Tweed Valley Hospital Development

Addendum 2 to Design Report

Civil & Structural

Issued for: State Significant Development Application – Response to Submissions

130559-BON-CIV-RPT-007

Revision: A

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Report Amendment Register

Rev. No.	Section & Page No.	Issue/Amendment	Author/Initials		Reviewer/Initials		Date
A		Addendum 2 to SSDA	Shebak Khan	SK	Stephen Naughton	SN	28/02/2019

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1. Introduction

The following has been prepared in response to the comments by NSW Department of Planning and Environment (DPE) as part of the Response to Submissions for the proposed new Tweed Valley Hospital Development. It is intended that the following is read in conjunction with the Civil and Structural Design Report prepared and submitted as part of the Concept Proposal and Stage 1 Early and Enabling Works, submitted under SSD 9575.

1.1. Additional Documentation

The following relevant additional documentation has been referenced in this document:

- MUSIC model “Tweed Murwillimbah 6m Rainfall”

2. Response to Submissions

2.1. Department of Planning and Environment (DPE)

Department of Planning and Environment (DPE) have made the following comments:

1. ***MUSIC model***

The MUSIC model has been independently reviewed and is considered unsatisfactory due to the following reasons:

Rainfall and potential evapotranspiration (PET) data – It appears that the applicant has not adopted Council's standard MUSIC template that incorporates the local rainfall and PET data. Council's template has rainfall data with an annual average of 1697mm. The adopted rainfall data has an average annual rainfall of 1436mm (approximately 15% lower). It is unclear why Council's standard template was not adopted for this site.

- Murwillumbah MLB file has been used. Results for this model run are discussed below and attached. The MUSIC model sqz file has also been provided.

Total catchment area – The total site areas modelled for the pre-development and post development condition were 17.04 ha and 19.68 ha. These areas should be the same to enable the treatment performance of the strategy to be compared. The total site area modelled also differs to that presented in Table 4-1 of the Design Report (i.e. 23.23 ha). The correct catchment area should be confirmed, and the models adjusted accordingly.

- Updated MUSIC catchment plans have been provided. Total MUSIC catchment area is 16.25ha for both pre and post. The difference in site area is explained in the catchment plans (attached) – it reflects the fact that the northern portion of the site is existing wetland, that is not to be changed. This area is excluded from the MUSIC model as it does not drain to any of the catchment areas nor is it to be changed as part of the proposed development.

Land uses – The pre-development land uses adopted for the site primarily comprise forest and agricultural areas. The estimated areas modelled for each of these land uses appears different to that suggested by recent aerial imagery.

- Updated MUSIC catchment plans have been provided. Total MUSIC catchment area is 16.25ha for both pre and post. See attached catchment plans for pre and post areas – the areas have been based on aerial photo, site survey and inspection.

  In pre:
  13.888ha agricultural
  0.065ha roof
  2.297ha forest

  In post
  4.349ha road/carpark
  2.313 roof (note that this is an allowance for building envelope and over 1.5 times greater than actual roof at present)

0.161ha treated forest
6.648ha treated residual vegetated land
2.577ha bypass vegetated land
0.202ha forest bypass

Rainfall-runoff parameters – Adopted pervious areas parameters differ between the pre and post development models. These parameters are based on the soils that exist with the site and should be the same for both models. The adopted parameters also appear to be inconsistent with relevant guideline values.

- Pervious parameters for pre and post have been adjusted and are the same in the attached MUSIC model. Data for this model run is attached. The MUSIC model sqz file has also been provided. The parameters used are taken from the documents specified in Tweed Shire Council Development Guidelines.

Treatment nodes – The post development model indicates that the extended detention depth in the bioretention swale would be 0.9m. The drawings indicate that biofiltration measures would have an extended detention depth of 0.15 to 0.5m. Typically, this depth should be around 0.3m maximum for a swale, and 0.6m for a bioretention basin to minimise the time vegetation would be inundated. The dimensions modelled should be adjusted to reflect what is proposed.

- The bio-retention basin extended detention depth has been updated (it was initially considered that the bio-retention would be incorporated in the detention basins – actual detail of this would be determined during detailed design, but depth could have been up to 0.9m, as this is what was modelled in DRAINS for water peak flows). The bio-retention area could be separated from the deeper detention area in the basins, and allowed to spill into the detention area once the maximum extended detention depth was reached. The subsurface underdrain pipes that convey the treated flows from the bio-retention would be connected to the outlet pit in the detention basin. Data for this model run is attached. The MUSIC model sqz file has also been provided.

Model configuration - The configuration of the treatment nodes in the model does not align with the concept outlined in the Design Report (i.e. Enviropods, swales, bioretention basin and detention basin) and on the drawings. The MUSIC model only includes one bioretention treatment node.

It is considered that the MUSIC models would need to be revised to appropriately reflect the Stage 2 WSUD strategy as proposed in the Design Report and on the drawings. Model inputs should be checked to ensure they accurately reflect the site, are consistent with current practice and reflect the requirements of Council. Adjustments to the proposed measures in the strategy may also be necessary to address the stormwater management issues that are of most concern for the wetland receiving runoff from the development site.

- The MUSIC model was provided to demonstrate that water quality targets could be met with bio-retention treatment measures, for the final fully constructed site incorporating buildings, roads as per the Architectural Masterplan. It was provided to demonstrate that the development is feasible and capable of meeting water quality requirements.

