, 1987) addresses the issue of safety and associated with urban drainage. "To prevent pedestrians being swept along streets and other drainage paths during major storm events, the product of velocities and depths in streets and major flow paths should generally not exceed 0.4 m^2/s. Where vehicles alone are affected, a higher depth-velocity product, 0.6 or 0.7 m^2/s depending on vehicle size is appropriate."

The strategy presents safe flood evacuation routes in the PMF flood event and considered pedestrian and vehicle stability using the following depth times velocity criteria outlined in Table 3.1 below (in contrast, the velocity-depth relationships that define unsafe wading and vehicle instability presented in the NSW Floodplain Development Manual do not indicate constant D.V relationships, but do place upper bounds on both depth (0.8 m) and velocity (2.0 m/s) for people to wade safely). Similar criteria were used for the Austral and Leppington North precincts flooding assessment (Cardno, 2011) and are consistent with Camden Council's policy.

Table 3.1 Velocity times depth criteria for pedestrian and vehicular stability

Velocity x depth	Description of criteria
≤ 0.4 m^2/s	Limit of stability for pedestrians
0.4 - 0.6 m^2/s	Unsafe for pedestrians but safe for vehicles if overland flood depths do not exceed 0.3m
> 0.6 m^2/s	Limit of stability for vehicles

It should be noted that there have since been updates to Australian Rainfall and Runoff as part of the revision project. *Project 10 Appropriate safety criteria for people* (EA, 2010) provides guidance on pedestrian and vehicular stability in floods and states that the current criteria is based on studies undertaken in the 1970s. The aim of the update is to collate a number of studies that have been undertaken over the last 40 years and develop guidelines for authorities. Updated depth and velocity criteria have been developed for different categories/age groups of the public and are found in Table 3.2 over the page.

Table 3.2 Flow hazard regimes – updated AR&R

<table>
<tr><th>DV (m^2s^{-1})</th><th>Infants, small children (H.M ≤ 25) and frail/older persons</th><th>Children (H.M = 25 to 50)</th><th>Adults (H.M > 50)</th></tr>
<tr><td>0</td><td>Safe</td><td>Safe</td><td>Safe</td></tr>
<tr><td>0 – 0.4</td><td rowspan="5">Extreme Hazard; Dangerous to all</td><td>Low Hazard[1]</td><td rowspan="2">Low Hazard[1]</td></tr>
<tr><td>0.4 – 0.6</td><td>Significant Hazard; Dangerous to most</td></tr>
<tr><td>0.6 – 0.8</td><td rowspan="3">Extreme Hazard; Dangerous to all</td><td>Moderate Hazard; Dangerous to some[2]</td></tr>
<tr><td>0.8 – 1.2</td><td>Significant Hazard; Dangerous to most[3]</td></tr>
<tr><td>> 1.2</td><td>Extreme Hazard; Dangerous to all</td></tr>
</table>

[1] Stability uncompromised for persons within laboratory testing program at these flows (to maximum flow depth of 0.5 m for children and 1.2 m for adults and a maximum velocity of 3.0 ms^{-1} at shallow depths).
[2] Working limit for trained safety workers or experienced and well equipped persons (D.V < 0.8 m^2s^{-1})
[3] Upper limit of stability observed during most investigations (D.V > 1.2 m^2s^{-1})

(Source: Engineers Australia, 2010)

Final evacuation routes will be informed by the Council's FRMS&P which is currently being undertaken. Road formation levels have not been designed at this stage of precinct planning so the evacuation strategy is preliminary and will need to be revised once road designs are completed. It is recommended that the final hazard and hydraulic categorisation be confirmed and updated if required on completion of the FRMS&P. The updates to AR&R (Table 3.2 above) should be consulted when finalising pedestrian and vehicular stability.

Once the ILP for the Leppington Precinct has been finalised, the location of community centres, final road layout design and flood immunity of road crossings should be considered for the final flood evacuation strategy developed as part of the FRMS&P by Council.

3.5.2 Flood evacuation routes

Leppington Precinct is traversed by Kemps and Scalabrini Creeks which flow in a northerly direction and are tributaries of the South Creek catchment. Leppington Precinct is contained within the upper parts of Kemps and Scalabrini catchments.

