REPORT

Traders in Purple

Kiama West

Preliminary Water Cycle Management and Flood Assessment

January 2023

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TABLE OF CONTENTS

PLATES

TABLES

APPENDICES

1. EXECUTIVE SUMMARY

This report has been prepared to summarise the outcomes of the Preliminary Water Cycle Management and Flooding Assessment undertaken to support the current planning phase of the Kiama West Planning Proposal site. The Planning Proposal seeks to rezone the site from RU2: Rural Landscapes to various Residential zonings to enable the development of 1140 dwellings.

Water quality will be managed by a treatment train which includes on-lot rainwater tanks, gross pollutant traps, bio-retention rain gardens or other WSUD practices to deliver Council's required WSUD and water quality objectives. Medium and high-density residential areas and other urban uses such as the agricultural college are proposed to manage their water quality needs onsite. Twelve (12) indicative locations for suitable bio-retention raingardens are proposed to manage stormwater quality runoff before discharge to Spring Creek. Proprietary (vortex style) GPTs are also proposed to be located at each discharge point of the development. The WSUD solution is flexible and the treatment locations can be tailored to suit the final form of the urban development without impact upon the broader planning principles or outcomes.

A series of On-Site Detention tanks or basins will be needed to meet Kiama Council's WSUD policy for the management of stormwater flows from the proposed development. It is expected that the development will require around 9,130 m^3 of detention storage to be provided. Due to the site topography and likely road gradients, it is proposed that the OSD system would typically consist of underground tanks located either in public lands on the urban interface with the riparian land or within the public road reserves. This approach to OSD minimises the visual impact of the storages and provides significant flexibility for staging delivery of the development

A flood assessment was also undertaken for the proposed development to define flood behaviour and establish 1% AEP flood depths and flood levels as key planning controls for the site. The flood mapping (refer to Appendix A) shows that flows are generally contained wholly within the defined watercourses and their associated riparian zones and do not impact the land proposed for development. Preliminary site grading of the main collector roads and the bushland perimeter roads demonstrate that the site can be developed without requiring any filling of the waterways. The waterway crossings associated with the development proposal can be configured to avoid impact upon the proposed new allotment and minimise flood impacts on adjoining land(s) to acceptable levels.

This preliminary assessment will be refined further through the Masterplanning process so that it evolves to become a Water Cycle Management Strategy that appropriately reflects the final planning proposal for Kiama West.

2. BACKGROUND INFORMATION

2.1. Existing Site

The site is located on the rural outskirts of Kiama, west of the Princes Highway and approximately 1.7km west of Kiama Train Station and Town Centre. The site is bound by Jamberoo Road to the north, Old Saddleback Road and Longbrush Road to the south, and Greyleigh Drive and Arnold Circuit to the east.

The site comprises several allotments and portions of an unformed crown road. The site is adjoining existing residential development to the east, and rural land uses to the north, south and west.

The site contains areas of steep land and is impacted by several watercourses and gullies (refer to *Plate* 2-1 and *Plate* 2-2).

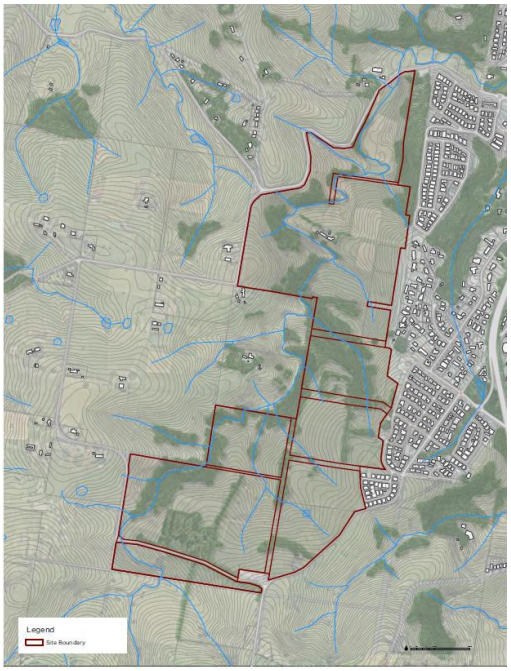


Plate 2-1 – Site Location (Source: E8 Urban)

