Bangalow Industrial Estate Conceptual Stormwater Management Plan

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Synopsis:	**This report presents the outcomes of conceptual stormwater quality and quantity assessments completed for a proposed rezoning of land at the Bangalow Industrial Estate.**	

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Executive Summary

This report has developed and assessed a conceptual stormwater quality and quantity system for the proposed Bangalow Industrial Estate extension. Both water quality and quantity modelling have been completed as a combined exercise for an indicative system that could be promoted at the Site.

Water quality modelling results indicate that the stormwater quality objectives will be achieved for the additional industrial estate area with use of commonly accepted treatment systems including swales and a bio-retention system. The proposed systems integrate with the current (indicative) site design and aim to avoid potential constraints such as riparian setbacks to Maori Creek. Further design development is required to further test aspects of civil integration for the selected stormwater management measures and system performance should be confirmed again at this later stage.

In terms of water quantity, assessments were completed using hydrologic models of the likely benefit of a detention basin to retard peak flows. The Byron Creek catchment at the location of the site is extensively rural and downstream of Bangalow. Modelling indicated that the inclusion of the 1 ha industrial allotment resulted in insignificant change to peak flows downstream of the site. As such, the addition of a detention basin was not considered of measurable value and has been excluded from the conceptual design.

Contents

List of Figures

List of Tables

1 Introduction

1.1 Project Overview

A portion of land described as Lot 4 on DP 635505 is proposed for rezoning from rural (RU1) to a land use compatible with industrial/commercial uses. The rezoning will facilitate the sub-division of this land to provide several individual allotments. The development will (in effect) extend the current Bangalow Industrial Estate to the east.

BMT has been engaged to prepare a high-level Stormwater Management Plan (SMP) for the site that integrates stormwater quality and quantity control measures. The concepts included in this SMP are high level and reflect a potential full-site design that allows for individual lot runoff to be treated at a single location, rather than on each lot once subdivided. The future progression of land sale and use, and potentially development of individual SMPs for each separate lot may also be a realistic outcome for the overall development.

The SMP takes into account flood conditions prevalent at the site which have also been assessed by BMT as part of a broader scope of works.

The stormwater quality and quantity measures outlined in the SMP are to as far as practicable, integrate with the site and environment (particular riparian corridors) such that outcomes are cost effective, maintainable and aesthetically suited.

The report is structured as follows:

- Section 2 – Stormwater Objectives and Modelling Overview.
- Section 3 – Opportunities and Constraints.
- Section 4 – Stormwater Assessments.
- Section 5 – Findings and Conclusion.

1.2 Site Location

The site is located immediately to the south-west of Bangalow, and lies in between the existing Bangalow Industrial Estate, Lismore Road, Maori Creek and the North Coast Railway Line. The site is approximately 1.5 ha and has approximately 200 m fronting Maori Creek.

The site location is shown in Figure 1-1. Note that the development is proposed only on the western portion of the lot highlighted (i.e. on the western side of Maori creek).

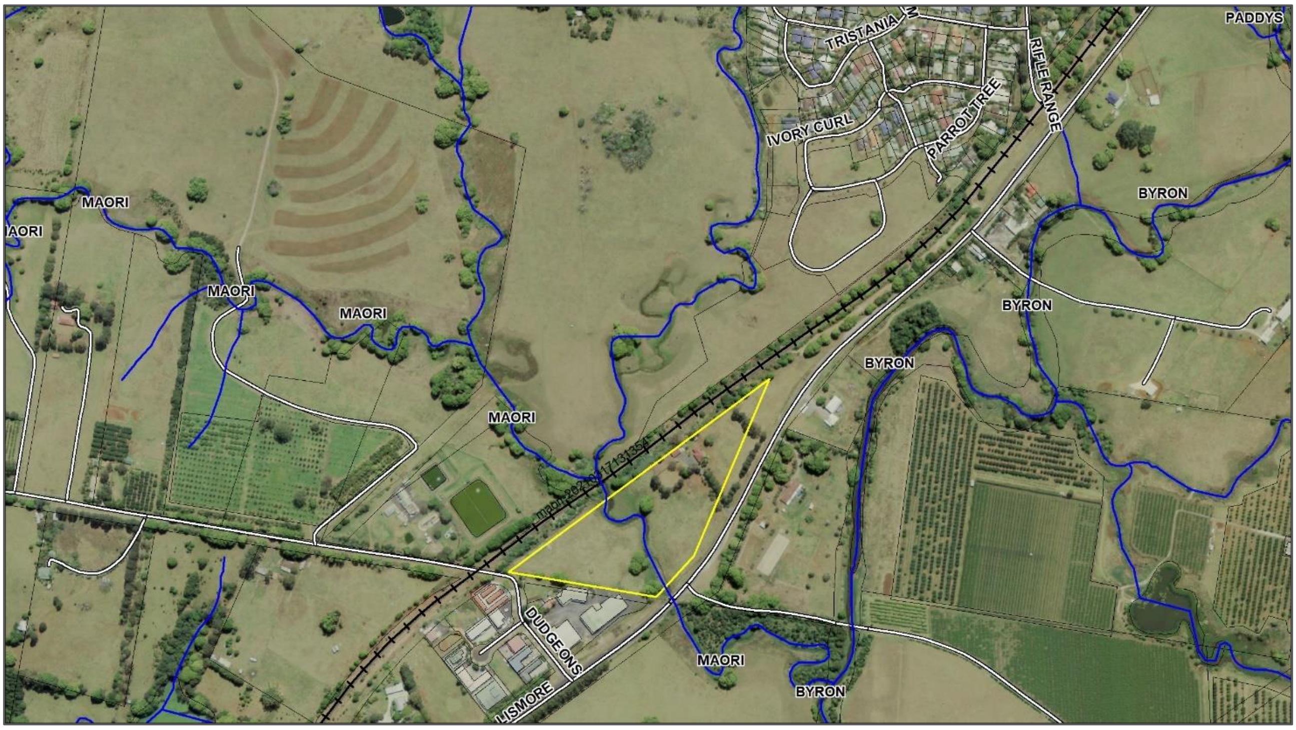

Figure 1-1 Site Locality

1.3 Existing and Proposed Development

In reference to the locality map shown in Figure 1-1. The existing land use is cleared rural paddocks, with scattered trees mainly in the southern end adjacent Lismore road and Maori Creek.

