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*Providing Specialist Services in the Fields of Hydrology and Hydraulics*

# Integrated Water Cycle Management Study Proposed Development at Henry Parkes Drive, Kiama Downs

*for The Owners*

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# Integrated Water Cycle Management Study
# Planning Proposal at Henry Parkes Drive, Kiama Downs

Prepared for:

## The Owners

Prepared by:


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# 1 INTRODUCTION

## 1.1 BACKGROUND AND PURPOSE OF THIS REPORT

Rienco Consulting was engaged by The Owners of Henry Parkes Drive, Kiama Downs (Lot 442 DP 1201931) to prepare an Integrated Water Cycle Management Study (IWCMS). The IWCMS is to accompany a Planning Proposal to Kiama Municipal Council (KMC) to rezone the land for urban development. The site is currently E2 Environmental Conservation (Kiama Local Environmental Plan, 2011), the proposed rezoning is for a portion to be changed to R2 (low density residential), and the remainder left in its existing E2 (Environmental Conservation) zone.

The purpose of this report is to:

a) Review the current site development plans and compare them with the proposed development requirements and other relevant information and studies.

b) Select a combination of WSUD approaches that will be both acceptable to the future residents and represent value for money in terms of the environmental benefits they deliver

c) Confirm KMC's water quality performance criteria for the proposed development, and establish appropriate water quality design principles.

d) Identify stormwater management infrastructure that is compatible with the environmental sensitivities of the site.

e) Describe the modelling process carried out to determine the effectiveness of the adopted WSUD configuration.

f) Develop and document preliminary concept designs for the water quality treatment system.

g) Demonstrate that the WSUD proposal meets the necessary water quality objectives.

## 1.2 LIMITATIONS AND ASSUMPTIONS

This report has been prepared strictly for the purposes stated in this report, for exclusive use by the client. No other warranty, expressed or implied, is made as to the advice included in this report. This study relies upon third party information for which we cannot guarantee its accuracy.

It should be noted that the preliminary WSUD designs presented in this report have been developed to sufficient detail to convey the possible opportunities for design intent only. The preliminary WSUD designs demonstrate only one way (of many ways) that KMC's water quality objectives can be met by this planning proposal.

Further detailed design will be required prior to construction, in particular once more detailed geotechnical information can be made available. During detailed design, the proposed WSUD measures may require some changes to suit detailed local issues and integration with the detailed subdivision design. It is not anticipated however that significant changes will be required to the physical parameters which govern WSUD measure performance (i.e., volume, surface area, length to width ratio and detention time etc.). The WSUD measures are thus not likely to require significant modification.

Nevertheless, it should be demonstrated to KMC that any future changes made are consistent with the preliminary design opportunities presented in this study. Additionally, further water quality modelling should be undertaken at the detailed design stage to confirm system performance.

# 2 RELATED INFORMATION

## 2.1 SITE DESCRIPTION

The subject site is contained within the Minnamurra River Catchment and is located adjacent to Minnamurra River, to the east of the Princes Highway. It has a total area of approximately 3.21 ha. The site is sloping steeply to the north-west with existing levels ranging in height from RL +1.7m AHD in the north to RL +26.5m AHD in the south. The site is currently undeveloped. **Figure 2.1-1** describes the site by way of an aerial image, and the indicative site is shown in yellow.


**Figure 2.1-1 Subject Site and Aerial Image**

*Note: Image supplied by NSW Land and Property Information. Area of the proposed residential development shown shaded.*

## 2.2 PREVIOUS FLOOD STUDIES

A flood study for the Minnamurra River Catchment was undertaken in December,1990 by Connell Wagner, as part of the Roads and Traffic Authority (RTA) Environmental Impact Statement (EIS) to identify the preferred corridor for the Princes Highway. This study involved hydrologic and hydraulic modelling to assess the effect on flood levels and flows of the proposed road structure and corridor options crossing the Minnamurra River and floodplain.