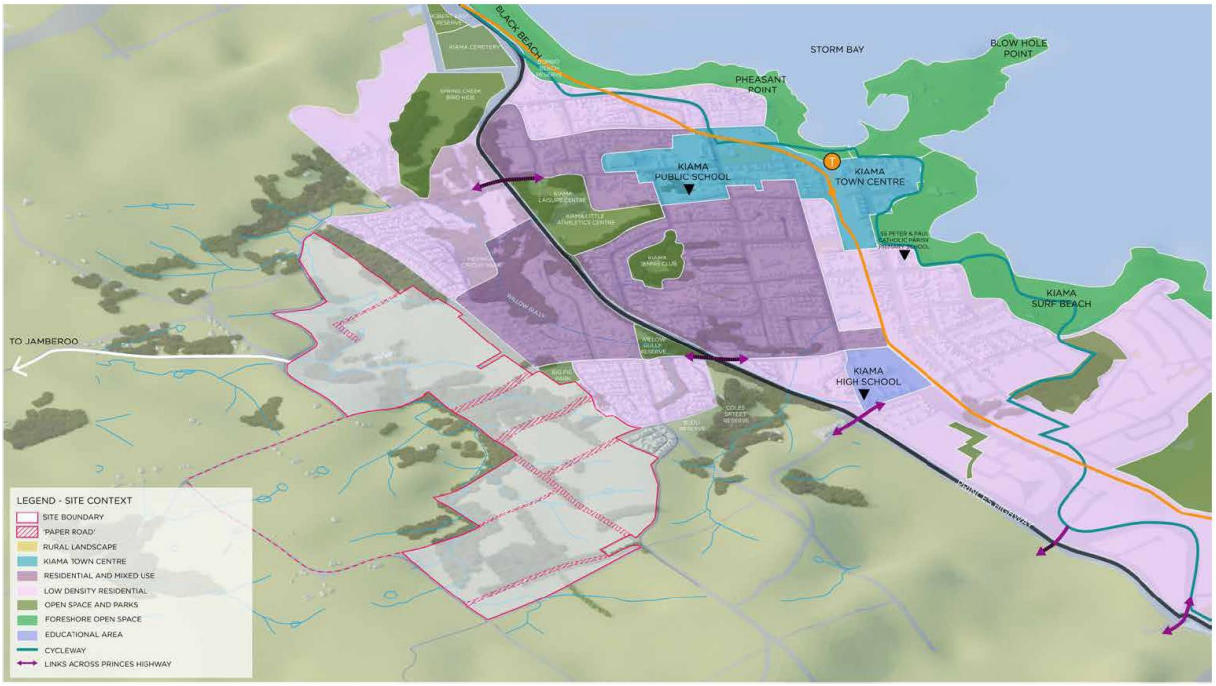


Plate 2-2 – Site Context (Source: Mecone)

2.2. Planning Proposal

The Planning Proposal seeks to rezone the site from RU2: Rural Landscapes to various Residential zonings to enable the development of 1140 dwellings. It is supported by a concept masterplan that includes a mix of residential, rural, recreation, employment and conservation land uses.

The proposed layout responds to the environmental attributes and topography of the land and is generally laid out to follow a centralised collector road that runs from Jamberoo Road in the north and creates a loop in the southern portion of the site. See *Plate 2-3* below.

