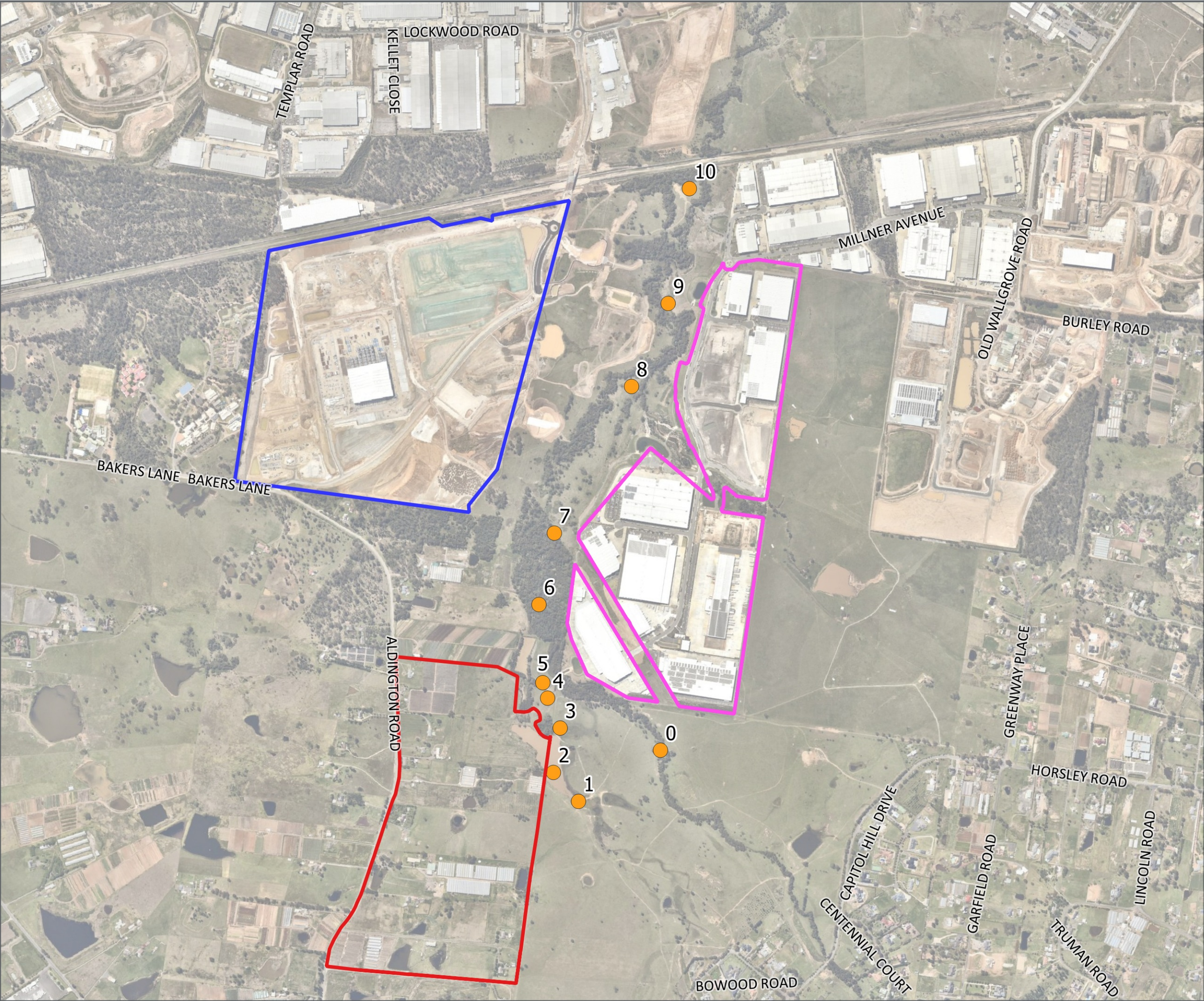




Fife Kemps Creek Pty
Limited

200 Aldington Industrial
Estate

Benchmark
Reference Location

Legend

- Oakdale_West_Study_Area
- Oakdale_South_Study_Area
- 200 Aldington_Study_Area
- Reference Points

FIGURE 21

1:14000 Scale at A3



Cardno

Map Produced by St Leonards Water (AWE)
Date: 2020-10-15 | Project: XXXXXXXX
Coordinate System: MGA Zone 56
Map: FKC Figures.qgz

APPENDIX B

PREVIOUS STUDIES

B.1 1991 South Creek Floodplain Risk Management Study

An overall South Creek Floodplain Risk Management Study was released in February 1991¹. As described by Willing & Partners, 1991:

The need for the floodplain management study has arisen largely as a result of plans for large scale urban developments in the catchment, mainly in the South Creek Valley Sector (SCVS). The principal requirement of the study is to identify and assess works and measures aimed at reducing the impact and losses relating to flooding. This applied to present problems and to the avoidance of problems resulting from future developments in the catchment. Flood problems in the catchment have been highlighted by the occurrence of several large floods in the last four years.