The future land use of the site is industrial and or commercial. The land is be serviced and include an internal road that accesses several future allotments. Specific individual uses of the lots are currently unknown. The creek frontage will be retained as riparian setback. As identified in the flood study, fill will be required along the eastern portion of the site to provide flood immunity.

A potential future lot layout is shown in Figure 1-2.

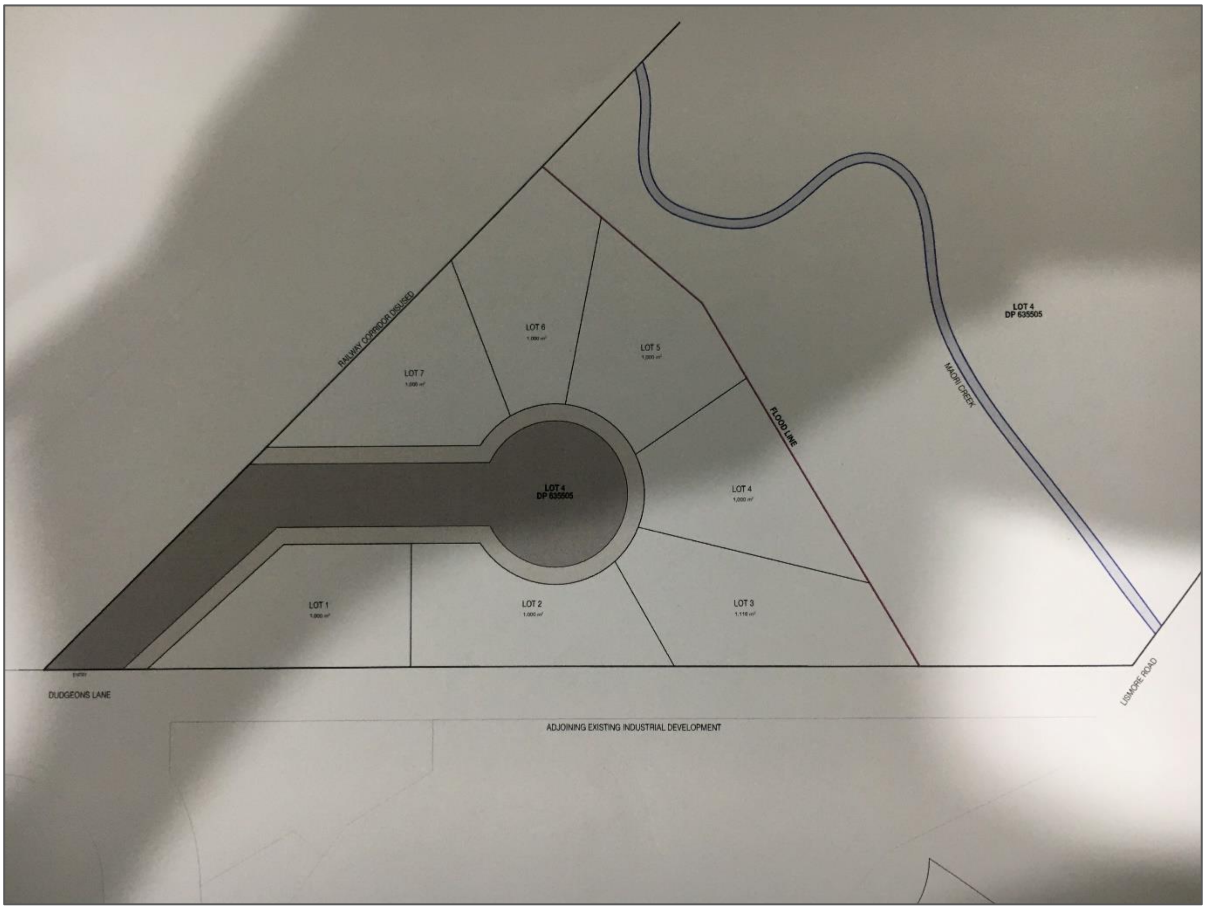

Figure 1-2 Potential site lot layout

1.4 Site Topography and Drainage

The site is gently sloping from west to east. The highest site elevation in the west is around 43.4 m AHD and at its lowest approximately 38m AHD at the creek line. The site has a slight depression in the south eastern corner.

The North Coast Railway Line sits on an embankment varying at 1 to 2 m higher than typical site elevations. The railway line has a bridge over Maori Creek as shown in Figure 1-3. Flow in Maori Creek is from north to south.

Lismore Road is also elevated above the site and Maori Creek. Maori Creek drains towards Byron Creek via 3 large concrete culverts as shown in Figure 1-4. Byron Creek is approximately 500m downstream of this crossing of Lismore Road (see also Figure 1-1).

Site survey was conducted to supplement existing LiDAR survey which was collected by NSW Government (Land and Property Information) in 2010. Survey of site ground levels relative to LiDAR were found to be within close agreement. Levels and other relevant details of Lismore Road, the North Coast Railway Line and cross-drainage structures were also obtained during site survey to inform hydraulic flood modelling (Cantys Surveying, March 2016). A digital elevation model of the existing site is shown in Figure 1-5.