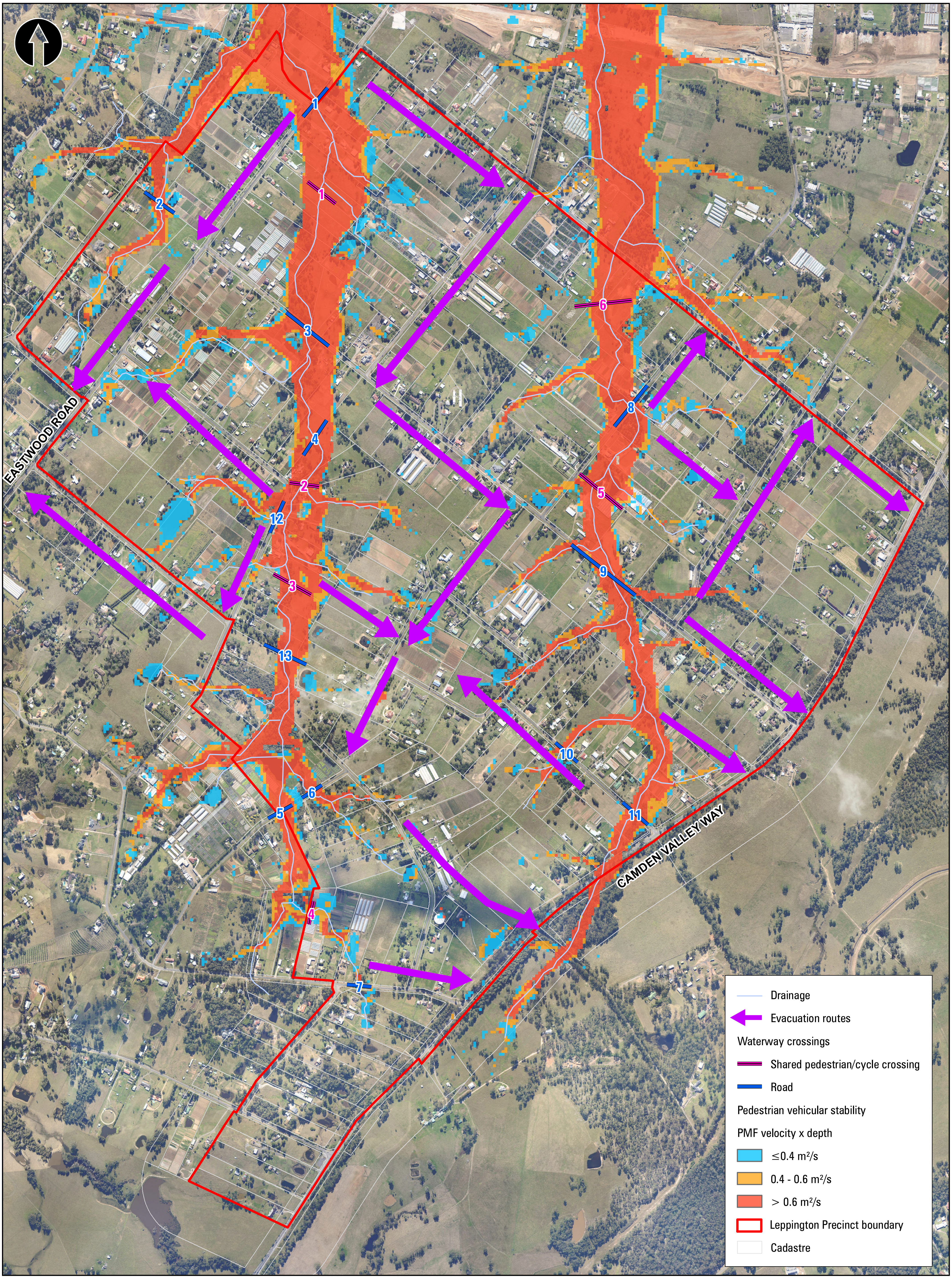
Figure 3.6 shows preliminary flood evacuation routes for the Leppington Precinct based on proposed road crossings identified for the draft road network produced by AECOM (see Appendix C). Whilst the evacuation strategy will only be required for the 1 in 500 year ARI flood (Camden Growth Centre Precincts DCP) the exercise was undertaken using the PMF to demonstrate preliminary flood evacuation routes. The development of safe evacuation routes takes into consideration pedestrian and vehicular safety based on the criteria mentioned in Section 3.5.1 above.

During a major flood event residents located within the PMF zone will need to be evacuated to safer areas. The aim of the evacuation would be to get everyone away from the flood zone and to higher ground and avoid crossing the floodplain. Figure 3.6 shows that much of the waterways in the Leppington Precinct have velocity and depth products in excess of $0.6m^2/s$ for the PMF event and are unsafe for pedestrians or vehicles to cross. During a major flood event, residents should move southwards, towards the upper parts of the catchment. Evacuation routes should be in parallel with the creeks as shown in Figure 3.6.

Camden Valley Way is to be upgraded and therefore will be a key evacuation route for the Precinct as well as the South West Growth Centre. Residents on the eastern side of the Precinct (east of Scalabrini Creek) should move eastwards towards Camden Valley Way. Residents situated in the middle of the precinct between the two creeks should move southwards and on to George Rd that links to the Camden Valley Way. The creek crossing of Bringelly Road over Scalabrini Creek should be avoided unless flood immunity of this road can be confirmed. Residents in the west of the Precinct should move westward and southward towards Eastwood Road which runs between the Kemps Creek catchment and the South Creek catchment. Eastwood Road then intersects with George Rd and links to Camden Valley Way in the east.

It is recommended that several of the proposed creek crossings are to be above the 500 year ARI flood level in order to provide safe evacuation routes, such as crossing number 10 and crossing number 7 (see Figure 3.6).

Council's *Flood Risk Management Policy* requires that all developments within flood prone land requires the demonstration that effective warning time and reliable safe flood access is available in the event of a major flood. Depth of floodwater over vehicular access routes and the safe and stable movement of vehicles up to and including the PMF event should be analysed.



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Editor: GK	Print Date: 11/03/2013
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Leppington Precinct Flooding Assessment

Figure 3.6
Flood evacuation routes in PMF

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3.6 Assessment of climate change impacts

Floodplain management decisions with respect to climate change predictions should follow a risk management process. As discussed in the Floodplain Risk Management Guideline: Practical Consideration of Climate Change (DECC, 2007) and the Flood Risk Management Guide, Incorporating sea level rise benchmarks in flood assessments (DECCW, 2010) the level of risk associated with the climate change predictions is dependent on the location.

For this assessment the Kemps and Scalabrini Creeks will not be affected by any predicted changes in sea level rise so only predicted changes to rainfall need to be considered. Including the predicted changes to flood behaviour as a result of climate change in the flood planning level and flood prone land zones will be the best long term way of managing the potential change in flood risk. Table 3.3 below summarises the climate change impacts predicted by the WMA Water (2011) study. It was found that peak flood levels are not overly sensitive to a 10 – 20% increase in rainfall intensity. Flood level increases at key crossing locations were found to be less than 100mm. The largest increases in peak flood level for the worst case climate change scenario (30% in rainfall intensity) were found to be 110mm at key crossing locations.