The study addresses:

- the existing flood problem, including the hazards and extent of inundation;*
- water quality and the stream environment, both existing and future;*
- impacts of possible short-term and long-term large scale urban and non-urban development on flood behaviour, and the constraints imposed by flooding on such development;*
- structural and non-structural measures to mitigate the effects of flooding on existing and proposed development;*
- the social and economic effects of floods, including assessment of tangible and intangible damages and the importance of flood preparedness;*
- the environmental impact of any proposed works;*
- trunk drainage, flood mitigation, water quality and environmental parameters to be used as guidelines for future new urban developments;*
- means of implementing, monitoring, co-ordinating and revising the management plan, and recommends the most appropriate means.*

B.2 2006 Penrith Overland Flow Flood "Overview Study"

In 2006 a study was undertaken to generate sufficient information to define flood risk and prioritise flood risk management across the Penrith LGA (Cardno Lawson Treloar, 2006)². The results from this study provide Council with a sound basis upon which to undertake a program of more detailed overland flood studies. This will ultimately lead to a complete Floodplain Risk Management Plan for the LGA.

The study area covers the LGA and was divided into the following three zones:

- Zone 1 – 'Central Urban'
- Zone 2 – 'Northern Rural'
- Zone 3 – 'Southern Rural'.

The majority of the population resides within Zone 1, which also includes the Penrith CBD.

¹ Willing & Partners (1991) South Creek Floodplain Risk Management Study" *Final report*, 2 Vols, prepared for the Department of Water Resources, pp 80 + Apps

² Cardno Lawson Treloar (2006) "Penrith Overland Flow Flood "Overview Study", Report J2453/R2251, Version 4, prepared for Penrith City Council, August

The primary objectives of the study were to:

- Identify, validate and map all major overland flow paths within the Study Area;
- Identify and map sub catchments for all catchments within the Study Area;
- Identify properties at risk of major overland flooding;
- Define local flood behaviour in the Study Area by producing information on flows, flood levels, depth of flows and velocities for the 20 year, 100 year ARI and the PMF events under existing catchment conditions;
- Assess provisional flood hazard for properties at risk from flooding for the 20 year and 100 year ARI events and the PMF; and
- Rank the nominated sub-catchment areas in terms of severity of flooding for further investigations. Council may also consider landuse, known flood affected areas and cost of potential mitigation works when prioritising the sub-catchments.

The above objectives were achieved through detailed hydrological/hydraulic modelling of the entire LGA described in the report. It is to be noted that ranking of the sub-catchments for further investigation was the main objective of the study and the majority of the other objectives were achieved through the process of establishing the sub-catchment rankings.

The mapped extents of overland flow flooding under existing conditions are given in **Figure B-1**. Note the property boundaries are indicative only. It will be noted that the 100 yr ARI flood extent (mainstream flooding) was excluded from the study and do not extend as far upstream in Ropes Creek as the site.