The Connell Wagner (1990) hydrology and flood modelling study employed an RORB routing model. The model was used to determine hydrographs for the hydraulic model. The study also used RUBICON for the hydrodynamic flow model to route the inflow hydrographs through the catchment (Connell Wagner, 1990).

The 1 in 100-year ARI design storm event and the probable maximum flood (PMF) were run through a calibrated model. Flood heights, flow distributions and velocities were determined from this for the existing Minnamurra River catchment (Connell Wagner, 1990). According to

the study, the 1 in 100-year ARI flood levels in the area are RL +4.13 AHD and RL +5.26 PMF AHD for the current day scenario (Connell Wagner, 1990).

A flood and coastal study of the Minnamurra River Catchment was also undertaken by Cardno (2019). This Study assessed the impacts of a proposed shared path on the flooding behaviour of the Minnamurra River catchment. The study defined catchments, identified catchment characteristics and rainfall data for use in a hydrological model (Cardno, 2019). The study determined critical duration and peak flows for the 5, 20, 100-year ARI and PMF events (Cardno, 2019).

Cardno used computer model 'Watershed Bounded Network Model' WBNM 2007 v104 (Boyd et al, 2007) for hydrological modelling to determine peak inflows around the subject area. This model was considered appropriate given its ability to model a wide range of catchment characteristics and its local development. The model allowed peak flows to be established at various locations throughout the subject site (Cardno, 2019). The computer program TUFLOW was also used to develop a 2D hydraulic model of the study area.

According to Cardno (2019) existing 100-year ARI flood levels RL +4.13 m AHD and PMF RL +5.35 AHD at Stage 2 location D. Flood velocities located closest to the proposed development at Stage 2 location D in the 1 in 100-year ARI event are 0.45 m/s and for the PMF 0.54 m/s (Cardno, 2019).

The Connell Wagner (1990) study encompasses the subject site of the proposed development. It uses an older, less rigorous modelling method in comparison to that of Cardno's (2019) study however, the PMF and the 1 in 100-year flood levels were able to be determined from this. Whilst the Cardno (2019) study has its focus on a section of the catchment further downstream of the proposed development subject site, it utilises a more modern and rigorous approach to modelling. The flood levels determined by Cardno (2019), such as the PMF and the 1 in 100 ARI event, reflect similar values to those provided in the Connell Wagner (1990) EIS, thus the results of Connell Wagner (1990) are calibrated by the Cardno (2019) study, and Rienco have confidence in their applicability to the proposed development location.

The majority of the proposed lots are located well above the 1 in 100-year flooding event (e.g. above the contour of RL +4.13 m AHD). A relatively minor volume of fill may be required for a small area within the proposed R2 zoning where it is located below the contour of RL +4.13 m AHD.

The re-zoning of land in the planning proposal is unlikely to cause any future impediment in terms of residential development and is suitable when taking into account its minimal interaction with flood levels.

## 2.3 PROPOSED DEVELOPMENT

The proposed development consists of residential lots and associated access roads. **Figure 2.4-1** describes the proposed development in the context of the zoning.