Table 3.3 Climate change impacts

Location	Base 100 yr ARI-2hr peak flood level (mAHD)	Climate change: 10% increase – difference (m)	Climate change: 20% increase – difference (m)	Climate change: 30% increase – difference (m)
Scalabrini Creek –DS Bringelly Rd	73.08	0.02	0.04	0.08
Scalabrini Creek –US Bringelly Rd	73.70	0.06	0.09	0.11
Kemps Creek – DS Bringelly Rd	74.13	0.03	0.06	0.09
Kemps Creek – US Bringelly Rd	74.25	0.03	0.06	0.09
US McCann Rd	79.69	0.01	0.03	0.04
US Eastwood Rd	79.49	0.04	0.07	0.10
US Heath Rd	84.79	0.01	0.03	0.07
Back of 146B Dickson Rd	76.37	0.04	0.07	0.11

US Ingleburn Rd	81.56	0.03	0.05	0.08
US Rickard Rd	85.01	0.04	0.07	0.11

(Source: adapted from Table 10 of WMA Water, 2011)

Climate change scenarios were also run for this flood assessment in order to more closely assess the change in flood behaviour as a result of a 10%, 20% and 30% increase in rainfall intensity, to expand on the available information from the WMA Water Flood Study. The WMA Water hydraulic model and direct rainfall files were utilised to assess climate change impacts in more detail. The results from the climate change model runs undertaken for this flooding assessment are summarised in this section.

Results grid analysis was undertaken for the climate change scenarios. It was found that the climate change impacts will not have a significant impact on flood behaviour, as concluded by WMA Water (2011) and presented in Table 3.3 above. In particular the following was observed:

- There was an increase in flood levels for the 30% increased rainfall scenario of up to 220mm; however, this was only found in small scattered pockets of the flood zone
- Increases in velocities for the 30% increased rainfall scenario were less than 0.2 m/s above the base case 100 year ARI velocities.
- Existing floodways are widened in the 30% increased rainfall scenario due to more areas of the channel having a depth and velocity product in excess of 0.25 m^2/s.
- The increase in rainfall intensity produces a corresponding increase in flood levels and velocities. These changes then cause an increase in the extent of the flood hazard within the precinct. The change in hazard is not likely to affect the high hazard areas but there may be a change for some areas from low to high hazard.
- As discussed in the Floodplain Risk Management Guideline: Practical Consideration of Climate Change (DECC, 2007), the increase in rainfall intensity will change the recurrence interval of rainfall from the current predicted recurrence. This means that severe rainfall events would become more frequent and therefore increase the frequency of inundation at the site. Flooding at the site occurs over a relatively short period of time so the increase in frequency can only be managed through appropriate planning restrictions on development of flood prone land.

The flood planning areas shown in Figure 3.1 and Figure 3.2 have been based on the 100 year ARI flood event plus 500mm freeboard. Generally, flood levels in the Precinct do not tend to increase significantly under climate change conditions and the flood planning level including the 500mm freeboard is sufficient to accommodate increased flood levels due to climate change. The FRMS&P currently being prepared will provide further discussion and recommendations in relation to FPLs and climate change allowances.

3.7 Summary of flood planning criteria

Table 3.4 below summarises the flood related planning criteria that should be adopted in the development of the ILP for the Leppington Precinct.

Table 3.4 Flood planning criteria

Flood management item	Risk management measure	Details
Flood planning level	Set FPL at 100 year ARI plus 500mm freeboard to reduce inundation of buildings during extreme events	Camden Growth Centres Development Control Plan
Flood compatible development zones	Assign appropriate land uses to flood hazard zones to reduce flood risks to community but not sterilise the land	Mapping, precinct plan
Flood hydraulic and hazard zones	Define flood hydraulic and hazard zones to enable appropriate risk management of the floodplain	Mapping
Flood evacuation routes during major flood events	Manage the risk of flooding by being prepared with an evacuation strategy	Preliminary flood evacuation strategy
Climate change predictions of an increase in rainfall intensity	The FPL to be used as the base case for planning restrictions since the freeboard is sufficient to account for climate change impacts	Mapping

4. Conclusion

In conclusion, the WMA Water flood model was used to supplement the range of flood events modelled so that a full suite of flood maps and information is available for planning purposes in the Leppington Precinct. This flood assessment modelled lower order events for Kemps Creek and Scalabrini Creek using the TUFLOW model developed by WMA Water. Using the results from the WMA Water Flood Study and this flood assessment, a series of flood maps was generated. It was found that flood extents for the Kemps and Scalabrini Creek generally follow the creek network with a small number of overland flow paths identified for the PMF flood event.

Controls on development within flood prone areas have been identified and the flood planning level set in the Camden Growth Centres Development Control Plan should be adopted for the Leppington Precinct since this will be consistent across all precincts of the South West Growth Centre. The provisional hydraulic and hazard categorisation together with flood extent mapping should be used to inform future re-zoning of land for the precinct. The FRMS&P should be consulted once it becomes available as it will contain more detailed flood extents, and full hydraulic and flood hazard categories.

5. References

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Cardno (2011), Austral and Leppington North Precincts Riparian Corridor and Flooding Assessment – Main Report, July 2011, prepared for NSW Department of Planning and Infrastructure.