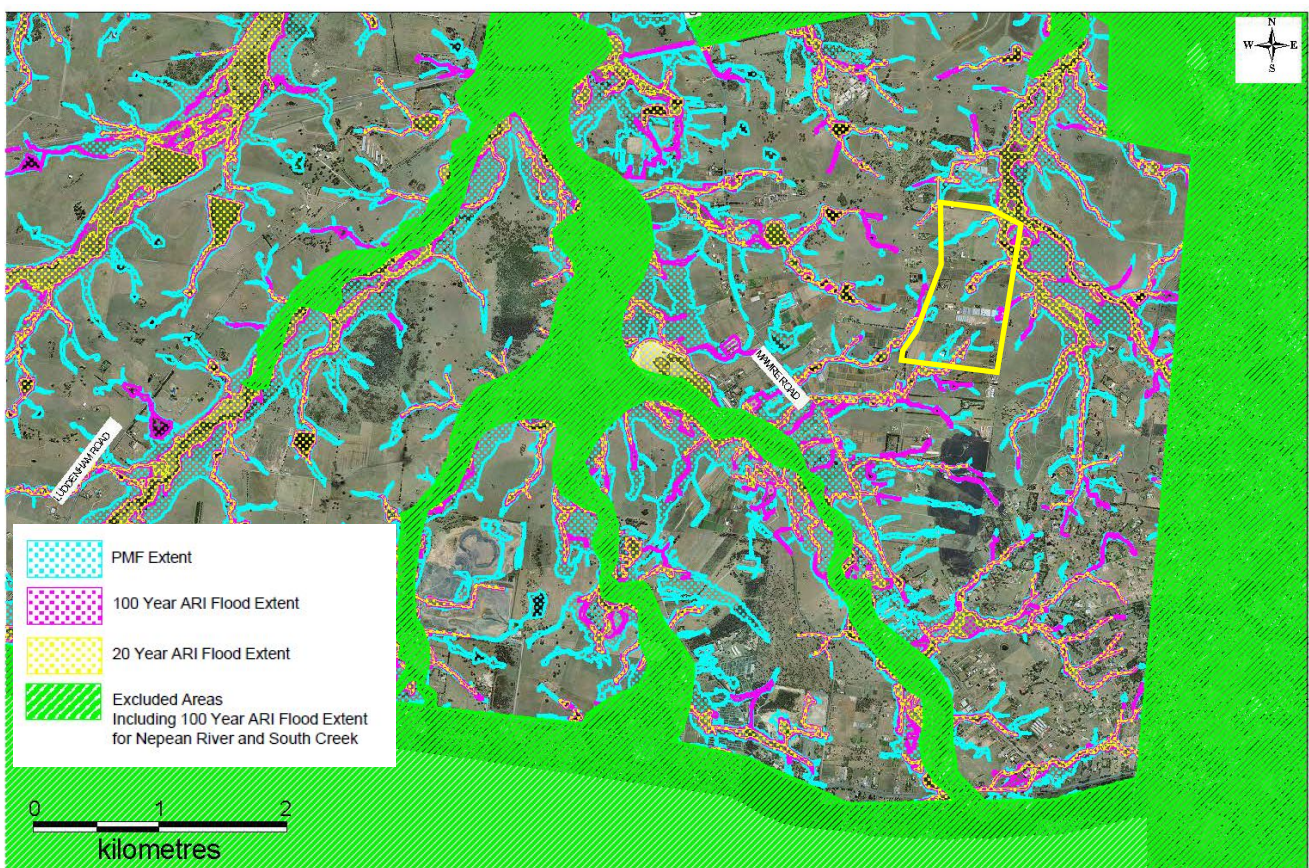


Figure B-1 20 yr ARI, 100 yr ARI and PMF Overland Flow Flood Extents
(after Figure 6.1K, Cardno Lawson Treloar, 2006)

B.2 2008 Ropes Creek Flood Study

In 2008 GHD³ undertook hydrological and hydraulic modelling of the upper Ropes Creek catchment including the overall Oakdale development (shaded green in **Figure B-1**).

Hydrological modelling was undertaken at the catchment and development scale. Results for the catchment hydrological modelling were not included in the 2008 report. Hydraulic modelling was undertaken using a 1D/2D TUFLOW model (refer **Figure B-2**).

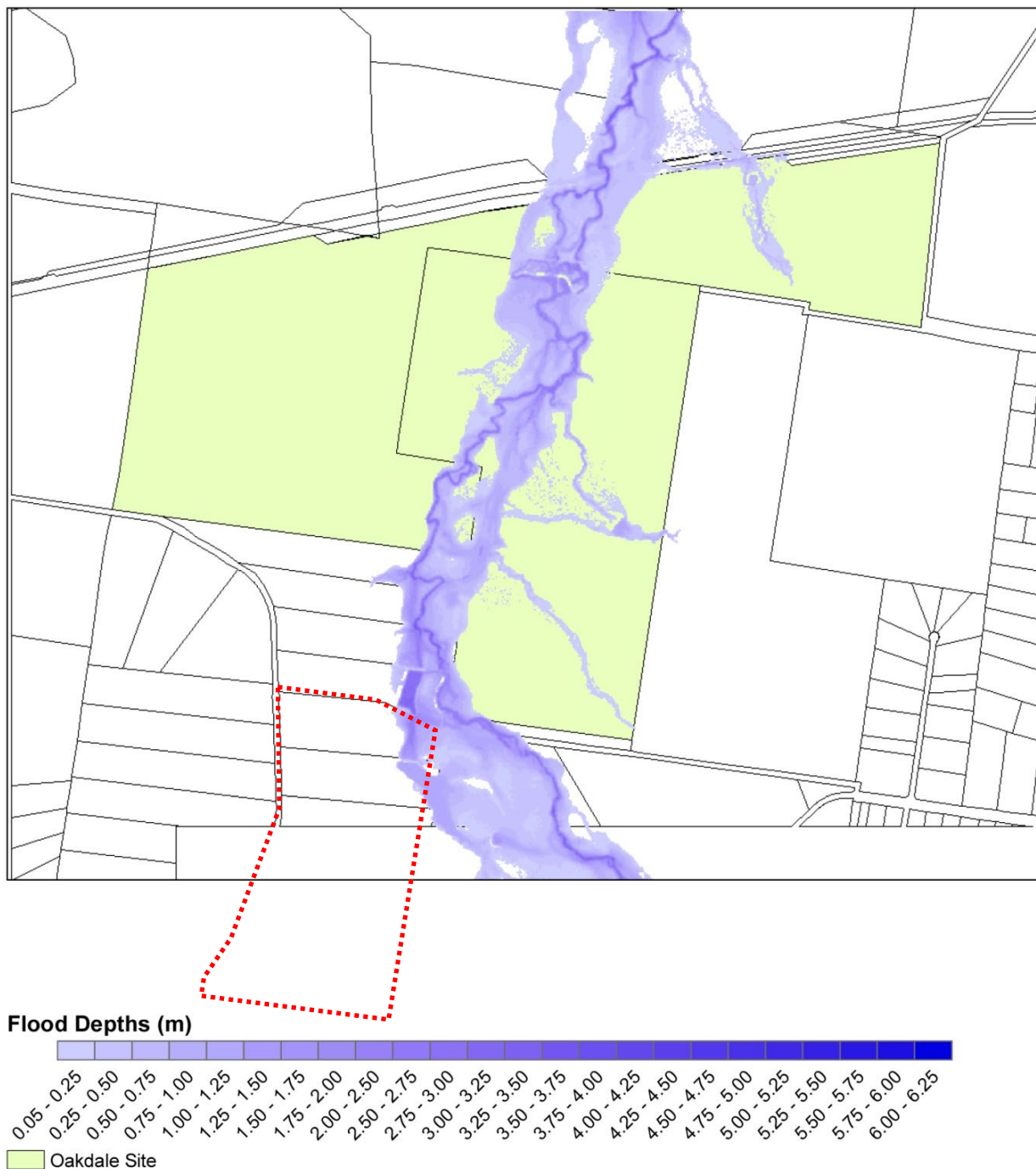


Figure B-2 100 yr ARI Flood Map (Rev A, June 2007) (after GHD, 2008)

³ GHD (2008) "Oakdale Concept Plan, Water Sensitive Urban Design Strategy", *Final Report*, prepared for Goodman International Limited, May, 27 pp + Apps.