Figure 1-3 Railway Bridge over Maori Creek

Figure 1-4 Culverts structures under Lismore Road on Maori Creek

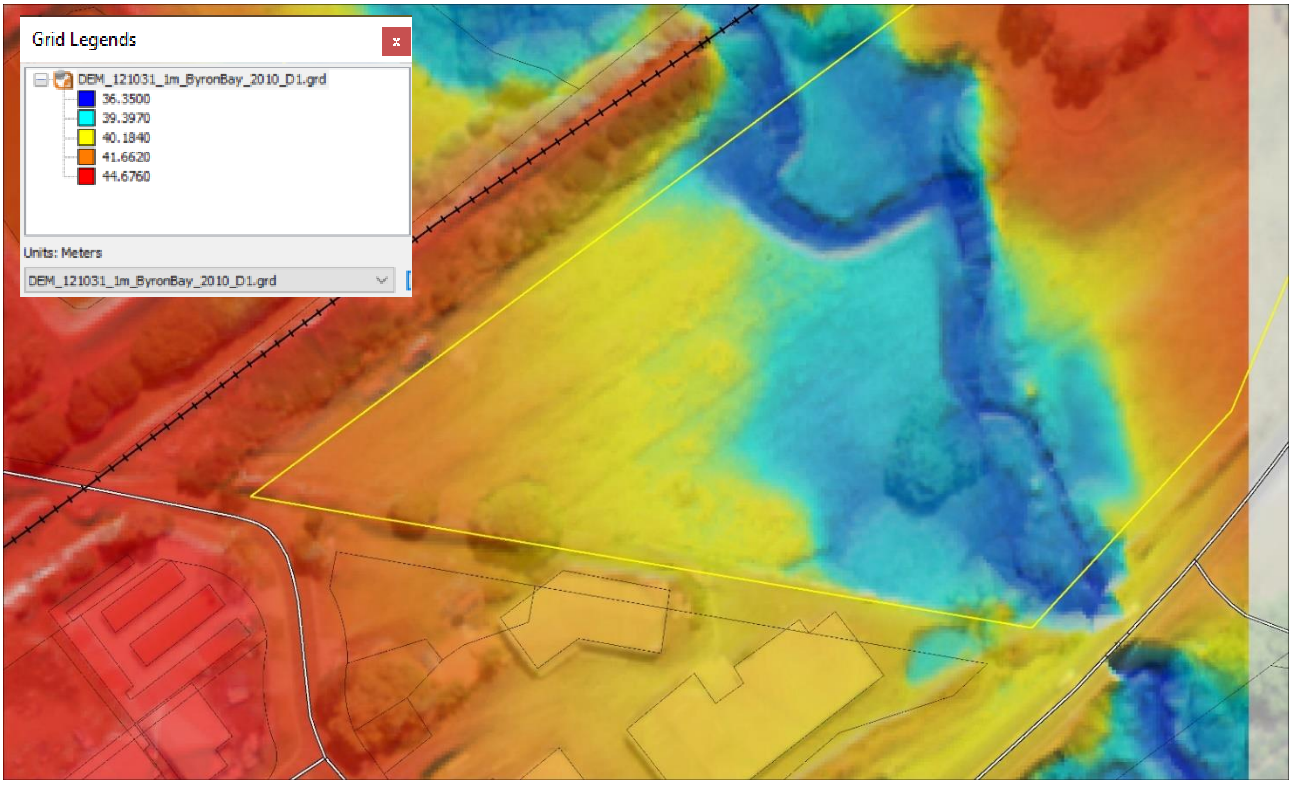

Figure 1-5 Existing Site Digital Elevation Model

1.5 Flooding

BMT has completed a Flood Impact Assessment (FIA) study of the proposed site filling using a 2-dimensional flood hydraulic model developed as part of previous flood studies for the Byron Creek catchment. The impacts of filling on peak flood levels have been assessed within the FIA.

2 Stormwater Objectives and Modelling Overview

2.1 Stormwater Management Objectives and Targets

2.1.1 Stormwater Quality Objectives

The stormwater management objectives to be achieved by this project include both quality and quantity objectives (Byron Shire Council, 2014 and 2014a).

As the proposed development involves an area of land greater than 2,500 m^2, the operational phase stormwater solution for the site must provide measures to address the “key” pollutants for all stormwater flows up to 25% of the 1-year ARI peak flow from the development site. Key pollutants are outlined in Table 2-1 (BSC, 2014a).

Table 2-1 Byron Shire Council Stormwater Quality Objectives

Table B3.2 – Pollutants and Retention Criteria

Pollutant / Issue	Retention Criteria
Litter	70% of average annual load greater than 5mm.
Coarse Sediment	80% of average annual load for particles 0.5mm or less.
Fine Particles	50% of average annual load for particles 0.1mm or less.
Total Phosphorous	45% of average annual load.
Total Nitrogen	45% of average annual load.
Hydrocarbons, motor fuels, oils & grease	90% of average annual load.

2.1.2 Stormwater Quantity Objectives

In terms of stormwater quantity, the on-site stormwater detention requirements of Council apply (except for discharge to tidal waterways). Council’s guidelines identify requirements that post-development flow is to be controlled to be no greater than the pre-development flow for all storm events up to the critical 100-year ARI event.

2.2 Stormwater Quality Modelling Overview

2.2.1 Model Description

Stormwater quality modelling was undertaken to estimate the hydrology and load of common stormwater pollutants (i.e. TSS, TP and TN) generated by the site using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC). MUSIC includes algorithms to evaluate the hydrology and concentrations / loads in stormwater runoff from urban catchments as well as estimate the performance of selected stormwater management measures to capturing these pollutants and achieve load and/or concentration reductions in discharges of stormwater.

MUSIC was designed to continuously simulate urban stormwater systems over a range of temporal and spatial scales utilising historically representative rainfall data. MUSIC is considered within the engineering industry to be an appropriate conceptual design tool for the analysis of runoff water quality in the urban environment.

The hydrologic algorithm in MUSIC is based on the model developed by Chiew & McMahon (1997). The model simplifies the rainfall-runoff processes and requires input of the following variables to perform the hydrological assessment:

- Rainfall data (time steps varying from 6 minutes to 1 days);
- Areal potential evapotranspiration (PET) rates;
- Catchment parameters (area, % impervious and pervious areas);
- Impervious and pervious area parameters (rainfall threshold, soil and groundwater parameters); and
- Storm event and base flow stormwater pollutant concentrations.

MUSIC can be applied for comparison of alternative scenarios that adopt the same base inputs. Although the magnitude of the estimates may not be equivalent to actual site conditions (due to limitations in available data for a particular site), the relative differences between scenarios is expected to be appropriate for decision making.

The MUSIC modelling approach applied to estimate stormwater pollutant loads for the Site is described in the following sections.

It should be noted that MUSIC modelling approaches have followed those recommended within the MUSIC Modelling Guidelines developed by Healthy Land and Water (2018). While currently a consultation draft, this version is noted to be extensively similar to earlier MUSIC modelling guidelines published by this organisation.

2.2.2 Rainfall and APET

The meteorological template includes the rainfall and areal potential evapotranspiration (APET) data and forms the basis for the hydrologic calculations within MUSIC.

The nearest Bureau of Meteorology (BoM) continuously recording rainfall station is located at the Federal Post Office (Station 58072) approximately 15 km west of the Site and is significantly elevated compared to the Site. This gauge was found not to be representative of the long-term rainfall at the Site due to its location.