Appendix A

Direct rainfall calculations

Table A. 1 Design rainfall depths for various ARI and durations – Bringelly at Upper South Creek

DURATION	1 Year	2 years	5 years	10 years	20 years	50 years	100 years
5Mins	76	98.2	127	145	167	196	219
6Mins	71.1	91.9	119	135	156	184	205
10Mins	58.1	75	97.3	110	127	150	167
20Mins	42.4	54.7	70.9	80.3	92.7	109	121
30Mins	34.4	44.4	57.5	65.2	75.2	88.3	98.4
1Hr	23.2	30	38.8	43.9	50.7	59.6	66.3
2Hrs	15.1	**19.5**	**25.2**	28.5	**32.9**	38.6	43
3Hrs	11.6	15	19.4	21.9	25.3	29.7	33
6Hrs	7.42	9.56	12.3	14	16.1	18.8	21
12Hrs	4.76	6.14	7.93	8.97	10.3	12.1	13.5
24Hrs	3.08	3.97	5.16	5.85	6.76	7.95	8.86
48Hrs	1.95	2.53	3.31	3.77	4.38	5.18	5.78
72Hrs	1.45	1.88	2.47	2.83	3.28	3.89	4.35
TOTAL RAINFALL (2hr duration)		**39.0**	**50.4**	**57.0**	**65.8**	**77.2**	**86.0**

(Source: WMA Water, 2011, p16)

Table A.2 Temporal pattern and direct rainfall input calculations

Time (mins)	Time (hrs)	% Rain	2 year 2hr	5 year 2hr	20yr 2hr
0	0	0	0	0	0
5	0.0833	2.2%	0.858	1.1088	1.4476
10	0.1667	5.3%	2.067	2.6712	3.4874
15	0.2500	3.1%	1.209	1.5624	2.0398
20	0.3333	4.9%	1.911	2.4696	3.2242
25	0.4167	9.6%	3.744	4.8384	6.3168
30	0.5000	5.2%	2.028	2.6208	3.4216
35	0.5833	18.0%	7.02	9.072	11.844
40	0.6667	12.4%	4.836	6.2496	8.1592
45	0.7500	5.6%	2.184	2.8224	3.6848
50	0.8333	3.1%	1.209	1.5624	2.0398
55	0.9167	3.3%	1.287	1.6632	2.1714
60	1.0000	4.2%	1.638	2.1168	2.7636
65	1.0833	4.3%	1.677	2.1672	2.8294
70	1.1667	2.1%	0.819	1.0584	1.3818
75	1.2500	2.2%	0.858	1.1088	1.4476
80	1.3333	3.4%	1.326	1.7136	2.2372
85	1.4167	1.9%	0.741	0.9576	1.2502
90	1.5000	1.2%	0.468	0.6048	0.7896
95	1.5833	1.0%	0.39	0.504	0.658
100	1.6667	2.3%	0.897	1.1592	1.5134
105	1.7500	0.9%	0.351	0.4536	0.5922
110	1.8333	1.3%	0.507	0.6552	0.8554
115	1.9167	1.1%	0.429	0.5544	0.7238
120	2.0000	1.4%	0.546	0.7056	0.9212
125	2.0833	0%	0	0	0
	TOTAL	**100%**	**39.0**	**50.4**	**65.8**

Table A.3 Check of 20 year 2hr calculation with WMA Water direct rainfall input file

Time_R (Hrs)	Rain (20yr 2hr) WMA Water	Rain (20yr 2hr) PB estimation
0	0	0
0.083	1.452	1.4476
0.167	3.498	3.4874
0.25	2.046	2.0398
0.333	3.234	3.2242
0.417	6.336	6.3168
0.5	3.432	3.4216
0.583	11.88	11.844
0.667	8.184	8.1592
0.75	3.696	3.6848
0.833	2.046	2.0398
0.917	2.178	2.1714
1	2.772	2.7636
1.083	2.838	2.8294
1.167	1.386	1.3818
1.25	1.452	1.4476
1.333	2.244	2.2372
1.417	1.254	1.2502
1.5	0.792	0.7896
1.583	0.66	0.658
1.667	1.518	1.5134
1.75	0.594	0.5922
1.833	0.858	0.8554
1.917	0.726	0.7238
2	0.924	0.9212
2.083	0	0
TOTAL	**66.0**	**65.8**

Appendix B

Camden Council Development
Guideline Matrix

FLOOD RISK MANAGEMENT POLICY

GROUND LEVEL OF FLOOD PRONE LAND

OUTER FLOODPLAIN (ABOVE 1% AEP FLOOD LEVEL TO PMF)

DEVELOPMENT CONTROL CONSIDERATION	SUBDIVISION	RESIDENTIAL	MINOR RESIDENTIAL ADDITIONS	COMMERCIAL OR INDUSTRIAL	RURAL (NON URBAN)	OPEN SPACE/RECREATION	CRITICAL UTILITIES & PUBLIC FACILITIES
FLOOR LEVEL		1	2	1,3	1		
GROUND LEVEL	1,2,3	3			2,3	3	
STRUCTURAL SOUNDNESS		1	1	1	1	1	
EVACUATION & ACCESS	2,3	1,2		1,2,3	1,2		
FLOOD AFFECTATION	2	2	2	2	2	2	
FLOOD AWARENESS	1,2	1,2	2,3	1,2	1,2	2	
BUILDING MANAGEMENT	4			4			

FLOOD FRINGE (UP TO THE 1%AEP FLOOD LEVEL)