An addendum to this report was produced in 2013 as part of the detailed design of Oakdale Central⁴. This report indicated that the adopted 2D grid size was 5 m x 5 m.

B.3 2015 Updated South Creek Flood Study

The Updated South Creek Flood Study was prepared by Worley Parsons Services on behalf of Penrith City Council, acting in association with Liverpool, Blacktown and Fairfield City Councils.

As described by Worley Parsons, 2015⁵:

This flood study covers the South Creek catchment extending from Bringelly Road in the south to the Blacktown/Richmond Road Bridge crossing in the north. The total study area is about 240 km² and lies within the Hawkesbury, Penrith, Blacktown, Liverpool and Fairfield LGAs.

The hydrologic modelling for this study is based on the previous RAFTS (Runoff Analysis and Flow Training Simulation) hydrologic modelling (Version 2.56, 1991) that was developed by the Department of Water Resources for the 'South Creek Flood Study' (1990). As part of this study, the RAFTS model of the South Creek catchment has been updated to Version 6.52 (2005) XPRAFTS.

As part of the current study, the sub-catchment delineation and break-up was compared against the latest topographic data available for the study area to determine whether the sub-catchment boundaries required adjustments.

Some further refinement of subcatchments was undertaken in order to improve the inter-relationship between the XPRAFTS model and the RMA-2 hydraulic flood model. This improved the interconnectivity between the hydrologic and hydraulic models and made possible the creation of additional localised inflows within the RMA-2 model.

The adopted roughness parameters for each sub-catchment were also reviewed against aerial photography in order to determine any changes in vegetation and/or floodplain development that may have occurred since 1990.

Intensity-Frequency-Duration (IFD) data was developed for the study catchment according to the standard procedures outlined in Chapter 2 of 'Australian Rainfall & Runoff – A Guide to Flood Estimation' (1987). Due to the significant spatial extent of the study area, across which numerous local catchments and tributaries apply, a total of nine (9) different IFDs were adopted. As no definitive loss rate data is available for the catchment of South Creek and its tributaries, the adopted rainfall loss rates were based on data contained in the 1990 Flood Study. ...

The validation of the updated XP-RAFTS model was based on a comparison between the peak discharge and hydrograph shape produced by the RAFTS model developed for the 1990 Flood Study and the results of the latest XP-RAFTS model.

⁴ GHD (2013) "S75W Mod 5 Application, Oakdale Stage 1 Ropes Creek Flood Study", *Addendum*, prepared for Goodman International Limited, July, 7 pp + Apps

⁵ WorleyParsons (2015) "Updated South Creek Flood Study", *Final Report*, 2 Vols, prepared for Penrith City Council, acting in association with Liverpool, Blacktown and Fairfield City Councils, 74 pp + Apps

In order to undertake validation of the model, the updated XP-RAFTS model was used to simulate the 100 year ARI storm with a critical storm duration of 36 hours.

Since completion of the 1990 Flood Study, there have been many changes occur across the South Creek catchment. These changes include the implementation of a number of measures recommended in the South Creek Floodplain Management Study, including works upstream of Elizabeth Drive, at Overett Avenue, and at South St Marys. Major development of the ADI site at St Marys and small areas on the fringe of Erskine Park has also occurred. Changes have also occurred to areas of the floodplain including the construction of levees and earthworks that have the potential to alter flooding patterns.

Accordingly, a two-dimensional hydrodynamic model of the South Creek system has been developed using the RMA-2 software package. The model is based on the latest topographic data for the catchment, which was derived from Light Detection and Ranging (LiDAR) data that was gathered for the entire South Creek floodplain between 2002 and 2006. ...

.... The computer models identified in Sections 4 and 5 were used to derive design flood estimates for the 20, 50, 100, 200 and 500 year recurrence floods as well as an Extreme Flood.

The calculated 1% AEP and PMF flood depths and velocities in the vicinity of Lots 31 & 32, Aldington Road, Kemps Creek are plotted in **Figures B-3** and **B-4** respectively.

The mapped 1% AEP hydraulic categories in the vicinity of Lots 31 & 32, Aldington Road, Kemps Creek are plotted in **Figure B-5**.