Due to the sparsity of long-term rainfall intensity records in proximity to the site, the Alstonville Tropical Fruit Research Station (Site 58131). This gauge is commonly utilised for MUSIC assessments and is recommended by Ballina Shire for assessments across their Shire. A 20 year simulation period has been adopted extending from 1/1/1989 to 1/1/2009. During this period mean annual rainfall was noted at 1,631 m.

Average monthly areal potential evapotranspiration (PET) rates adopted for the MUSIC modelling are summarised in Table 2-2. These values are specific also to the Alstonville gauge.

A 6-minute time step was adopted for the MUSIC modelling.

Table 2-2 Adopted Average Monthly Areal PET Rates

Month	Mean daily areal PET (mm)
January	6.41
February	5.99
March	5.04
April	3.56
May	2.29
June	1.75
July	1.76
August	2.24
September	3.39
October	4.91
November	5.90
December	6.68

2.2.3 Land Use

Land use categories based on the existing and proposed site conditions are summarised in the respective modelling sections (refer to Section 2.2.3 and Section 4.3.1 for land use descriptions for stormwater quality and quantity modelling, respectively).

For stormwater quality purposes the site's land use has been treated as a single industrial/commercial land use (i.e. 'lumped' land use) in accordance with the methodology outlined in HLW (2018). This approach is appropriate for modelling development applications in MUSIC and also for broad-scale planning. Currently definition of individual uses and site designs for allotments is unknown and this makes splitting the catchment into road, ground level and roof impractical due to the large number of assumptions required. Further detail on areas is included in Section 4.3.1.

2.2.4 Rainfall-Runoff Parameters

Modelling of the rainfall-runoff process in MUSIC requires the definition of one impervious surface parameter and eight pervious surface parameters. The impervious surface parameter (rainfall threshold) and pervious surface parameters utilised were the default MUSIC hydrologic parameters for Commercial / Industrial land use, as summarised in Table 2-3.

Table 2-3 MUSIC Rainfall-Runoff Parameters (HLW, 2018)

Impervious Area Parameters	Commercial and Industrial
Rainfall Threshold (mixed urban surfaces, mm)	1.0
Pervious Area Parameters	
Soil Storage Capacity (mm)	18
Initial Storage (% of capacity)	10
Field Capacity (mm)	80
Infiltration Capacity Coefficient – a	243
Infiltration Capacity Exponent – b	0.6
Groundwater Properties	
Initial Depth (mm)	50
Daily Recharge Rate (%)	0
Daily Baseflow Rate (%)	31
Daily Deep Seepage Rate (%)	0

2.2.5 Runoff Quality Parameters

MUSIC requires stormwater constituent concentrations for storm flow and base flow for the site's land uses. These concentrations are converted to logarithmic values for input into MUSIC. The adopted $\log_{10}$ values are summarised in Table 2-4.

Table 2-4 Lumped Land Use Concentration Parameters (mg/L-log10) (HLW, 2018)

Surface Type	TSS		TP		TN	
	mean	std. dev	mean	std. dev	Mean	std. dev
Industrial/Commercial Base Flow	0.78	0.45	-1.11	0.48	0.14	0.20
Industrial/Commercial Storm Flow	1.92	0.44	-0.59	0.36	0.25	0.32

2.3 Stormwater Quantity Modelling Overview

A detailed local hydrologic model has been developed for the Byron Creek catchment. The hydrologic model was developed as part of the process of developing a flood hydraulic model for the catchment. These models have been utilised to complete the Bangalow Industrial Estate Flood Impact Assessment (FIA) for the development and has been reported separately.

The hydrologic model has been also been utilised in this Stormwater Management Plan to assess quantity management requirements to accord with Council guidelines as per Section 2.1.2. For full details on the hydrologic model please refer to the Bangalow Industrial Estate Flood Impact Assessment.

3 Opportunities and Constraints

This section identifies site opportunities and constraints for stormwater management. The opportunities and constraints were identified in consideration of existing site conditions, and the intended future use of the site.

3.1 Opportunities

Some of the key opportunities identified for this Site include:

- Setbacks from Maori Creek that were required to maintain flood storage volumes and minimise flood impacts. Some of these areas remain out of riparian setbacks (to Maori Creek) and can be considered for stormwater management; and
- Site slopes are gentle and trend towards Maori Creek. The fall of land can be maintained after filling for flood immunity, this can maintain gentle grade lines towards potential treatment systems (quantity and or quantity) adjacent (but setback) from Maori Creek. Gentle grades of less than 4% are suited to the use of swales.

3.2 Constraints

Some of the key constraints identified for this Site include:

- Setbacks from Maori Creek for preservation of riparian corridors. Setbacks to this level 3 stream are 30m from the creek bank (which is relatively close to the creek centreline for Maori Creek); and
- Ground water levels require confirmation. High ground water may interfere with the operation of specific types of stormwater management measures that utilise infiltration.

In summary, the approach considered for stormwater management makes maximum benefit from the natural opportunities afforded by the site. Consideration has been applied to using areas external to the proposed fill platform that is within the site boundary, but external to areas required for riparian setback.

4 Stormwater Assessments

The following sections provide the stormwater quantity and quality assessments.

4.1 Model Preparation

To support the quality and quantity modelling the catchment of the proposed development has been determined. It has not been necessary to break the catchment up into smaller catchments, due to limited upstream catchment area and uniformity of drainage path (i.e. it's possible to drain the entire site to a single location).

The process for preparing data for models includes:

- review of the existing site including site inspection;
- review of site survey conducted by others;
- preparation and review of GIS data for the existing site and the post-developed site, particularly elevation data and cadastral boundary information;
- consideration of potential sites for placement of stormwater quality and/or quantity devices; and
- consideration of the nature of the existing land use and post-developed land use.

Without providing exhaustive information on the above model preparation steps, Figure 4-1 has been prepared to illustrate the developed sites catchment and land use for the purposes of modelling.

It is likely that upstream catchments including the existing Bangalow Industrial Estate and railway embankment can be diverted around the site using an existing easement and or shallow grassed diversion channel around the site. For the purposes of MUSIC modelling, there are no upstream flows accessing the site. Additionally, Areas outside of the fill extent (adjacent Maori Creek) are not proposed to be developed and do not form part of the MUSIC model.