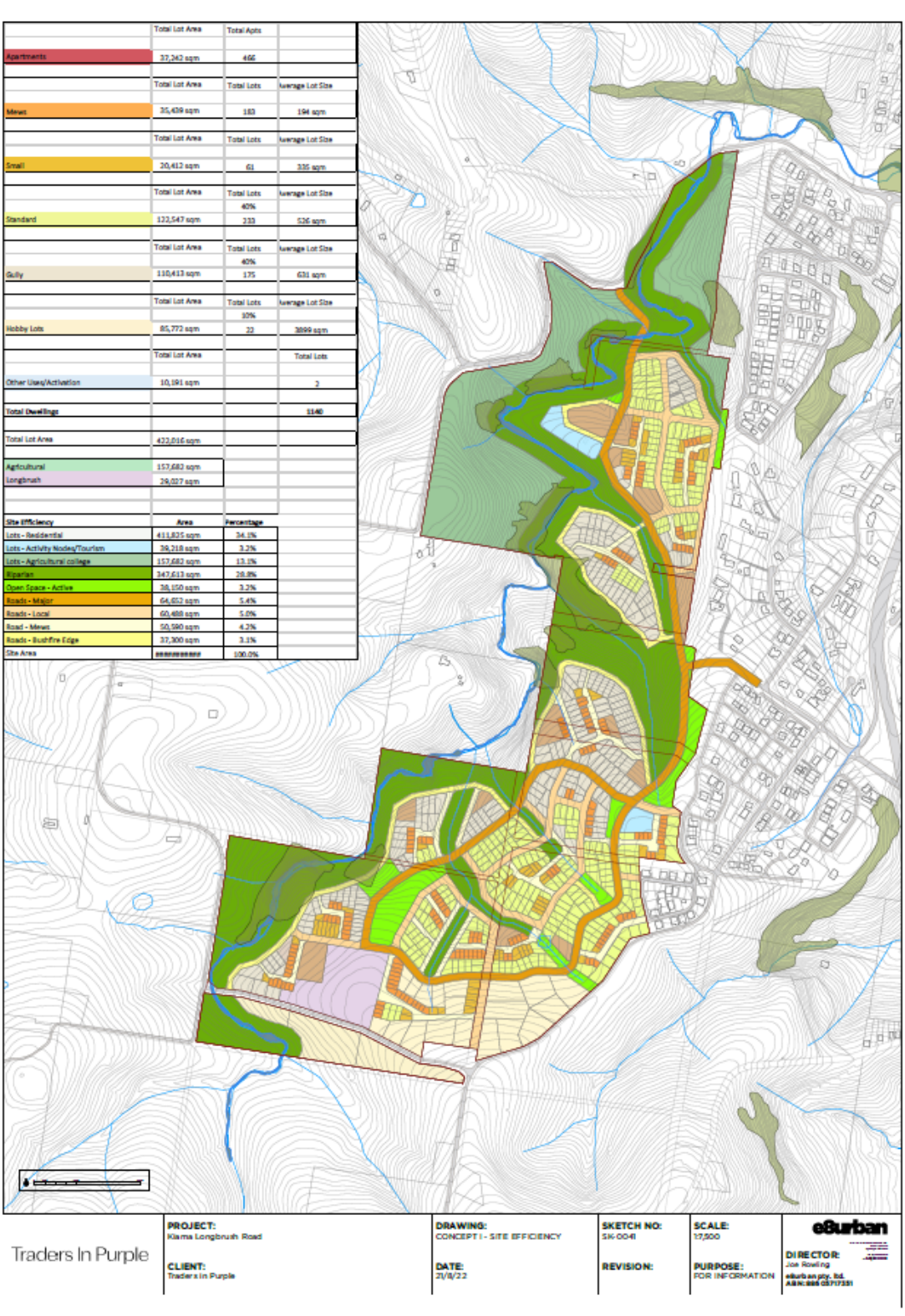


Plate 2-3 – Concept Masterplan (Source: E8 Urban)

3. DEVELOPMENT CONTROLS

3.1. Kiama Development Control Plan 2020

A range of objectives and controls within the Kiama DCP 2020 are relevant to water cycle management and flooding for the proposed development.

Riparian Lands

The site contains and interfaces with riparian lands as identified in Kiama LEP 2011. As a consequence, there are a range of DCP controls/topics that are relevant to the proposed development site. Many of these have common development controls relating to water cycle management and water quality which are best summarised in the following controls:

2.2.1 Development on or near to land identified as being riparian and in the Kiama LEP 2011 must ensure that it does not have significant adverse environmental impact, including, but not limited to, impacts on:·

- *water quality,*
- *bank and bed stability,*
- *ecological processes and any habitats.*

2.2.2 Riparian land affected by proposed development must be protected and improved through any development

This preliminary water cycle management assessment was undertaken to identify the expected water management controls required to address the DCP and other relevant controls so that any land required to be dedicated for these functions can be accommodated in the site planning.

Flood Prone Land

The proposed development interfaces with Springs Creek and a few of its eastern tributaries. The DCP objectives relating to Flood Prone Land are relevant.