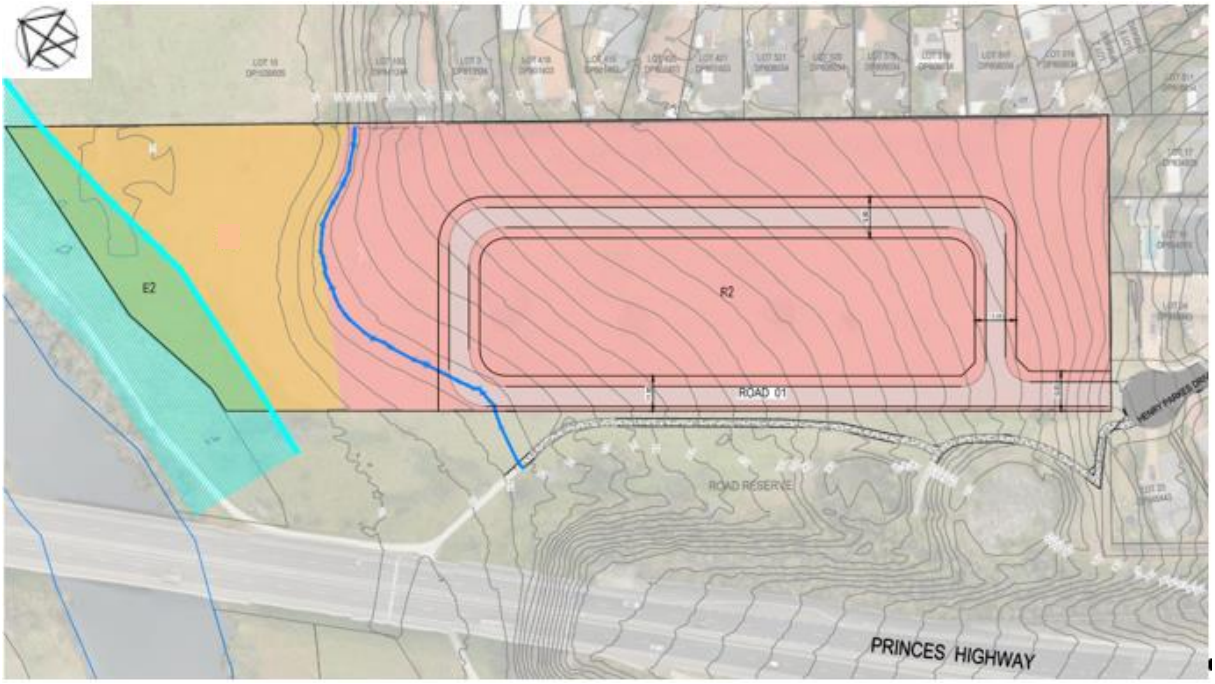


**Figure 2.3-1 Proposed Layout Plan**

*Note: Provided by Indesco (blue line indicates approximate 1 in 100-year flood level).*

# 3 WATER SENSITIVE URBAN DESIGN (WSUD) PHILOSOPHY

## 3.1 KIAMA MUNICIPAL COUNCIL REQUIREMENTS

Kiama Municipal Council provides the required development controls for water quality via their *Kiama Council Municipal Council Urban Design Policy (2005)*. The document aims to ensure that building design and development incorporates effective water and soil management measures and is the focal point of the suitable water quality requirements for this planning proposal.

**Table 3.1-1** below describes the KMC requirement for potential developments.

**Table 3.1-1 – KMC Required Stormwater Pollutant Load Reduction**

| Pollutant | % post development average annual load reduction |
|---|---|
| Gross Pollutants | **70%** |
| Total Suspended Solids | **80%** |
| Total Phosphorus | **45%** |
| Total Nitrogen | **45%** |

These load reductions have been applied throughout this study.

## 3.2 POTENTIAL WSUD MEASURES

A number of WSUD measures have been evaluated for their considered effectiveness and suitability for the proposed rezoning and potential R2 residential land use. It is noted that potential WSUD measures have been evaluated on the basis of the proposed land re-zone and conceptual access road layout (**Figure 2.4-1**), which may be subject to changes. **Table 3.2-1** summarises these measures and provides commentary on their anticipated suitability.

**Table 3.2-1 – Potential WSUD Measures**

| WSUD Component | Specific Measure | Considered Applicable to Development? |
|---|---|---|
| Stormwater management | GPT Style Units with additional sand filtration | Yes. These units (proprietary litter/sediment traps) could be provided at a location where the piped drainage system discharges into the natural watercourse. These systems entail a GPT and sand filtration unit in one precast pit that facilitates access for maintenance and cleaning. They are particularly suitable for residential land use applications. |
| | Water quality control ponds/ artificial wetlands | Yes. Ponds/wetlands provide physical filtration and capture of fine sediments as well as biological uptake. |
| | Bio-retention swales | No. Bio-retention swales are not considered a suitable solution due to the relatively steep topography of the site. |
| | Bio-retention basin | Yes. A Bio-retention basin is suited to the site, in particular with regard to the slope of the site and the required access for the |