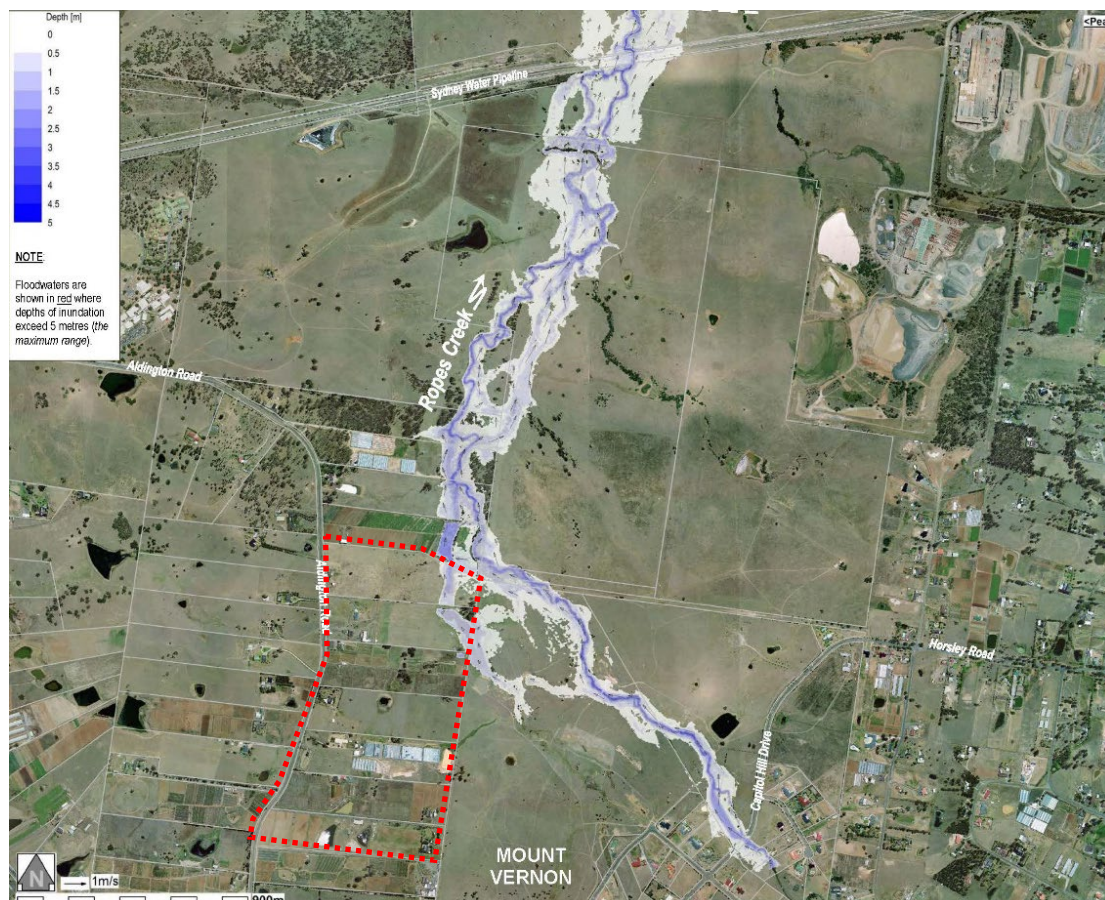


Figure B-3 1% AEP Flood Depths and Velocities (after Figure 6.120, Worley Parsons, 2015)