O:2.5.4 To ensure that dwellings and ancillary buildings are not subject to flooding (including sea/storm surge/tidal inundation).

O:2.5.5 To minimise the risk posed by floods to people and property and emergency services officers who provide assistance in flood emergencies

A preliminary flood study was undertaken on the watercourses within and adjacent to the proposed development and details of this investigation is presented in Section 5 of this report.

Construction Stage Controls

There is a general expectation that all construction sites must apply soil erosion management measures to prevent disturbed and exposed soil from discharging to watercourses and the downstream environment.

Other Controls

The proposed development is not located within a Sydney Drinking Water Catchment so the requirements of Topic 2.3 Natural Resources are not applicable.

The proposed development is not located within land identified in the Acid Sulphate soils map in Kiama LEP 2011 so Control 2.5.23 is not applicable.

3.2. Water Sensitive Urban Design Policy (2005)

The requirements of the policy for Large Scale Subdivision Development (≥ 10 lots) are:

A comprehensive Water Cycle Strategy is developed which addresses:

- *Site conditions - topography, soils, groundwater, vegetation, natural streams or watercourses, habitat connectivity*
- *Catchment context and land capability*
- *Estimates of all water flows (where applicable)*
- *including –*

  - *potable water supply requirements*
  - *wastewater (black and grey water components)*
  - *roofwater volumes*
- *Water quality of the receiving waters*
- *Water quality objectives of the receiving waters*
- *Likely pollutants generated from the development*
- *Pre development modelled pollutant loads*
- *Post development modelled baseline pollutant loads (without any pollution control measures)*
- *Pre development hydrology: runoff volumes and peaks*
- *A management plan identifying how relevant treatment measures and general WSUD principles specified in this Policy are adopted into a "treatment chain" approach to address water quality, hydrology and flooding requirements and to reduce potable water demand*
- *Post development modelled pollutant loads*
- *Post development hydrology: runoff volumes and peaks*
- *Maintenance requirements for all stormwater and wastewater management measures and landscape features*

The relevant Performance Criteria are:

> *Quality of stormwater discharging from the development shall meet the following targets unless locally specific "sustainable load targets" have been designated by Council, or in the case of extremely sensitive environments, a "neutral or beneficial" pollutant load target may be requested.*

Pollutant	***Target***
Total Suspended Solids (TSS)	*80% retention of baseline annual load**
Total Nitrogen (TN)	*45% retention of baseline annual load**
Total Phosphorous (TP)	*45% retention of baseline annual load**
Litter >= 50mm (for commercial and industrial developments only)	*70% retention of baseline annual load**

** Baseline annual pollutant load is the expected post-development pollutant load that would be discharged from the site if no stormwater reuse or treatment measures were applied*

- *Post development peak flows do not exceed those for predevelopment for events up to Q100*
- *Baseline mains water consumption is reduced by 40%. Baseline mains water consumption is the expected average annual mains water consumption that would be generated by the development if no water conservation measures were applied*

On-Site Stormwater Retention, Detention and Infiltration

The requirements of the policy for managing stormwater discharge volumes from urban development are:

> *In order to reduce flooding arising from increased stormwater runoff due to urban development, Kiama Council requires all developments (other than single detached dwellings) to provide onsite retention/detention in accordance with the site storage requirement (SSR) and Permissible Site Discharge (PSD) specified in this policy.*

There are some limited exemptions applicable but these are not relevant to this development proposal The development does not fall within the areas indicated in Appendix A of the policy where stormwater infiltration techniques are either recommended or not recommended.

The relevant Performance Criteria are:

> *OSR/OSD shall be designed using the Site Storage Requirement (SSR) of **132 m3/ha** and Permissible Site Discharge rate (PSD) of **600 L/s/ha;***
>
> *Where on-site stormwater retention/infiltration devices that capture runoff from roofs and paved areas are used as a designated stormwater source control, they are to be designed, constructed and operated so as to:*
>
> - *Promote natural water balance*

- *Take into account site constraints and hazards present on the site*
- *Prevent adverse impacts on water table levels*
- *Prevent adverse impacts on the structural integrity of nearby buildings*
- *Provide for the removal of some pollutants prior to the discharge of runoff to receiving waters*
- *Reduce stormwater runoff from the development site*
- *Protect downstream properties in case of infiltration system failure*
- *Ensure that no property or structure downstream is adversely impacted due to stormwater runoff*
- *Ensure system is recessive and unobtrusive to the streetscape*

Some limited credits towards the SSR values are applicable for the use of large (greater than 5000 l) rainwater tanks. These credits have been conservatively ignored for this preliminary assessment.