DEVELOPMENT CONTROL CONSIDERATION	SUBDIVISION	RESIDENTIAL	MINOR RESIDENTIAL ADDITIONS	COMMERCIAL OR INDUSTRIAL	RURAL (NON URBAN)	OPEN SPACE/RECREATION	CRITICAL UTILITIES & PUBLIC FACILITIES
FLOOR LEVEL		1	1,2	1,3	1,2		
GROUND LEVEL	1,2,3	3			3	3	
STRUCTURAL SOUNDNESS		1	1	1	1	1	
EVACUATION & ACCESS	1,2,3	1,2		1,2,3	1,2	2	
FLOOD AFFECTATION	1,2,3	1,2	1,2	1,2	1,2	1,2	
FLOOD AWARENESS	1,2	1,2	2,3	1,2	1,2	2	
BUILDING MANAGEMENT	4	1,2,3		1,2,3,4	1,2,3	3,4	

FLOOD STORAGE (UP TO THE 1%AEP FLOOD LEVEL)

DEVELOPMENT CONTROL CONSIDERATION	SUBDIVISION	RESIDENTIAL	MINOR RESIDENTIAL ADDITIONS	COMMERCIAL OR INDUSTRIAL	RURAL (NON URBAN)	OPEN SPACE/RECREATION	CRITICAL UTILITIES & PUBLIC FACILITIES
FLOOR LEVEL		1	1,2	1,3	1,2		
GROUND LEVEL	1,2,3	3			3	3	
STRUCTURAL SOUNDNESS		1	1	1	1	1	
EVACUATION & ACCESS	1,2,3	1,2		1,2,3	1,2	2	
FLOOD AFFECTATION	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3	
FLOOD AWARENESS	1,2	1,2	2,3	1,2	1,2	2	
BUILDING MANAGEMENT	4	1,2,3		1,2,3,4	1,2,3	3,4	

FLOODWAY (UP TO THE 1%AEP FLOOD LEVEL)

DEVELOPMENT CONTROL CONSIDERATION	SUBDIVISION	RESIDENTIAL	MINOR RESIDENTIAL ADDITIONS	COMMERCIAL OR INDUSTRIAL	RURAL (NON URBAN)	OPEN SPACE/RECREATION	CRITICAL UTILITIES & PUBLIC FACILITIES
FLOOR LEVEL			1,2		1,2		
GROUND LEVEL					3	3	
STRUCTURAL SOUNDNESS			1		1	1	
EVACUATION & ACCESS					1,2	2	
FLOOD AFFECTATION			1,2,3		1,2,3	1,2,3	
FLOOD AWARENESS	1,2	1,2	2,3	1,2	1,2	2	
BUILDING MANAGEMENT					1,2,3	3,4	

NOT RELEVANT

UNSUITABLE LAND USE

FLOOR LEVEL

1	Habitable floor levels are to be equal to or greater than the FPL. The FPL is the 1% AEP flood event level plus a freeboard of 600mm. See glossary for definitions of habitable rooms for residential/industrial/commercial situations
2	Notwithstanding the provisions of (1), Council may permit a once only minor addition of habitable floor area of up to 30m² of habitable floor area to an existing dwelling that has been lawfully constructed providing the work must not increase the number of bedrooms within the dwelling. A minor addition shall be allowed at the same level as the existing ground floor level of the dwelling. Council may consider applications for major additions of greater than 30m² providing the work must not increase the number of bedrooms within the dwelling. For a major addition the requirements of RESIDENTIAL apply, as well as Section 4.5 of this Policy.
3	Notwithstanding the provisions of (1), Council may approve additions to existing flood liable industrial/commercial buildings, allowing habitable floor levels below the FPL. The applicant must demonstrate that all practical measures will be taken to minimise the impact of flooding. In determining such an application, Council will assess the application on a merits based approach with consideration to nature of business, frequency and depth of flooding and whether the raising of floor levels will be out of character with adjacent land uses or streetscapes.

GROUND LEVEL

1	All allotments in future subdivisions are to be a minimum of 300mm above the 1% AEP flood level.
2	For rural residential subdivisions, all proposals must nominate a building envelope which is a minimum of 300mm above the 1% AEP flood level. The building envelope must have a minimum area of 500m² and a minimum one way dimension of 15m, suitable for the erection of a dwelling. The building envelope, and access from the road, must be free of any site constraints such as mainstream flood affectation, local overland flow paths, required sewage and stormwater disposal areas, setbacks and significant trees/vegetation.
3	Where on-site sewerage management systems are to be installed and operated, no portion of the sewerage management system (ie treatment tanks, pumps, etc) is permitted below the 1% AEP flood level. No portion of the irrigation area, absorption or evapo-transpiration area is permitted to be located below the 5% AEP flood level or within 40m of the top of bank of a watercourse.

STRUCTURAL SOUNDNESS

1	Engineers report required to prove that any portion of a structure can withstand the force of flood water, debris and buoyancy, up to and including the PMF flood event.

EVACUATION & ACCESS

1	Reliable safe access for pedestrians and vehicles required during the PMF flood event.
2	Consideration required regarding an appropriate flood evacuation strategy and pedestrian/vehicular access route during a flood event up to the PMF. In the case of amenities building, which are not used for any storage or which will not have any valuable chattels permanently located in them, this consideration will not apply.
3	The evacuation route from land above the 1% AEP flood level in each proposed allotment in future subdivisions must be contiguous to land not lower than the PMF flood level so as to allow evacuation in extreme events.

FLOOD AFFECTATION

1	Engineers report required to prove that the proposed development will not adversely increase flood affectation elsewhere
2	The impact of the proposed development on flooding elsewhere is to be considered
3	No net reduction in flood storage below the 1% AEP flood level

FLOOD AWARENESS

1	Restrictions to be placed on title advising of flood planning levels (floor level) required relative to the 1% AEP flood level
2	S149 certificates to notify affectation by the PMF flood
3	Restrictions to be placed on title advising that a once only addition of habitable area has been undertaken and no further addition of habitable floor area will be permitted.