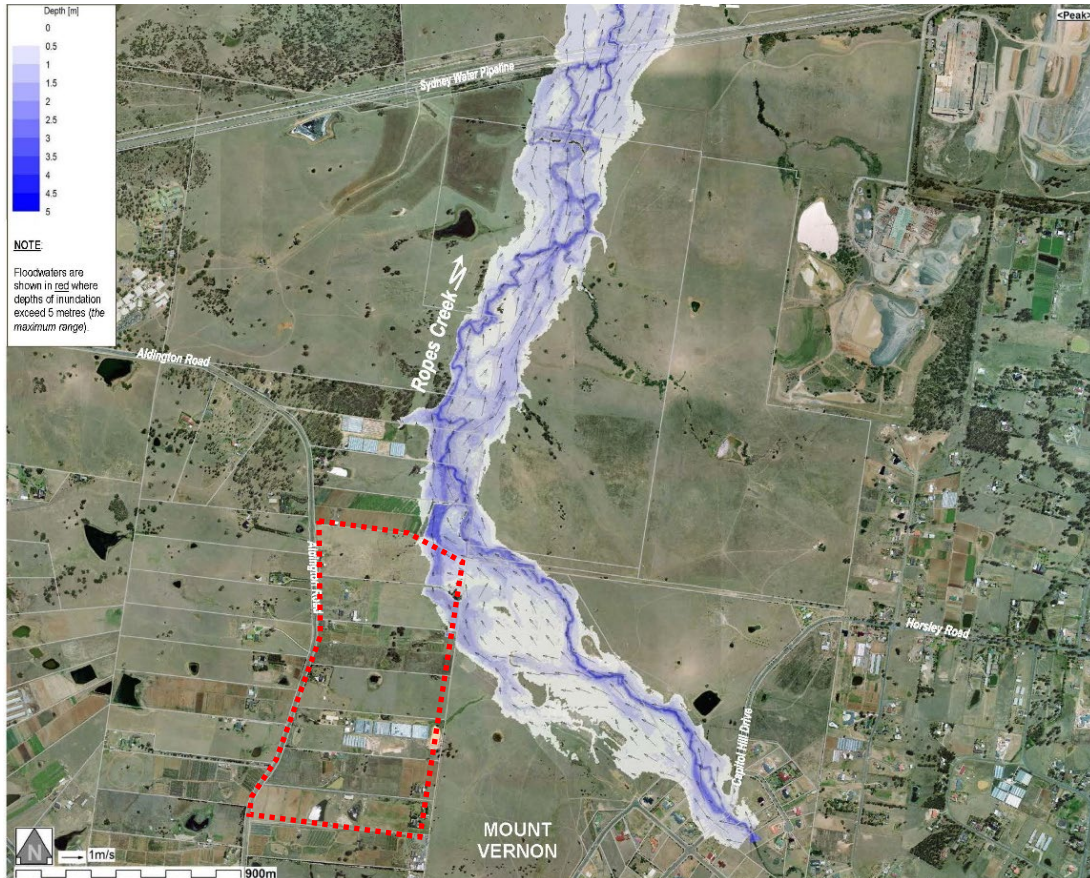


Figure B-4 PMF Depths and Velocities (after Figure 6.154, Worley Parsons, 2015)

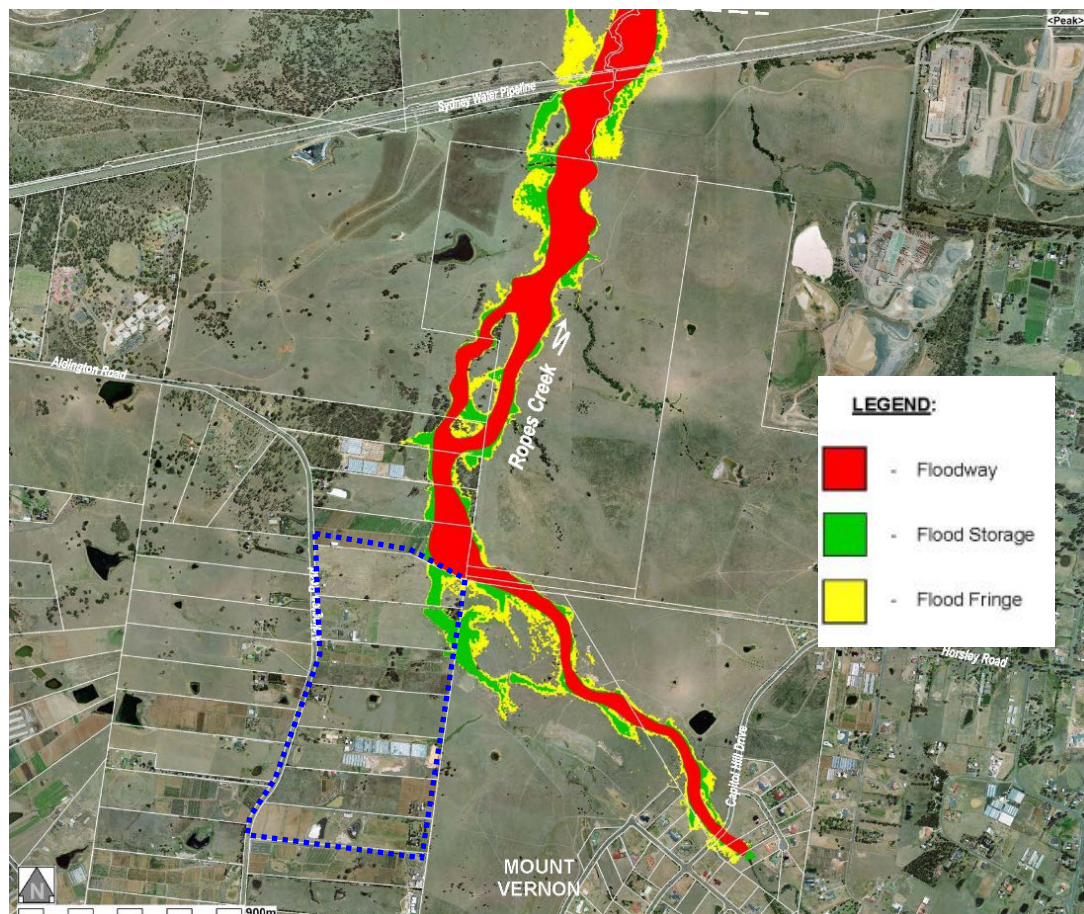


Figure B-5 1% AEP Hydraulic Categories (after Figure 7.31, Worley Parsons, 2015)

B.4 2016 Oakdale South Industrial Estate Flood Impact Assessment

As described by Cardno:⁶

An updated flood impact assessment has been prepared to address the Oakdale South – Secretary’s Environmental Assessment Requirements in relation to Soils and Water which require in part:

An assessment of flooding impacts associated with the proposal including details of any flood liability of the site and changes to flood behaviour.

As part of the master planning for the precinct the existing flood modelling was reviewed, re-run and an assessment was undertaken of the impacts on flooding of the proposed earthworks and measures associated with the planned development of the Oakdale South Industrial Estate.

Hydrological modelling was based on the upper Ropes Creek catchment model assembled by GHD which was amended to represent the proposed local subcatchments in the Industrial Estate.

Likewise, hydraulic modelling was based on the upper Ropes Creek floodplain model assembled by GHD which was amended to represent the proposed earthworks for the industrial estate. The model was the run to estimate 100 yr ARI flooding under Future Conditions based on the approach adopted by GHD previously when assessing Future Condition. The model was also run to estimate PMF levels.