4. PRELIMINARY WATER CYCLE MANAGEMENT STRATEGY

To inform the current estate masterplanning the configuration of an indicative water cycle management strategy, consistent with Kiama Municipal Council's Water Sensitive Urban Design (WSUD) Policy was identified and the expected locations and likely sizes for the major elements of this system have been estimated using industry-accepted unit rate sizing techniques.

It is expected that the preliminary strategy will be refined further as the planning proposal evolves over the masterplanning process (before the gazettal of the Planning Proposal).

4.1. Water Quality Management Measures

It is proposed that stormwater quality will be managed using a treatment train approach. A proposed treatment train of water quality devices has been identified to achieve the target pollutant removals.

- Rainwater harvesting and re-use of residential roof runoff by utilising rainwater tanks;
- Gross Pollutant Traps (GPTs) to pre-treat runoff before discharge into bioretention gardens;
- Bioretention Raingardens which will receive flows from the GPTs;
- On-lot treatment devices for Medium and High-Density residential land, school sites, and any other urban land.

The location of the devices would be resolved at the concept design stage for each stage of development. The site topography and the associated road gradients are typically greater than 5% and, as a consequence, there is limited opportunity to locate "water sensitive" water quality devices/basins, such as raingardens, within the streetscape. It is recommended that the location of GPTs and raingardens are located on the bushland interfaces. As typical sub-catchment sizes ranging from 2 to 10 ha, these would be typically located at the end of the pipe drainage networks before discharge into the riparian corridors and watercourses. There is also an opportunity to passively irrigate street trees with diverted stormwater flows which can be considered as the development planning progresses.

The indicative location of the expected Raingardens are shown in Figure 1 in Appendix A. The catchment and treatment bed areas proposed for each device are summarised in Table 4-1.

Table 4-1 –Raingarden Catchments

Basin ID	Catchment (ha)	Raingarden Filter Area (m²)
B1	1.92	240
B2	6.63	800
B3	14.45	1,740
B4	5.71	690
B5	3.51	430
B6	9.91	1,190
B7	24.93	3,000
B8	4.28	520
B9	4.27	520

* Raingarden filter areas sized at an assumed 1.2% of catchment

The land take required for stand-alone bio-retention rain gardens is approximately 150-200% of the bio-retention media bed area. This accounts for the required Extended Detention Zone (EDZ), batters, setbacks, maintenance access tracks and retaining walls/transitions to the surrounding terrain.

4.2. OSD / Detention Basins

A series of On-Site Detention tanks or basins will be needed to meet Kiama Council's WSUD policy for the management of stormwater flows from the proposed development. The typical sub-catchments expected to drain to each device are indicated in Figure 1 in Appendix A. The expected total storage volumes for each sub-catchment are summarised in Table 4-2.

Table 4-2 –Expected Detention Basin/Tank Volumes

Basin ID	Catchment (ha)	Volume (m^3)
B1	1.92	260
B2	6.63	880
B3	14.45	1,910
B4	5.71	760
B5	3.51	470
B6	9.91	1,310
B7	24.93	3,300
B8	4.28	570
B9	4.27	570

After our initial consultation with Kiama Council's planning and engineering teams, and considering the steep site topography and road gradients, it is proposed that the OSD system would typically consist of underground tanks located either in public lands on the urban interface with the riparian land or within the public road reserves. While more expensive to construct, this approach will avoid the need for large visually obtrusive storage solutions and the associated dedicated drainage land that often characterises these devices in similar circumstances. This approach also provides flexibility in tailoring the OSD solution to fit with the final development design as dedicated drainage land does not need to be set aside at the rezoning stage.