| | | |
|---|---|---|
| | | dwellings. Allow for physical filtration and capture of fine sediments as well as biological uptake |
| | Rainwater tanks to collect roof runoff | Yes, rainwater tanks should be utilised (as per the minimum requirements of BASIX). |
| Water supply management | Demand management | Yes. Promote use of water efficient showerheads & dishwashers, and tap aerators where appropriate. Provide native landscaping with a lower water demand than traditional urban planting regimes. |
| | Aquifer recharge | No. Not considered necessary given the relatively minor changes to impervious cover as part of the development. |
| | Dual reticulation (potable/ non-potable) | Only to the extent of using tank water for toilet flushing (and externally for garden watering). Combination of economics & environmental returns for a more elaborate system unlikely to be attractive for this site. |
| Wastewater management | Aquifer recharge | No. Not considered necessary. We consider the impervious cover changes are insignificant in terms of causing any changes to the recharge characteristics of the groundwater system. |

As can be seen from **Table 3.2-1**, WSUD measures considered most appropriate to the planning proposal are in the areas of stormwater quality control. Options relating to stormwater quality control and groundwater management are discussed in **Section 3.3** below.

## 3.3 STORMWATER QUALITY MANAGEMENT

As can be seen from **Table 3.2-1** a number of stormwater quality management options are potentially available for the site given the proposed rezoning. The exception is of a bio-retention swale which is considered unsuitable due to the topography of the site. A potential treatment train may be the combination of a proprietary litter/sediment trap and rainwater tanks.

An important aspect of modern WSUD is recognising that rainfall patterns are inherently variable and that a pollutant removal system should be designed with variable treatment mechanisms. These must perform across a range of pollutant concentrations (generally governed by the duration of the inter-event period), and for a range of hydraulic loadings (a function of rainfall intensity during any given storm event). For this reason a treatment 'train' commencing at an early stage in the runoff cycle is advocated.

The proposed water quality treatment system for this project takes account of this recent research by incorporation of a range of physical and chemical/biological mechanisms occurring at different locations within the treatment train and which provide optimum performance at different pollutant and hydraulic loadings. The expected performance of the various components in the proposed treatment system is described in **Table 3.3-1** below.

**Table 3.3-1 – Proposed Treatment Train**

| Treatment Measure | Purpose | Comment |
|---|---|---|
| Rainwater Tanks | • Rainwater tanks to collect roof runoff | Yes, rainwater tanks should be utilised (as per the minimum requirements of BASIX). |

| | | |
|---|---|---|
| GPTs and Sand Filtration | • Removal of coarse pollutants, litter and nutrients | The Ecosol GPT style unit is considered a sound choice for this specific application, to be used at the outlet to the proposed main stormwater lines. It is designed to be one unit, making construction much simpler, and can treat gross pollutants and litter (via its GPT), as well as remove nutrients (via its sand filter). |

Now that a treatment train has been developed commensurate with the opportunities and constraints of the subject site, **Section 4** overleaf describes the modelling of the performance of that treatment train.

# 4 WSUD PERFORMANCE MODELLING

## 4.1 MODELLING APPROACH

The water quality software package MUSIC v6.20 (Model for Urban Stormwater Improvement Conceptualisation) was used to optimise the configuration of the various WSUD measures identified above and to ensure water quality objectives are met. The model is designed to evaluate conceptual stormwater treatment designs by simulating the performance of stormwater quality improvement measures and allowing comparison with water quality targets.

MUSIC was used to predict pollutant loads under both pre-development and post-development conditions, based on a range of project-specific input data including daily rainfall, monthly evapo-transpiration rates and sub-catchment characteristics.

Once the complete suite of input data was entered (refer **Section 4.2** below for further detail), the model was run for a near 100-year continuous simulation period. It is noted that 100 years of data represents a substantial record set. Continuous simulation over such a period given increased confidence in modelling output, and reduces the effects of assumed starting water levels and allows treatment train performance to be predicted over a range of climatic conditions.