.... the proposed updated development will have a minor impact on 100 yr ARI flooding on the Ropes Creek floodplain which will not adversely impact on any adjoining property subject to Post-Development peak flows being limited to Pre-Development levels.

B.5 2019 Oakdale West Industrial Estate Flood Impact Assessment

As described by Cardno:⁷

A flood impact assessment has been prepared to inform an SSD for the Oakdale West precinct which is being submitted to the Department of Planning.

As part of the master planning for the precinct the existing flood modelling was reviewed, re-run and an assessment was undertaken of the impacts on flooding of the proposed earthworks and measures associated with the planned development of the Oakdale West Estate.

The hydrological and hydraulic modelling of the Oakdale West Industrial Estate was based on the hydrological and hydraulic modelling of Oakdale South Estate which was based on the GHD flood modelling which was reviewed, updated, re-run and an assessment was undertaken of the impacts on flooding of the proposed earthworks and measures associated with the planned development of the Oakdale South Industrial Estate.

⁶ Cardno (2016) “Flood Impact Assessment, Oakdale South Industrial Estate”, *Final Report*, prepared for Goodman, 18 October 2016, 13 pp + Apps

⁷ Cardno (2019) “Flood Impact Assessment, Oakdale West Industrial Estate”, *Final Report*, prepared for Goodman, 22 August 2019, 12 pp + Apps

It was concluded, in part, that:

..... the proposed development will have a minor impact on 100 yr ARI flooding on the Ropes Creek floodplain which will not adversely impact on any adjoining property subject to the peak outflows from Basins 1, 2, 3, 4 and 5 not exceeding the 2 yr ARI and 100 yr ARI peak flows from the same catchment areas under Existing Conditions.

It is also concluded that the assessed impacts on 100 yr ARI and PMF flood levels and velocities are primarily associated with the Oakdale South development and the local impact of Oakdale West development is primarily created by Lot 5A and the incremental impacts are confined within the overall Oakdale precinct.

B.6 2019 Draft South Creek Floodplain Risk Management Study and Plan

The 2019 draft study report and draft plan were prepared by Advisian (part of the WorleyParsons Group) on behalf of the South Creek Floodplain Risk Management Committee acting in association with Penrith City Council and the Office of Environment & Heritage (OEH). It was placed on Public Exhibition from 31 October to 28 November 2019. As described by Advisian, 2019⁸

The study is the culmination of many months of investigation, analysis and flood modelling, which has been supported by valuable contributions from representatives of the community of Penrith and Penrith City Council.

It has been prepared by incorporating contributions from individuals from the local community and key stakeholders. Contributions from members of the Floodplain Risk Management Committee have been essential to the formation of management strategies that have been considered as part of the Study ...

The draft study and plan were prepared to assist Council in identifying and assessing management options to reduce the existing flood problem for the South Creek catchment and to manage flooding into the future.

Options to address the flood risks and potential flood damages are typically separated into the following categories:

- **Flood modification measures.** *These are typically structural works, such as flood protection levees, flood detention basins or bypass floodways, which act to reduce flood damages.*
- **Property modification measures.** *These measures include flood planning controls for future development to ensure that land uses are compatible with flood risk. They can also include voluntary house raising and purchase, or flood-proofing of buildings, which can act to reduce flood damages.*
- **Response modification measures.** *These typically include emergency response management measures, flood predictions and warnings and community flood awareness and preparedness.*

⁸ Advisian (2019) "South Creek Floodplain Risk Management Study", *Exhibition Draft Report*, prepared for Penrith City Council, August, 142 pp + Apps.

B.7 2020 Draft Southern Link Road Flooding and Drainage Investigation

As described by Lyall & Associates, 2020:⁹

This report presents the findings of an investigation that was undertaken to assess the impact that the construction of a new road linking Mamre Road in the west with Wallgrove Road to the east (denoted the Southern Link Road by Transport for NSW (TfNSW)) (the project) would have on flood behaviour.

*Ropes Creek has a catchment area of about 16.4 km² upstream of the future road corridor. Land use within the catchment that lies to the south generally comprises large lot rural residential type development, with industrial development currently being constructed immediately adjacent to the future road corridor. The catchment plan is given in **Figure B-6**.*

Hydrologic (DRAINS) and hydraulic (TUFLOW) models were developed as part of the present investigation to define flood behaviour in the vicinity of the future road corridor. A number of hydrologic sub-models are available within the DRAINS software. The RAFTS sub-model has been adopted for undertaking the present investigation given the predominantly rural/semi-rural areas nature of the catchments which lies upstream of the future road corridor¹⁰

The design storms which were assessed included: 20% (1 in 5), 10% (1 in 10), 5% (1 in 20), 2% (1 in 50) and 1% (1 in 100) Annual Exceedance Probability (AEP), as well as the Probable Maximum Flood (PMF).

Design rainfall was based on ARR,1987.

The structure of the hydrologic and hydraulic models that were developed to define flood behaviour under pre-project day conditions was adjusted to incorporate the strategic road design for the project, as well as details of the concept drainage strategy.