4.3. Construction Stage

Erosion and sediment control measures are to be implemented during the construction phase in accordance with the requirements of Kiama Municipal Council and the guidelines set out by Landcom (the "Blue Book" 2004).

As the operation of 'bio-retention' (raingarden) water quality treatment systems are sensitive to the impact of sedimentation, construction phase controls should generally be maintained until the majority of site building works (approximately 80%) are complete.

4.4. Long Term Management

Regular maintenance of the stormwater quality treatment devices is required to control weeds, remove rubbish and monitor plant establishment and health. Some sediment build-up may occur on the surface of the raingardens and may require removal to maintain the high standard of stormwater treatment. Regular management and maintenance of the water quality control systems will ensure long-term, functional stormwater treatment. It is strongly recommended that a site-specific Operation and Maintenance (O & M) Manual is prepared for the system as part of future Development Applications. The O & M manual will provide information on the Best Management Practices (BMPs) for the long-term operation of the treatment devices. The manual will provide site-specific management procedures for:

- Maintenance of the GPT structures including rubbish and sediment removal;
- Management of the raingarden including plant monitoring, replanting guidelines, monitoring and replacement of the filtration media and general maintenance (i.e. weed control, sediment removal); and
- Indicative costing of maintenance over the life of the device.

5. FLOOD ASSESSMENT

A 1d/2d hydraulic model has been developed for the site using TUFLOW HPC. TUFLOW is a fully dynamic two-dimensional model that can dynamically link 1D and 2D flow regimes together with mainstream and local overland flow all in one model. The existing site and catchment conditions was modelled to define the flood behaviour within the site and its general vicinity for the 1% AEP flood event which is the key constraint for site masterplanning purposes. It is expected that the flood assessment will be refined further as site planning and design stages progress in the future.

5.1. Modelling Approach

The flood modelling for this assessment was based on the direct rainfall method (DRM) approach adopting the Australian Rainfall and Runoff (ARR) 2019 methodology to define the rainfall and loss parameters for the catchment. The DRM flood modelling involves the application of rainfall to all areas of the model, and runoff is routed within the hydraulic model producing the hydrology of storm events more accurately.

5.1.1 Available Data

The following data was used to inform the hydraulic assessment:

- ARR 2019 data hub.
- Digital Elevation Model (DEM) February 2011 on the NSW Government Spatial Services website (http://elevation.fsdf.org.au/);.
- Existing survey of the site dated 27 October 2022 by Masters Surveying.
- Aerial photography of the site recorded by Metromap, 2022.

5.1.2 Storm Events, Durations and Losses

This study has adopted ARR 2019 rainfall methodology. ARR 2019 rainfall includes ten temporal patterns for each storm burst duration. Typically, all ten temporal patterns were assessed for each storm burst duration, from 10 min to 720 min, and the median peak result was determined at each location of interest for the 1% AEP flood event.

To limit the number of rainfall on-grid model runs, the identified median peak storm burst duration and the temporal pattern were used to assess the existing and developed condition flood behaviour for each storm event.

The storm burst losses have been calculated by using Probability Neutral Burst Initial Losses provided by the ARR 2019 Datahub.

.In accordance with the Review of ARR Design Input for NSW (OEH, 2019) the 0.4 continuing loss factor was applied to the continuing loss rainfall

5.2. TUFLOW Model Parameters

The model boundary for this study includes the site catchment of approximately 398 ha. The TUFLOW model boundary extent is illustrated in Figure 2 in Appendix A.

The underlying terrain of the TUFLOW 2D domain has been based on DEM data downloaded from NSW Government Spatial Services.

The cell sizes of the 2D domain need to be sufficiently small enough to reproduce the hydraulic behaviour and provide accurate results to define the flood behaviour. As such a 4 m x 4 m grid was adopted within the model domain.

5.2.1 Catchment Roughness

A hydraulic roughness map is required for 2D modelling to classify the surface roughness for various land uses within the defined catchments affecting the site. The roughness map was based on the latest aerial photography presented in Metromap.

5.2.2 Downstream Boundary Condition

The downstream boundary of the model is nearly 450 m downstream of the subject site as such the automatically generated stage-discharge curve based on the slope of 1% along the discharge location of the TUFLOW model boundary is considered. The downstream Tuflow model boundary location is shown in Figure 2 in Appendix A.