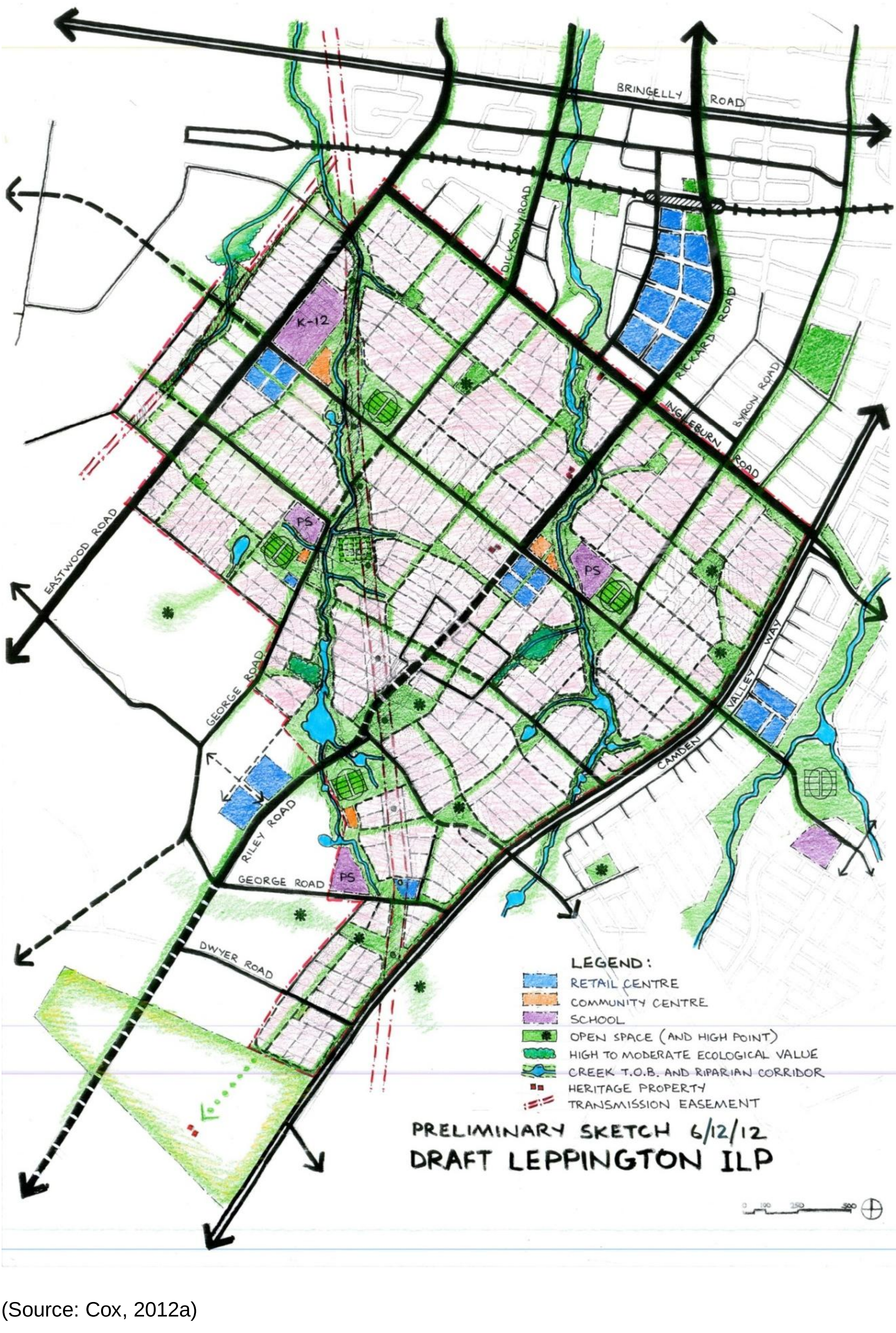
BUILDING MANAGEMENT

1	Flood management plans are required where floor levels are below the FPL.
2	Applicant to demonstrate that there are adequate storage areas are available for hazardous materials and valuable goods and equipment at or above the FPL.
3	No external storage of material below the 1%AEP flood level which may be hazardous during flood events
4	Applicant to demonstrate that potential development as a consequence of a subdivision proposal can be undertaken in accordance with this policy