Figure 4-1 MUSIC Model Catchment Extent and Land Use (red bounded area)

4.2 Selection of Stormwater Management Measures

The process of selecting potential stormwater management measures has been to primarily avoid site constraints and take advantage of identified opportunities. Some of the key considerations in selecting and siting potential management measures have included:

- Presence (or likely presence) of suitable gradient;
- Presence (or likely presence) of available space to effect treatment;
- Presence (or likely presence) of subsurface features which may restrict treatment options including services, groundwater, etc;
- Presence of riparian setbacks;
- Visual appearance of the selected infrastructure in the environment and likely compatibility; and
- Ability to access and ease of maintenance.

Further descriptions are provided in the following sub-sections and in Section 3.

The stormwater management measures selected for the developed site are outlined in Figure 4-2 and are described further in the following sections.

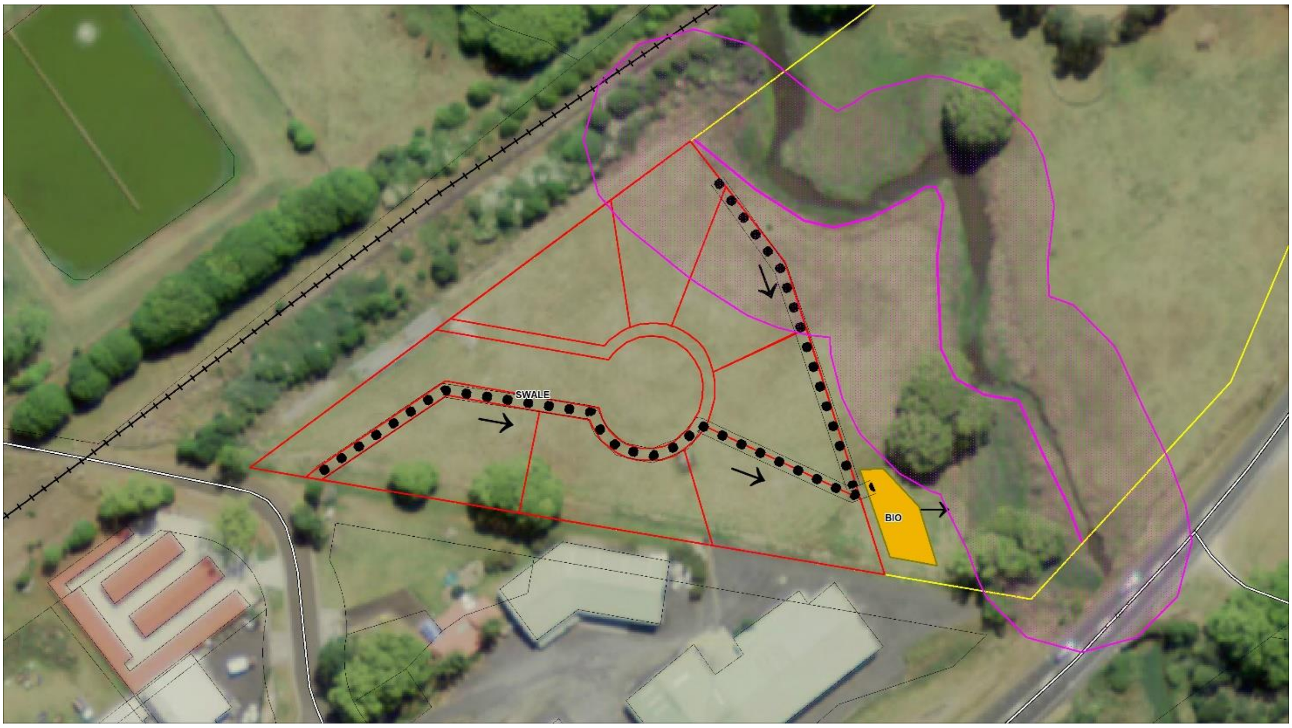

Figure 4-2 Types and Locations of Selected Stormwater Management Measures

4.3 Stormwater Quality Modelling

4.3.1 Changes in Load Generation and Load Reduction Targets

MUSIC models have been developed for the site's catchment to enable accurate estimation of the effect of the development on pollutant discharge. The total modelled area is 1 ha. The existing site is cleared agricultural (grazing land). With the proposed development, the area of hardstand (i.e. road, roof, driveway, etc) increases with a corresponding decrease in the pre-existing land-use, as outlined in Table 4-1.

Table 4-1 Developed Land Use

Surface Type	Area (ha)	Imperviousness (%)
Industrial / Commercial	1	90%*
Total	1	90%*

* Recommended in Table 3.7 HLW, 2018m typical Impervious Fraction for Lumped Catchment Land Use

Developed unmitigated modelling results are provided in Table 4-2.

Table 4-2 MUSIC Modelling Results – Developed Unmitigated Site

Parameter	Annual Loads Existing Site (unmitigated)
Total Suspended Solids (kg/yr)	2,000
Total Phosphorus (kg/yr)	5.2
Total Nitrogen (kg/yr)	33.4
Gross Pollutants (kg/yr)	337

4.3.2 Stormwater Quality Measures

A variety of stormwater management measures have been integrated into the existing case MUSIC model as treatment nodes. Selected measures include:

- Swales; and
- Bio-retention system.

Stormwater management measures selected are outlined in Figure 4-2. The MUSIC model structure is outlined in Figure 4-3.