It is further advised that:

While the project would generally have a minor impact on flood behaviour should the concept drainage strategy that is set out in this report be incorporated in its design, further liaison with adjacent land owners and more detailed flooding investigations are required to be undertaken at concept design stage in order to address the following outstanding issues:

- (iii) *Liaison is required with the developers of the Oakdale West Industrial Estate to ascertain the timing of proposed earthworks as a temporary transverse drainage structure may be required to control runoff which presently discharges to a low point which is located in the corridor at about Design Road Chainage 2180. Further liaison is also required with the developers to ascertain the nature of development on the western overbank of Ropes Creek and how it might influence flood behaviour in the vicinity of the future road corridor. The impact that the project would have on the available freeboard to future development within the estate also needs to be assessed.*

⁹ Lyall & Associates (2020) "Southern Link Road Flooding and Drainage Investigation, Draft Report, 2 Vols, prepared for Transport for NSW, May, 17 pp

¹⁰ *While several large-scale commercial/industrial develops are presently being constructed in the immediate vicinity of the future road corridor, for the purpose of the present investigation it was assumed that the detention basins which form part of these developments would limit the rate at which runoff discharges to the various drainage lines to no greater than pre-developed conditions. On this basis, the land use in the sub-catchments within which these developments are located were modelled as being rural in nature.*

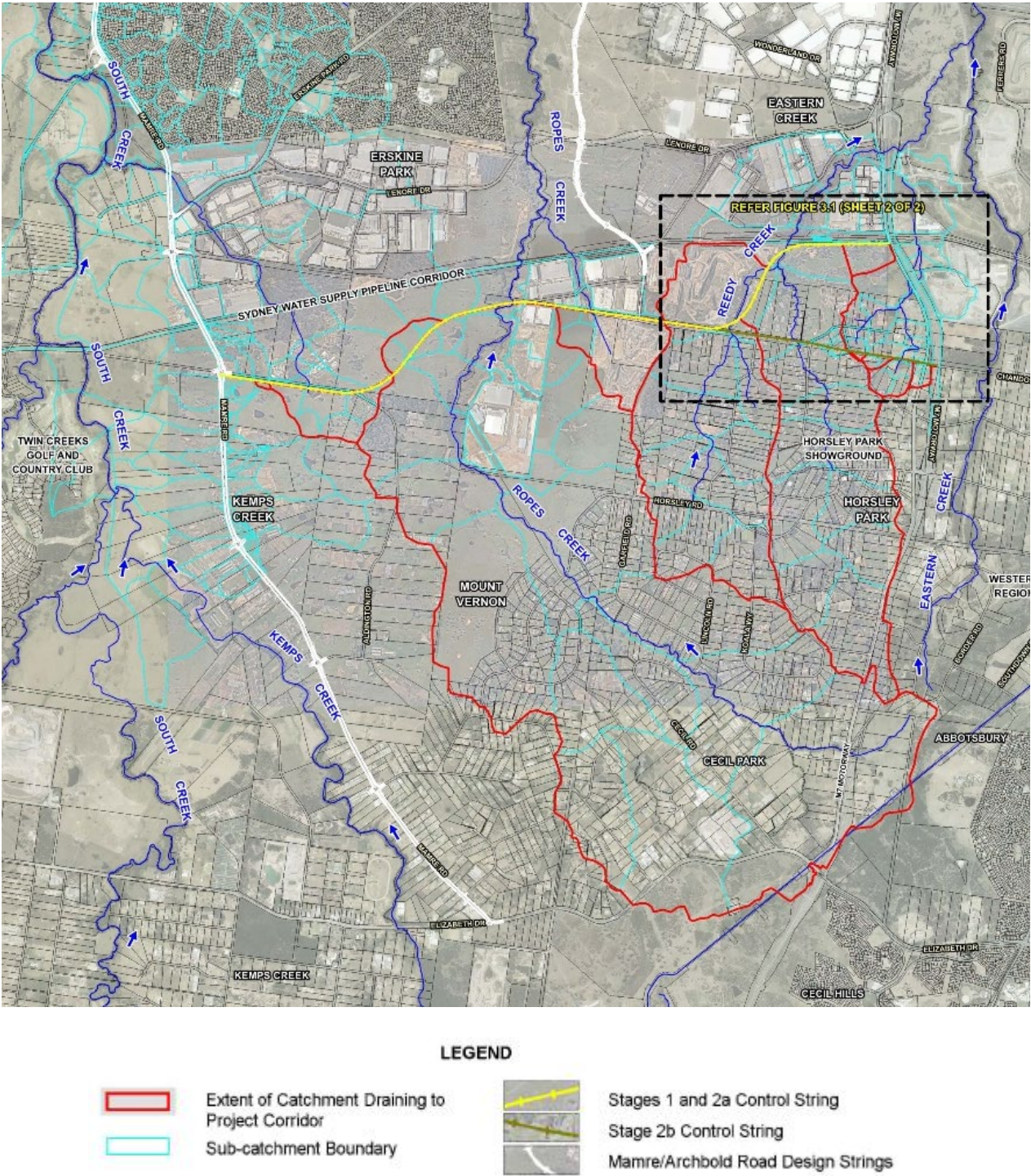


Figure B-6 Ropes Creek Catchment Plan (Source: Figure 3.1, Vol 2, Lyall & Associates, 2020)