## 4.2 MODELLING PARAMETERS AND INPUTS

A total of 104 years of daily rainfall data (July 1899 to November 2003) from the Bureau of Meteorology gauging station No 68034 at Point Perpendicular Lighthouse was used for continuous simulation purposes. The lighthouse is within a reasonable proximity to the subject site, and so provides an accurate meteorological template on which to model the proposed system in particular given its length of record. Monthly average evapo-transpiration data input to the model was taken from Bureau of Meteorology mapping for the region. **Figure 4.2-1** describes the rainfall and evapo-transpiration data series.

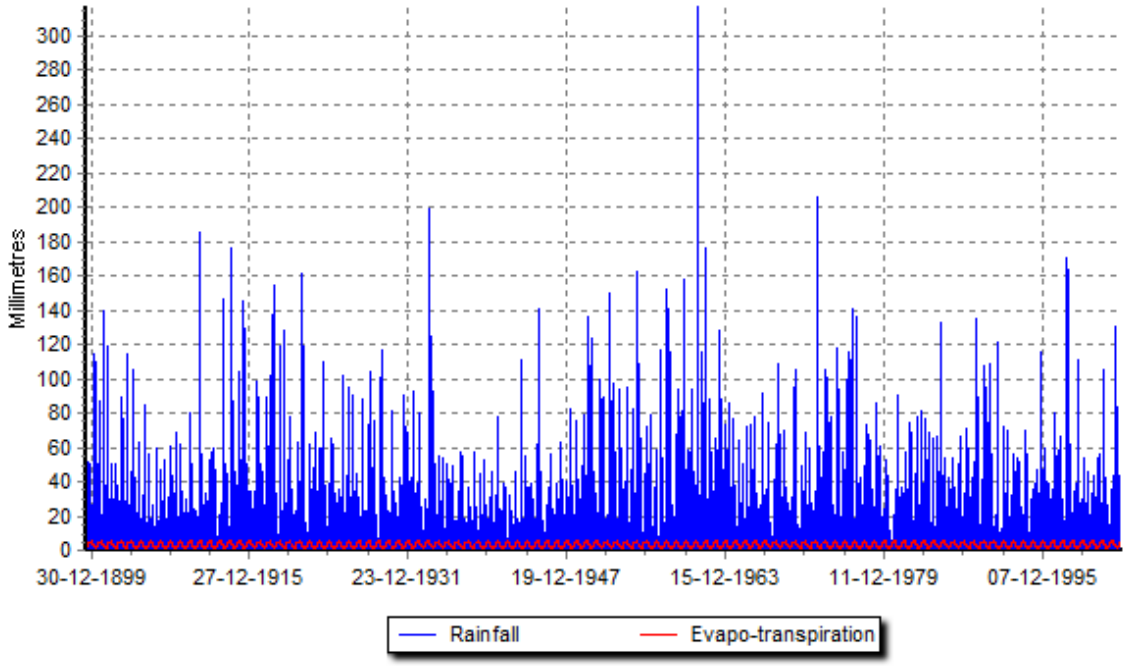


**Figure 4.2-1 MUSIC Rainfall and Evapotranspiration Data**

*Note: Data supplied by Bureau of Meteorology, graph extracted from MUSIC model.*

## 4.3 MODEL SCHEMATISATION

A MUSIC model was created for the proposed residential development. One 'urban (mixed)' node within MUSIC was used to represent the catchment area that drains to the Ecosol unit via road drainage and rainwater tanks (capturing roof runoff from each lot). The 'urban (mixed)' node was given an impervious area of 80%. All other MUSIC parameters, in terms of event mean concentrations for the various suite of pollutants, were set at the default MUSIC values.

A standard Ecosol sand filtration unit was applied at the final location prior to the discharge outlet to Minnamurra River as shown in the Stormwater Concept Plan, in strict accordance with the manufacturer's guidelines. This is a standard unit and it contains a GPT and filtration device all within the one pit.