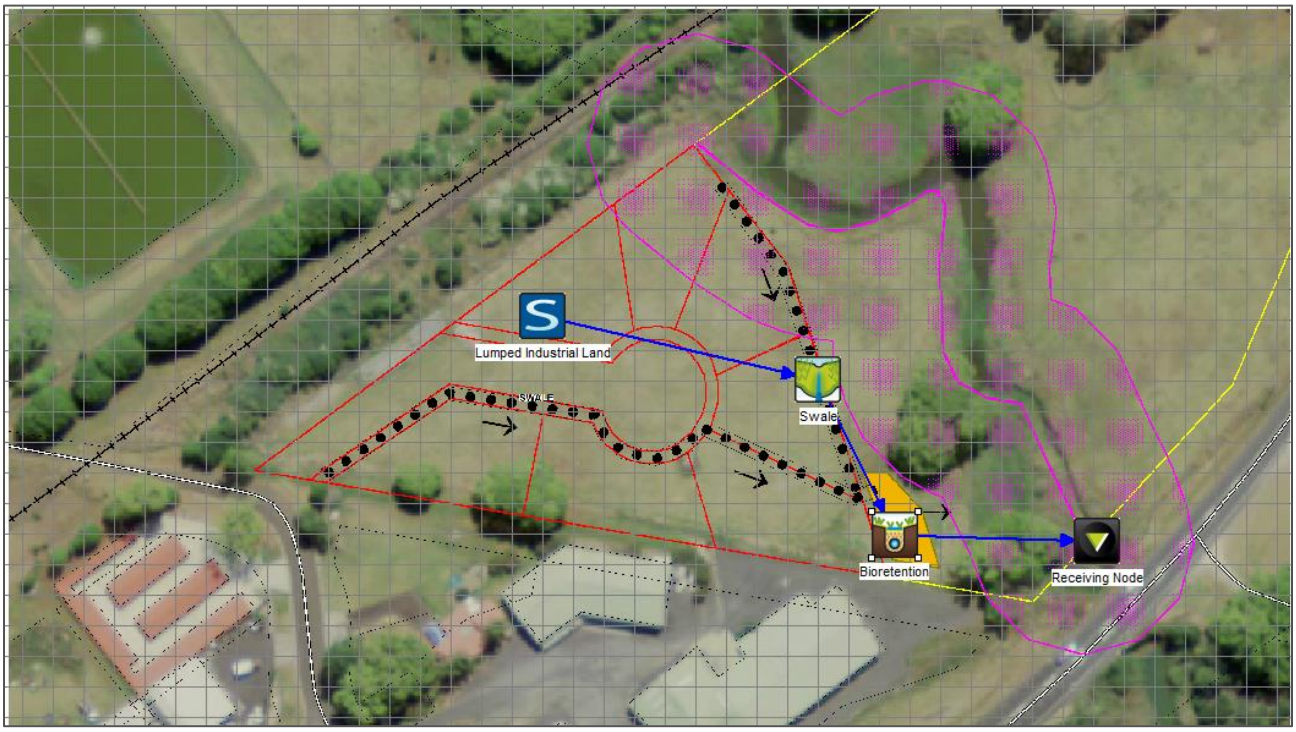

Figure 4-3 MUSIC Model Arrangement

Swale(s)

The location of swales are indicative, but it is likely that they could be accommodated adjacent the internal road (with site accesses designed accordingly), and or along the eastern fill boundary draining towards the location of the proposed bio-retention basin. Swales are an ideal pre-treatment for bio-retention systems due to their propensity to collect coarse to medium sized sediments and ability trap a large percentage of gross pollutants.

The swale sizing for flow capacity is estimated at this stage, however, a part of detailed design the swale would be sized to convey the required major/minor flow by itself or in combination with a piped network. Normally major flows are contained within the road reserve and with the provision of an easement this flow path could be directed towards the site's stormwater quantity control systems.

Properties for the swale are provided in Table 4-3.

Table 4-3 Specifications for swales

Parameter	Swale
Low Flow bypass (m^3/s)	0
Length (m)	60
Bed slope (%)	1
Base Width (m)	0*
Top width (m)	4
Depth (m)	0.3
Vegetation height (m)	0.1
Exfiltration Rate (mm/hr)	0

*provides for mowable 1:4 batters

Bio-retention Basin

A single bio-retention basin style system is proposed to improve the quality of the site's runoff. Key design parameters for the bioretention include:

- It will bypass three month flows around the sediment basin as a 'high flow' bypass. This will protect bio-retention system vegetation. Currently the high flow bypass has not been set. Application of the high flow bypass is not expected significantly affect the performance of the bio-retention basin as high flows will primarily exist the basin by the weir with minimal treatment. The high flow bypass system would need to be located between the site's drainage system and the bio-retention system.
- The bio-retention basin style proposed is that of a pipeless system. As per the methodology of the outlined in HLW (2018). Key assumptions which will need to be confirmed include the depth of groundwater on-site below the location of the proposed system, as well as confirmation of surrounding soil hydraulic conductivity. As per regional soil mapping, the locality of the site is

characterised by well-drained Krasnozems soils (red soils), although some lenses of alluvial soil exist along drainage lines as per DECCW mapping Sheet 9540-9640.

- The bio-retention basin will be planted out in suitable species for nutrient retention and uptake.
- As the system is unlined on its base, exfiltration to groundwater has been assumed at the rate of 3 mm/hr which is appropriate for a medium clay soil. Soil conditions/saturated hydraulic conductivity (through double ring infiltrometer testing or similar) would need to be confirmed on site as part of detailed design activities.

Properties for the bio-retention system are provided in Table 4-4.

Table 4-4 Specification for bio-retention basin

Parameter	Value
Low Flow bypass (m^3/s)	0
High Flow bypass(m^3/s)	100
Extended Detention Depth (m)	0.3
Surface Area (m^2)	275
Filter Area (m^2)	240
Unlined Filter Media Perimeter (m)	60
Saturated Hydraulic Conductivity (mm/hr)	180
Filter Depth (m)	0.5
TN content of Filter Media (mg/kg)	400
Orthophosphate Content of Filter Media (mg/kg)	30
Exfiltration Rate (mm/hr)	3
Lined	No
Vegetated	Vegetated with Effective Nutrient Removal Plants
Overflow Weir Width (m)	3
Underdrain Present	No
Submerged Zone	No

Modelled Results

The modelled results of the developed mitigated site are included in Table 4-5.

Table 4-5 MUSIC Modelling Results – Developed Unmitigated Site

Parameter	Annual Loads Existing Site (unmitigated)	% Reduction
Total Suspended Solids (kg/yr)	249	87
Total Phosphorus (kg/yr)	1.41	72.1
Total Nitrogen (kg/yr)	17.7	44.9
Gross Pollutants (kg/yr)	0	100

Outcomes of the MUSIC modelling indicate that the stormwater objectives will be achieved for the proposed development. Design of the stormwater measures will ensure integration for the selected stormwater management measures with the civil design.

Access

Access to the bio-retention system will be required via easement from the internal service road. Allowance for this access will be determined during detailed site design. If the bio-retention system is to be handed to Council, then an easement may also be required over this access providing this long-term access.