Appendix C

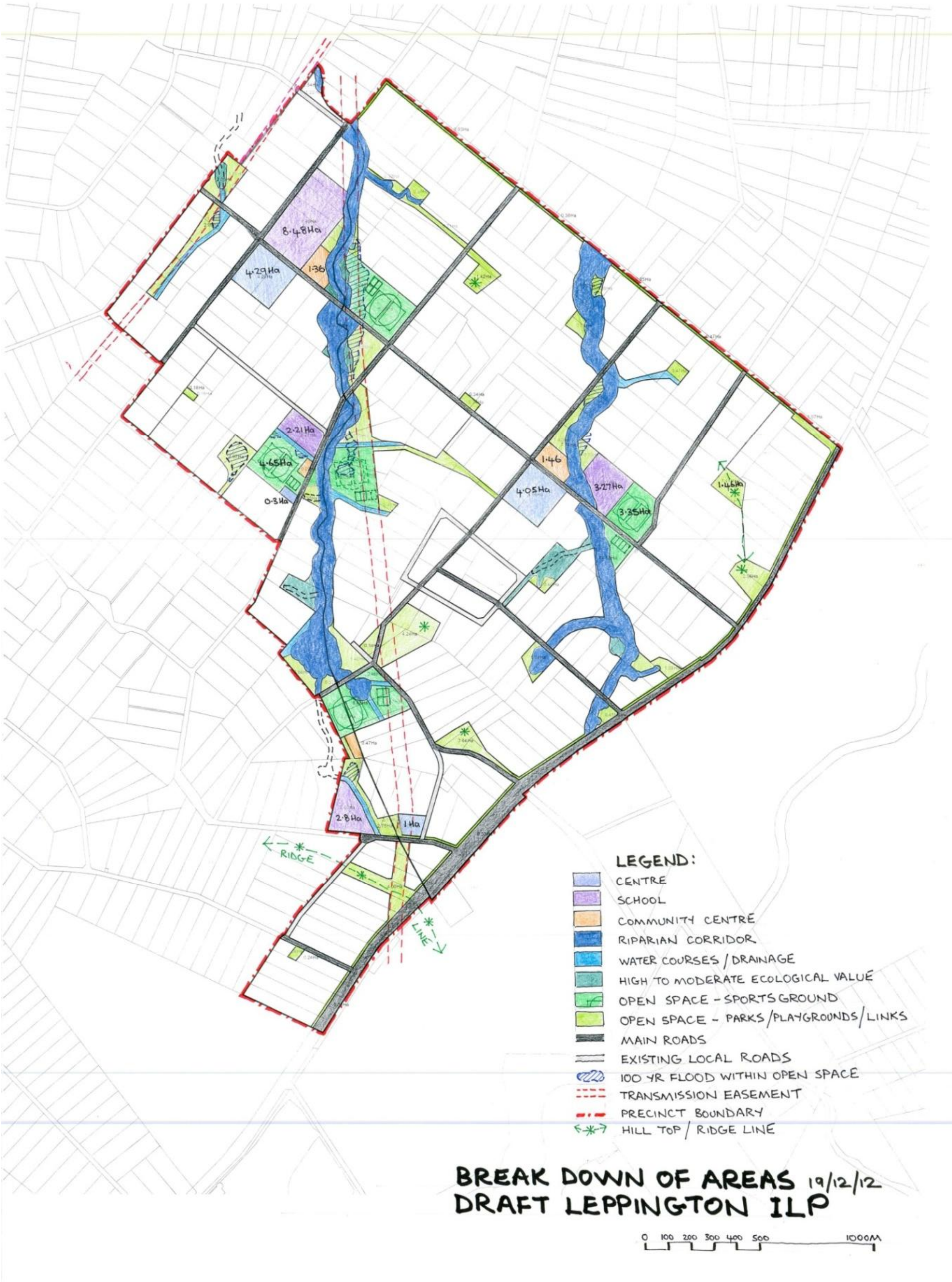
Preliminary draft ILP sketches used for draft assessment

Figure C.1 Preliminary sketch – Draft Leppington ILP dated 6/12/12



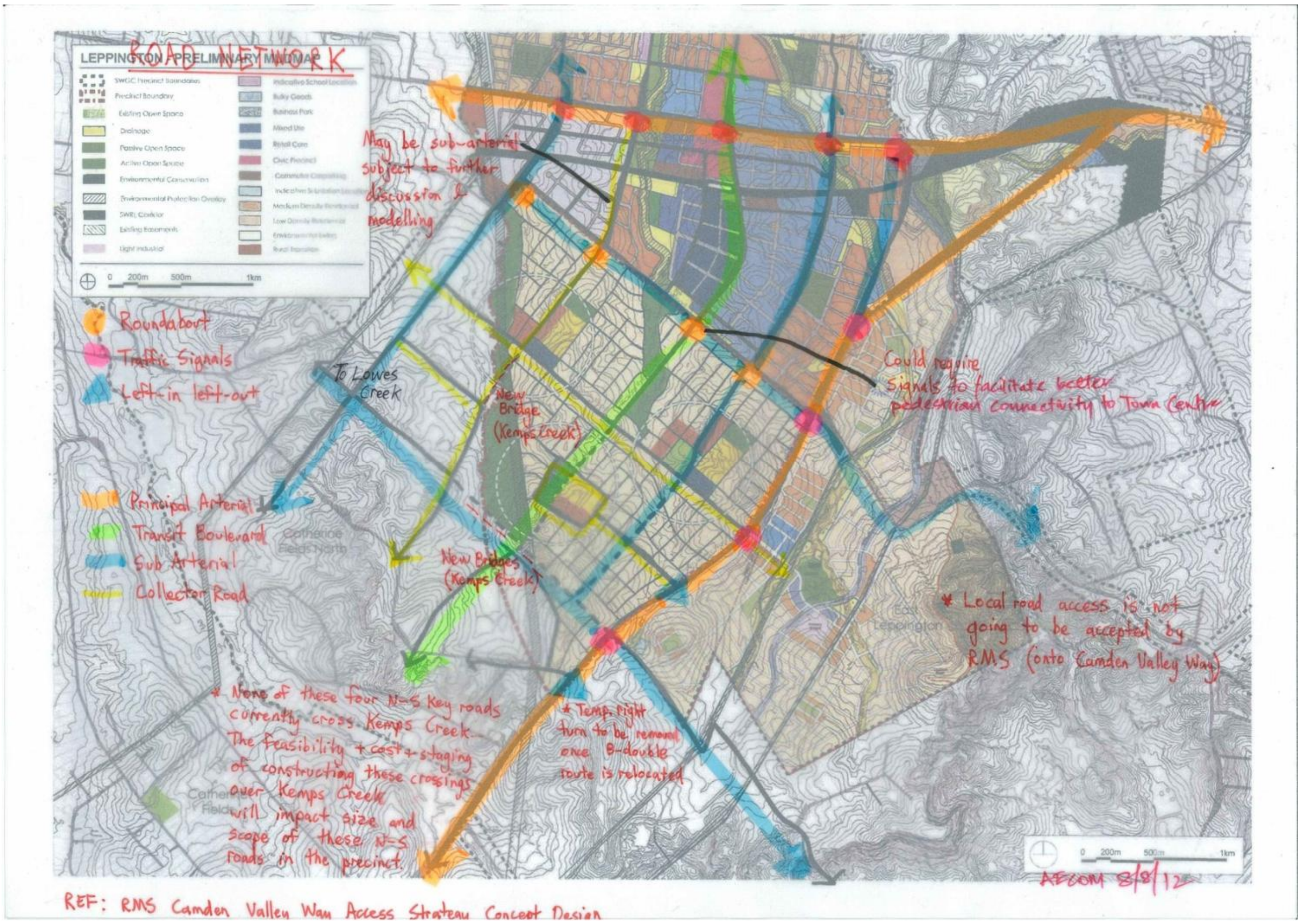
(Source: Cox, 2012a)