5.3. Flood Mapping

TUFLOW DRM modelling has many advantages, including the ability to automatically determine local overland flow paths. However, due to the nature of the model input, each grid cell receives rainfall and the associated runoff is applied as a nominal flow depth on each cell. Unless some form of filtering is applied, each cell is mapped as being inundated. Ponding of isolated pockets in the terrain model can also occur.

These factors reduce the practical value of the “unfiltered” model output and the application of an appropriate flood depth filter is required. The results of the TUFLOW RDM modelling have been filtered to show results greater than 0.15 m depth and isolated pockets of ponding area greater than 100 m^2.

The 1% AEP flood depth and level results have been mapped for the existing conditions on the site and are indicated in Figure 2 of Appendix A.

5.4. Flood Planning Levels

As indicated in Figure 2 of Appendix A, the 1% AEP peak flood level inundation within the area proposed for development ranges from RL 90 to RL 20 m AHD along its interface with Spring Creek.

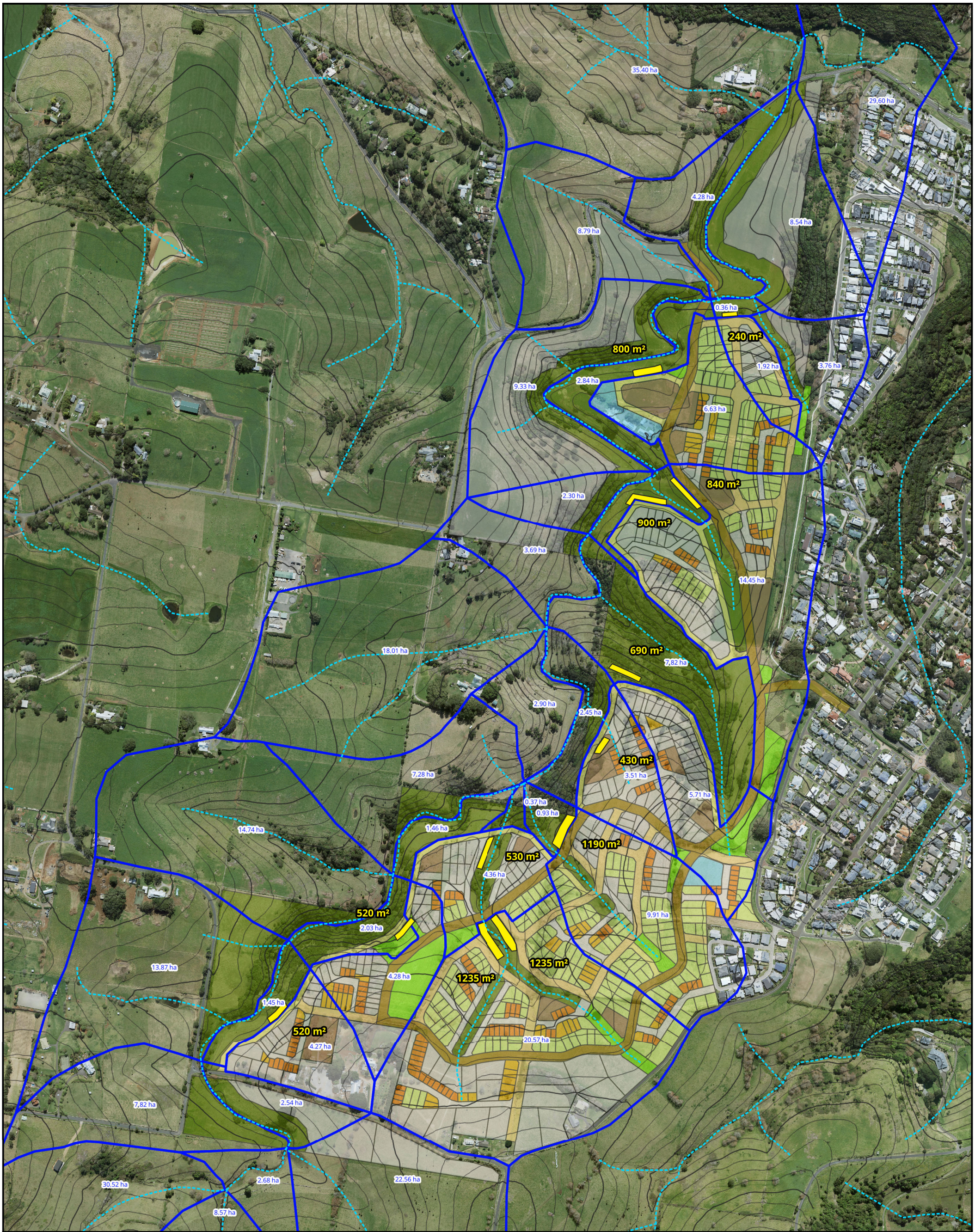
Council’s development control plan (DCP) requires that residential development is to have habitable floor levels no lower than the 1% AEP flood level plus 0.5 m freeboard. The flood extent mapping in Figure 2 demonstrates that the existing and proposed ground levels adjacent to Spring Creek and its eastern tributaries comfortably exceed these requirements.