4.4 Stormwater Quantity Modelling

In terms of quantity management, BMT has considered the potential benefit of integrating a detention basin into the stormwater treatment system to mitigate peak flows. However, the proposed development is relatively small in a primarily rural catchment with a hydraulic restriction immediately downstream. Hence, prior to simply adopting the detention basin, the likely hydraulic benefit of the proposed detention basin has been assessed.

The Byron Creek catchment hydrologic model (see the Bangalow Industrial Estate Flood Impact Assessment for further details) was used to assess differences in peak flows with and without the development. To achieve this, the model was adjusted to represent both the pre-and post-development scenarios. For the developed scenario, an imperviousness value of 90% was adopted for the proposed site, while in the existing scenario, it was assumed to be 100% pervious.

Flow results for critical duration events were obtained for the sub-catchment located directly downstream of the Industrial Estate area. As Table 4-6 indicates, differences in peak discharges between the developed and existing scenarios are negligible. This finding is further supported by Figure 4-4, which displays the flow scheme of the Industrial Estate downstream sub-catchment for both the developed and existing 1% AEP, 5% AEP and 20% AEP scenarios. As can be observed, both the developed and existing discharge level trends match one another, with no notable change.

Table 4-6 Peak Discharge results for critical duration events at Industrial Estate downstream sub-catchment

Event (AEP)	Developed Scenario Peak Discharge (m³s)	Existing Scenario Peak Discharge (m³s)	Difference (Developed – Existing)
1%	339.15	339.17	-0.02
2%	293.60	293.60	0
5%	226.46	226.46	-0.04
10%	186.20	186.20	-0.02
20%	145.63	145.63	-0.05
50%	84.60	84.60	0
63.2%	68.97	68.97	0

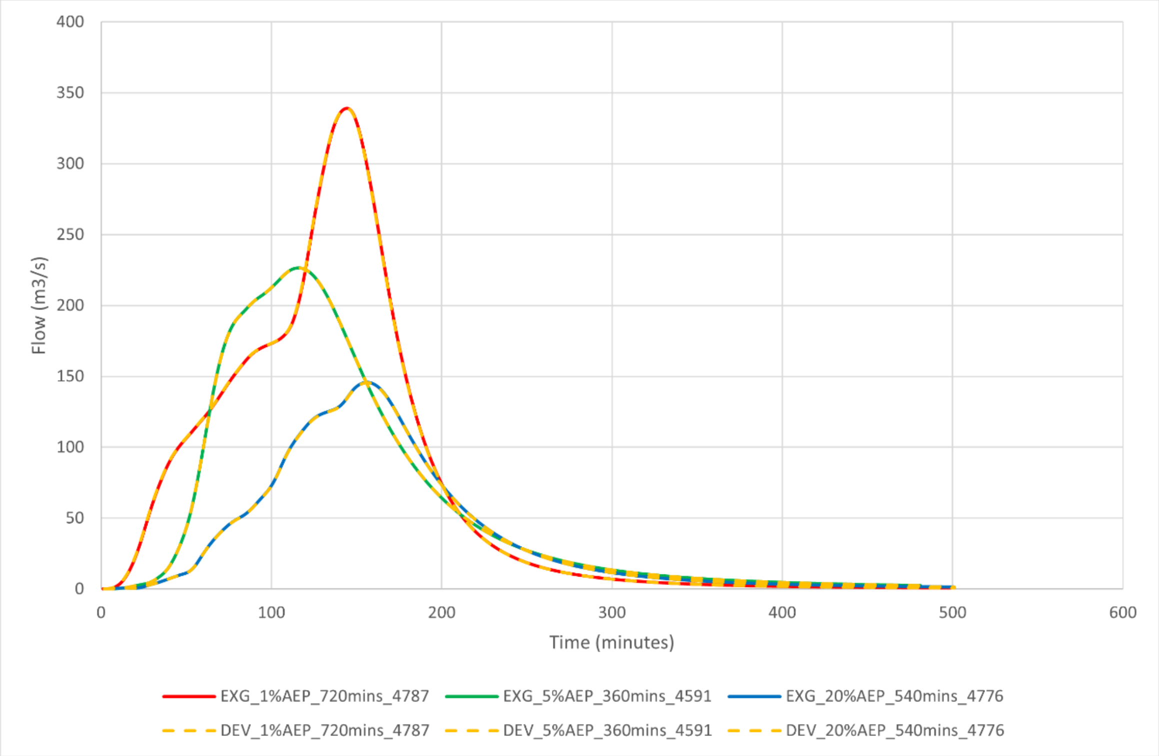

Figure 4-4 Critical duration hydrographs for Industrial Estate downstream sub-catchment

4.5 Riparian Corridor

Hydro lines are referred to by the Water Management (General) Regulation 2018. The hydro line spatial data is a dataset of mapped watercourses and waterbodies in NSW. It is based on the Spatial Services (Department of Finance, Services & Innovation) NSW Hydro Line dataset. Hydro line mapping for the site, shows the presence of Maori Creek in the east.

There are a variety of ‘controlled activities’ on waterfront land, where ‘waterfront land’ includes the bed and bank of any river, lake or estuary and all land within 40 metres of the highest bank of the river, lake or estuary. The proposed site development may require assessment to ensure that no more than minimal harm will be done to waterfront land as a consequence of carrying out the controlled activity if controlled activity works are proposed within the 40m boundary.

Within the waterfront land extent, there is a recommendation for minimum vegetated riparian zones (VPZ) that varies according to the steam order of the waterway. Using the Strahler system of stream order, Maori Creek is stream order 3. This provides a VPZ of 30m either side of the bank of the channel.

The hydro line mapping appears relatively coarse at the site scale and this may be due to the methods used to create this dataset. When compared to LiDAR for the site a relatively clear top of bank is observed typically within about 10m of the physical location of Maori Creek as observed in LiDAR and aerial photography. In the southern portion of the site the landform appears to include a former flowpath and historical outer creek banks. As Maori Creek is located in areas of alluvial and krasnozems soils, its location is expected to meander over long time scales in responses to flood events, etc. Adopted these older outer banks of the former flowpaths would impose excessive restriction on site use and results in VPZs of in excess of 70m from the current assumed creek bank.

In the north-eastern corner of the site it is proposed to bring the development boundary close to the actual top of bank as this ground has higher elevation and is most suited to development. While the development will pull significantly away from the creek line in the southern portion with setbacks in excess of 50m from the estimate top of bank. This balance of give and take with the VPZ is expected to provide an average VPZ approximately equivalent to the required VPZ across the site. Additionally, the proposed stormwater quality systems have been located outside of the VPZ. The site is primarily cleared grass lands with sporadic mature camphor laurels in the southern extent. As part of the development the VPZ would be revegetated with native endemic riparian plant species.