Figure C.2 Breakdown of areas – Draft Leppington ILP dated 19/12/12



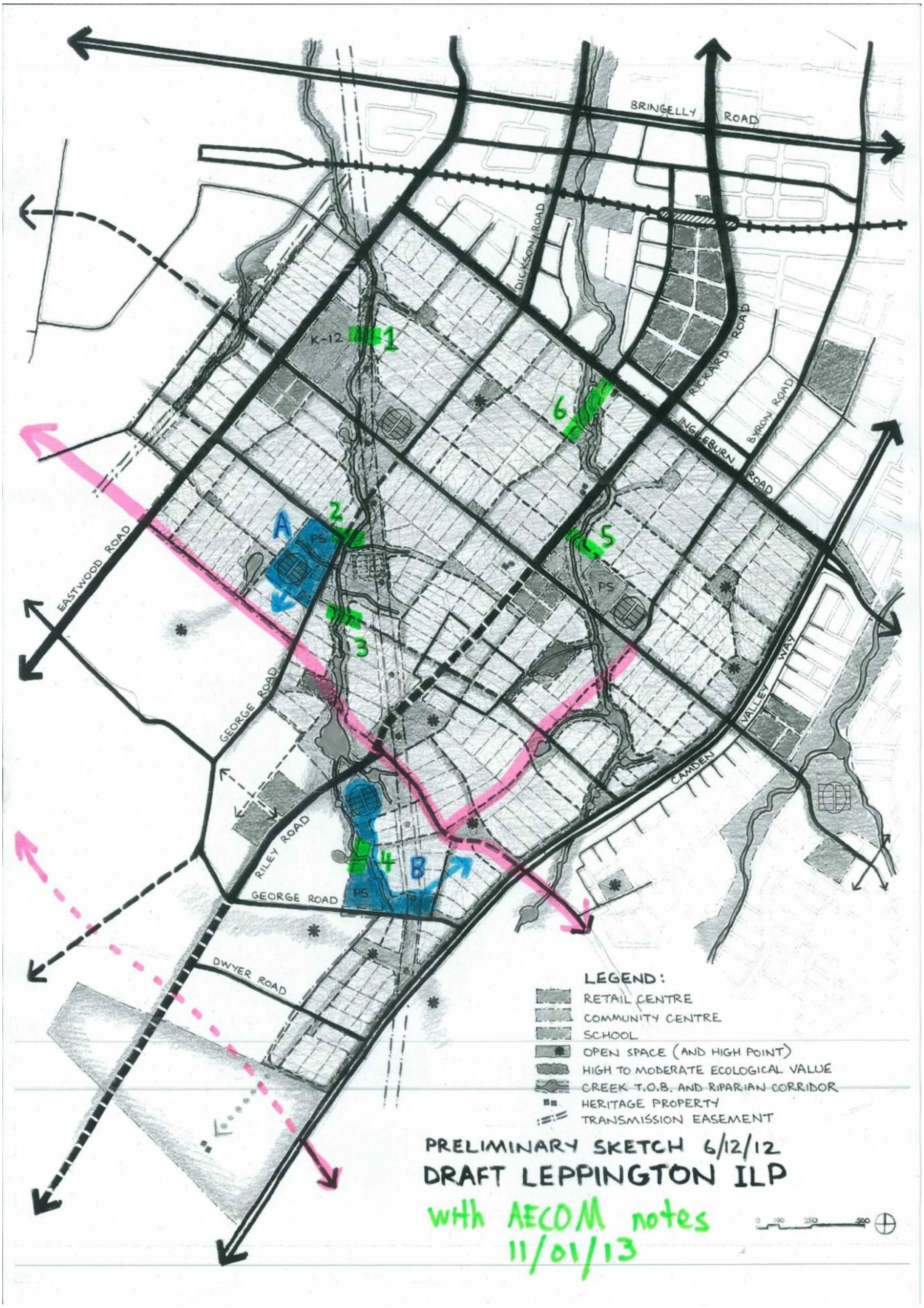
(Source: Cox, 2012b)

Figure C.3 Preliminary sketch – road network dated 16/10/12



(Source: AECOM, 2012a)

Figure C.4 Preliminary sketch – mark-up of shared pedestrian/cycle crossings dated 11/1/13



(Source: AECOM, 2013)