## 4.4 MODEL RESULTS

MUSIC modelling results for the proposed lots are presented in **Table 4.4-1**.

**Table 4.4-1 – MUSIC Model Results**

| Target Pollutants | Post Development Source Loads | Residual Loads | % Reduction | *Council Reduction Targets* |
|---|---|---|---|---|
| Total Suspended Solids (kg/yr) | 6290 | 566 | **91%** | *80%* |
| Total Phosphorus (kg/yr) | 13.1 | 2.4 | **82%** | *45%* |
| Total Nitrogen (kg/yr) | 92.7 | 51 | **45%** | *45%* |
| Gross Pollutants (kg/yr) | 842 | 8.42 | **99%** | *70%* |

These results show that the proposed Ecosol unit alone is readily capable of meeting the water quality targets of KMC's *Kiama Council Municipal Council Urban Design Policy (2005)*. The modelled Ecosol unit is a basic water quality treatment measure in comparison to many others that are also available for consideration on the subject site. The MUSIC Model results for the sand filtration unit are a good indicator that there are a number of WSUD measures and treatment train combinations that would also prove suitable.

# 5 DETAILS OF WSUD / STORMWATER CONCEPT PLAN

## 5.1 SAND FILTRATION

Whilst sand filters are readily available and come in a range of sizes and styles, our preference for the final specification of the sand filter would be the Ecosol Sand Filter.

For the purposes of the concept design and MUSIC modelling, we have adopted the Ecosol Sand Filter, which is an all-in-one primary and secondary filtration system that helps overcome the need for multiple treatment measures on catchments where space limits the use of a bio-retention or wetland system. The Ecosol Sand Filter consists of an inlet chamber with a removable capture basket for primary treatment (i.e. an additional GPT). This significantly enhances the life of the sand media. It also consists of a fore-bay chamber to reduce flow velocities and a third chamber with sand filter media for removing finer particulates. A fourth chamber acts as an overflow by-pass and also reduces the potential for scouring in peak flows. **Figure 5.2-1** below describes the unit.

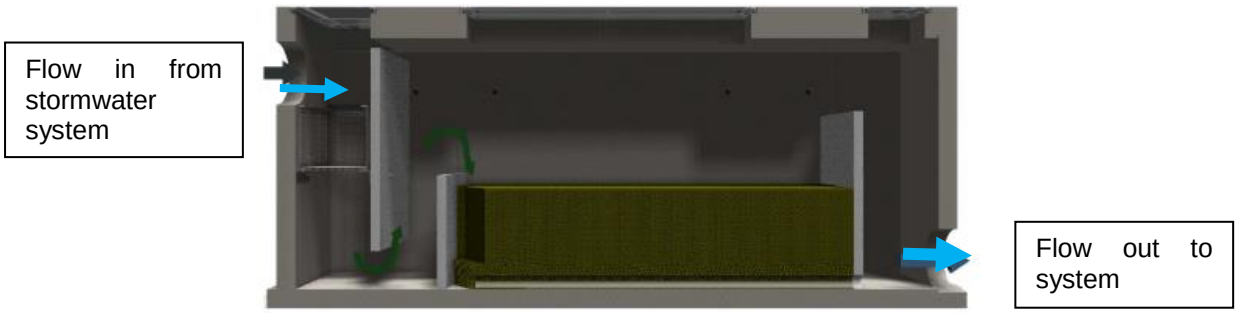


**Figure 5.1-1 Section through Ecosol Sand Filter**

*Note: Data supplied by Ecosol.*

## 5.2 CONCEPTUAL METHOD OF DISCHARGE

The proposed treatment train and conceptual method of discharge for stormwater management involves the collection of stormwater runoff from urban areas including rainwater tanks, roads, yards and verges into associated guttering, which will then be piped underground and directed through the Ecosol Sandfilter connecting to a headwall, before discharging directly into Minnamurra River.