6. GLOSSARY

Term	Definition
Annual Exceedance Probability (AEP)	The chance or probability of a natural hazard event (usually a rainfall or flooding event) occurring annually. Normally expressed as a percentage.
Australian Rainfall and Runoff (AR&R)	Refers to the current edition of Australian Rainfall and Runoff published by the Institution of Engineers, Australia.
Exceedances per Year (EY)	The number of times a year that statistically a storm flow is exceeded.
Floodplain Planning Level (FPL)	The FPL is a height used to set floor levels for property development in flood-prone areas. It is generally defined as the 1% AEP flood level plus 0.5m freeboard.
Floodplain Development Manual (FDM) and Guidelines (April 2005)	The FDM is a document issued by the Department of Environment Climate Change and Water (DECCW) that provides a strategic approach to floodplain management. The guidelines have been issued by the NSW Department of Planning (DoP) to clarify issues regarding the setting of FPLs. This document is also the framework for the development of Floodplain Risk Management Studies and Plans.
Hydrograph	Is a graph that shows how the stormwater discharge changes with time at any particular location.
Hydrology	The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods.
J. Wyndham Prince Pty Ltd (JWP)	Consulting Civil Infrastructure Engineers and Project Managers undertaking these investigations
MUSIC	A modelling package designed to help urban stormwater professionals visualise possible strategies to tackle urban stormwater hydrology and pollution impacts. MUSIC stands for Model for Urban Stormwater Improvement Conceptualisation and has been developed by the Cooperative Research Centre (CRC),
Peak Discharge	Is the maximum stormwater runoff that occurs during a flood event
Probable Maximum Flood (PMF)	The greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends.

Term	Definition
TUFLOW	A computer program that provides two-dimensional (2D) and one-dimensional (1D) solutions of the free surface flow equations to simulate flood and tidal wave propagation. It is specifically beneficial where the hydrodynamic behaviour, estuaries, rivers, floodplains and urban drainage environments have complex 2D flow patterns that would be awkward to represent using traditional 1D network models.
XP-RAFTS	Is a runoff routing model that uses the Laurenson non-linear runoff routing procedure to develop a sub-catchment stormwater runoff hydrograph from either an actual event (recorded rainfall time series) or a design storm utilising Intensity-Frequency-Duration data together with dimensionless storm temporal patterns as well as standard AR&R 1987 data.

APPENDIX A – FIGURES



Kiama West Planning Proposal

Preliminary Raingarden Plan Concept I

FIGURE 1

110835-02 SK03

Date: 22/12/2022

Revision: B

N

0 50 100 m

Scale 1: 7000 @ A3

Projection: GDA2020 / MGA zone 56

LEGEND

- Developed Catchments
- Watercourses
- Raingarden Filter Area

2011 LiDar

- 5 m
- 50 m

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Kiama West Planning Proposal

1% AEP Flood Depth and Level - Existing Conditions

FIGURE 2

110835-02 SK02

Date: 22/12/2022

Revision: B

N

0 100 200 m

Scale 1: 7000 @ A3

Projection: GDA2020 / MGA zone 56

LEGEND

Depth (m)

- 0.15 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- Tuflow Model Boundary
- Site Boundary
- 2011 LiDar 5m contours

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