Figure 4-5 includes approximate mapping details of the potential development, including approximate location of top of bank (showing DEM and aerial underneath), along with the 30m VPZ to Maori Creek. It can be seen by eye that an approximate balance of area for the VPZ is achieved with the alignment. Further assessment of areas could be completed at later project stages as required.

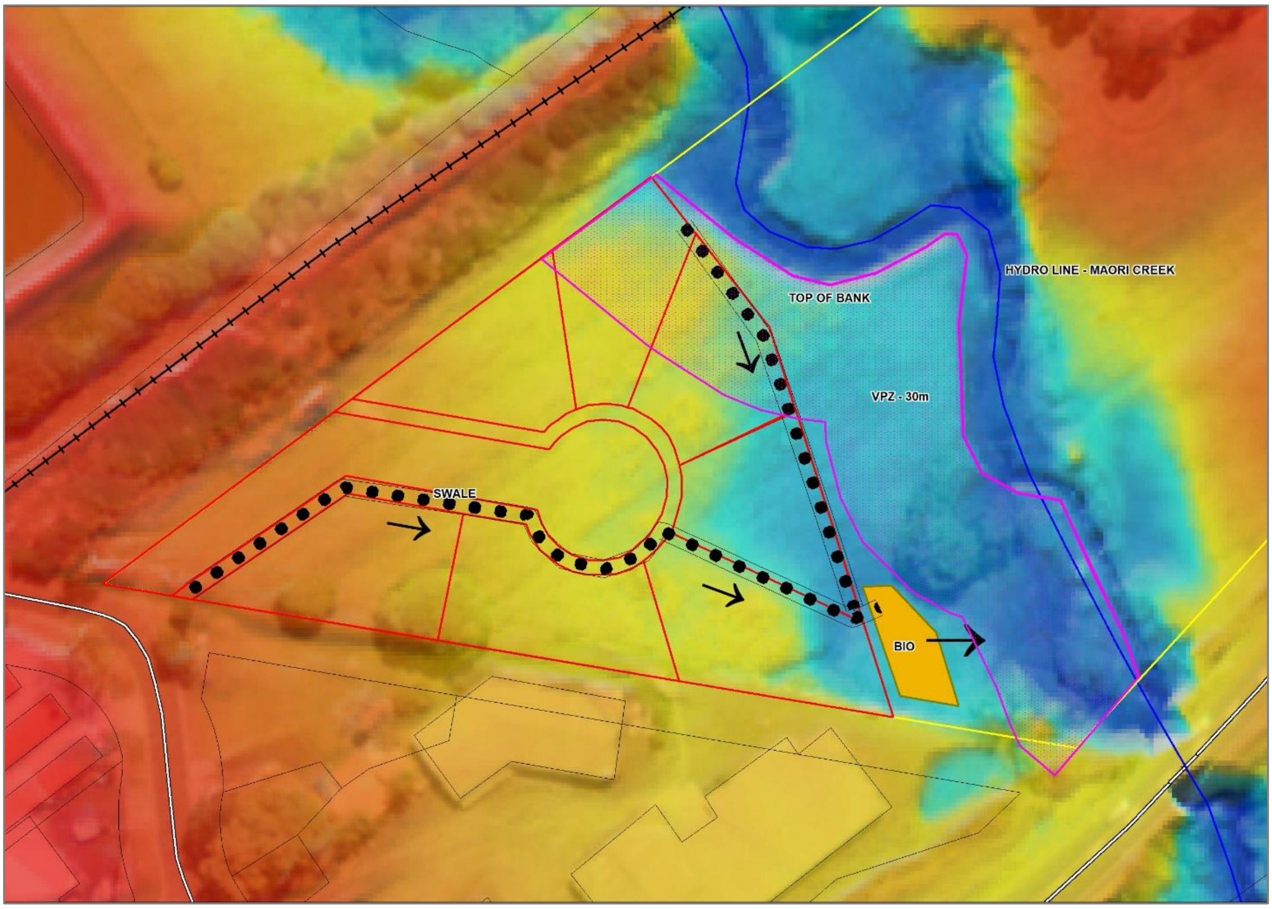

Figure 4-5 Approximate location of Hydro Line, Top of Bank and VPZ

5 Findings and Conclusions

This report has developed and assessed a conceptual stormwater quality and quantity system for the proposed industrial/commercial development adjacent the current Bangalow Industrial Estate.

Stormwater objectives are relevant for both water quality and quantity, where water quality objectives include a set of pollutant load reduction targets, and quantity objectives require mitigation of peak post-development flows to existing case conditions.

In terms of water quality, the assessment approach has been to utilise MUSIC to test the performance of the conceptual stormwater management systems and demonstrate achievement of Council's water quality objectives.

MUSIC models were established for the development based on diverting upstream flows and draining the site via swales to a bio-retention system. Site inspections completed during the study furthered site understanding of opportunities, constraints, and existing site features and assisted in the identification of potential stormwater management options and locations. The high-level conceptual design is also cognisant of riparian corridor locations and setbacks to the bank of Maori Creek.

The outcomes of the MUSIC modelling indicate that the stormwater objectives will be achieved for the development using a variety of standard water sensitive urban design approaches and proprietary systems. Design of the stormwater measures will ensure integration for the selected stormwater management measures with the civil design.

Water quantity modelling was completed using an XP-RAFTS hydrology model developed previously by BMT for the Byron Creek catchment. The model was initially used to test the benefit of a detention basin in the middle of a large rural area when connected to a relatively small impervious development (the Site). It was found that the inclusion of the new industrial area did not significantly increase the peak flows downstream from the Site and it is not recommended to include a detention basin in the current design.

Overall, this SMP, including the design and assessment of mitigation measures identifies that stormwater quality measures can be accommodated in the project, allowing it to achieve Council's stormwater management targets for water quality, subject to confirmation of assumptions, and further design to integrate solutions into the overall civil design of the site. Stormwater quantity management was found not to be required on the basis of the small additional contribution of peak flow from the Site to flows in Byron Creek which generate the highest peak flood levels in the area.

6 References

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