Summarily this option involves:

1. Collecting runoff of all urban areas of the proposed development and directing flow via stormwater pits and pipes.
2. Stormwater is channelled underground through drainage pipes to the Ecosol GPT style unit.
3. Once filtration takes place stormwater will flow via connecting headwall discharging directly into Minnamurra River.

## 5.3 KLEP CLAUSE 6.5 DISCUSSION

Clause 6.5 of the KLEP (2011) aims to protect and maintain water quality within watercourses, the stability of the bed and banks of watercourses, any aquatic and riparian habitats, and the ecological processes within watercourses and riparian areas. **Table 5.3-1** below summarizes the SLEP requirements under Clause 6.5, together with commentary on how the proposal meets the requirements of Clause 6.5.

**Table 5.3-1 – Summary of KLEP Clause 6.5 Requirements**

| **Before determining a development application for development on land to which this clause applies, the consent authority must consider:** | **Where this report addresses the requirement** |
|---|---|
| (a) whether or not the development is likely to have any adverse impact on the following:<br>(i) the water quality and flows within the watercourse,<br>(ii) aquatic and riparian species, habitats and ecosystems of the watercourse,<br>(iii) the stability of the bed and banks of the watercourse,<br>(iv) the free passage of fish and other aquatic organisms within or along the watercourse,<br>(v) any future rehabilitation of the watercourse and its riparian areas, and | It is our view that all impacts are reasonably avoided, due to the proposed development being entirely consistent with KMC's DCP controls.<br>Impacts on aquatic species, passage of fish are discussed outside this report. |
| (b) whether or not the development is likely to increase water extraction from the watercourse, and | The development does not propose or imply any water extraction from any watercourse. |
| (c) any appropriate measures proposed to avoid, minimise or mitigate the impacts of the development. | It is our view that all impacts are reasonably avoided, due to the proposed development being entirely consistent with KMC's DCP controls. |
| **Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that:** | **Where this report addresses the requirement** |
| (a) the development is designed, sited and will be managed to avoid any significant adverse environmental impact, or | The development proposed is commensurate with the zoning of the land. Suitable setbacks and water quality measures are proposed consistent with the requirements of KMC's DCP to ensure suitable environmental outcomes. |
| (b) if that impact cannot be reasonably avoided—the development is designed, sited and will be managed to minimise that impact, or | It is our view that all impacts are reasonably avoided, due to the proposed development being entirely consistent with KMC's DCP controls. |
| (c) if that impact cannot be minimised—the development will be managed to mitigate that impact. | It is our view that all impacts are minimised, due to the proposed development being entirely consistent with KMC's DCP controls. |

# 6 CONCLUSIONS AND RECOMMENDATIONS

Based on the information contained within this report, it can be concluded that:

a) A review of the current site conditions and opportunities/constraints has been completed, and compared with the proposed development requirements.

b) A collection of background information has been sourced for use in this study, from detailed and lengthy rainfall records to the flood impact statement (Rienco, 2019) and current WSUD best practice guidelines.

c) A multitude of WSUD measures were assessed for inclusion in the proposed treatment train. After due consideration, a number of treatment train options would be suitable, with the exception of a bio-retention swale due to the topography of the site.

d) MUSIC modelling has been carried out on the nominated treatment train of a sand-filtration unit/GPT. The MUSIC model results confirm that Kiama Council's water quality performance criteria for the proposed development can be readily met.

e) A very basic treatment train of rainwater tanks and sand-filtration unit would easily meet KMC performance criteria, therefore there are a range of options for WSUD.

f) Concept designs have been provided for the proposed stormwater management infrastructure that are compatible with the environmental sensitivities of the site.

g) Based on the above, we consider that there is no flood or water quality related impediment to the adoption of the Planning Proposal.

h) The proposed extent of R2 zoned land is principally outside the 1% AEP flood extents, and the minor extent of filling required to ensure all R2 land is free from flooding in the 1%A EP event is unlikely to have any material influence on flood behaviour in the Minnamurra River.

Based on the information contained within this report, it is recommended that this report is included in the submission to KMC for the planning proposal.

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