Additional treatment measures will also be provided – they will most likely include Enviropods (treating runoff from carparks and roads prior to discharge to bio-retention) and will include a Puraceptor or equiva(which will be required for the Helipad that is likely to be located on the roof). These treatment measures were not included in the model, as the progression of the architectural design has not advanced to a stage where the catchment areas draining to these measures is known. These additional treatment measures would provide higher rates of pollutant removal, which may allow reduction in bio-retention area provided (to be determined during further detailed design). The MUSIC model sqz file has been provided.

It is considered that concluding that Council's water quality targets would be achieved for the Stage 2 works is not possible at this stage based on the provided strategy and modelling. However, the discrepancies in the MUSIC model are required to be clarified and a correct model submitted.

It has been demonstrated that the bio-retention treatment measures meet the water quality targets for the current proposed Stage 2 architectural layout. Due to the current level of design detail, the catchments and treatment measures were "lumped". As the design progresses, the MUSIC model will be refined to reflect discrete catchments and treatment measures that will be provided to them. The required area of bio-retention to treat the site is 2,000m^2. The basins at the north of the site have significantly more area than that required for bio-retention, with almost 3000 m^2 of basin base area available. Note that the bio-retention area required will be reduced as the MUSIC model is developed in conjunction with the architectural layout, as Enviropods and Puraceptors etc are utilised. This is subject to detailed design. Note that the MUSIC model was only produced to demonstrate that the development was feasible (and able to meet water quality targets).

2. Drainage treatment Strategy

The Design report states that the stormwater would drain into a bio-filtration swell and then discharge into the wetlands. However, the plans for the strategy indicate that stormwater treated through bioretention swales and basins would be discharged into the detention basins that function as dry sediment basins for water quality purposes.

This is likely to result in the treated water being mixed with sediment deposited in the basin and this would lower the runoff quality. Stormwater treated through bioretention should bypass the detention basins. This bypass flow should be accounted for when finalising the detention basin design. Notwithstanding that this can be considered in detail at a later stage, the discrepancies in the plans and reports should be addressed.

The required area of bio-retention (as single treatment measure) to treat the site in accordance with requirements is 2,000m^2 (800 m^2 of filter media area is required as shown in the MUSIC model). It is proposed to utilise bio-retention basins. The basins at the north of the site have significantly more area than that required for bio-retention, with almost 3000 m^2 of basin base area available. The bio-retention area could be separated from the deeper detention area in the basins, and allowed to spill into the detention area once the maximum extended detention depth was reached. The subsurface underdrain pipes that convey the treated flows from the bio-retention would be connected to the outlet pit in the detention basin, and would bypass the detention storage as noted by DPE. Note that the bio-retention area required will be reduced as the MUSIC model is developed in conjunction with the architectural layout, as Enviropods and Puraceptors etc are utilised. This is subject to detailed design. Note that the MUSIC model was only produced to demonstrate that the development was feasible (and able to meet water quality targets).

3. Sealing of haul roads

The SRtS states that the haul roads are going to be sealed. While this is considered to be an improvement (less dust to be generated), this has not been taken into consideration in the soil and water management plans or the Stage 1 civil drawings by Bonacci, neither mentioned in the MUSIC model. The square meter of haul roads have also not been provided. If sealed areas are proposed then water quality improvement measures should be implemented (triggers a MUSIC model). Please confirm whether the blue roads shown in the Stage 1 drawing are the sealed roads proposed? How are these roads proposed to be drained and water quality managed?

The sealed haul roads are part of construction staging and will be managed in accordance with the Soil and Water Management Plan. All runoff from the haul roads will be directed to the sediment basins. If all final roads and carparks are sealed for construction staging, the sealed area is approximately 4.349Ha. The preliminary stormwater system proposed to convey the runoff from haul roads and carparking areas is shown on Drawing C009 (attached). This will be further developed in consultation with the contractor – with the intention to utilise the construction stage stormwater system as part of the final stormwater system. The sediment basins have been sized based on the site being disturbed, as noted in the SWMP detailed calculations (refer attached Drawings C007, C008 and C009). The sealed haul roads and carparks are shown on this drawing, but result in lower area of disturbed soil (and hence a lower sediment basin volume). Water quality is managed through the Soil and Water Management Plan during construction, and no MUSIC model is required. In accordance with legislative requirements, the quality of the water that leaves the site must meet minimum requirements. The Soil and Water Management Plan must be operational until completion of the project (not just Stage 1). The Soil and Water Management Plan will be developed during further design and construction methodology workshops, and will need to be updated to show proposed stormwater systems and works zones. It is anticipated that a number of Soil and Water Management Plans will be required for the various stages of Construction – these should be provided prior to commencement of construction, once the final architectural layout, construction methodology and staging have been determined. The MUSIC model is provided for the final project stage, being hospital building, carparks and associated roads (and landscaping). It demonstrates that the operational facility can meet the water quality targets.

3. Appendix A – Civil Drawings

Note: These "Detailed Calculation" spreadsheets relate only to high erosion hazard lands as identified in figure 4.6 or where the designer chooses to use the RUSLE to size sediment basins. The "Standard Calculation" spreadsheets should be used on low erosion hazard lands as identified by figure 4.6 and where the designer chooses not to run the RUSLE in calculations.

1. Site Data Sheet

Site Name: TWEED VALLEY HOSPITAL

Site Location: TWEED VALLEY HOSPITAL CUDGEN ROAD KINGSCLIFF

Precinct: HEALTH

Description of Site:

Site area	Site						Remarks
	1	2	3	4	5	6a	
Total catchment area (ha)	1.9	3.12	2.17	0.34	0.21	0.86	
Disturbed catchment area (ha)	1.9	3.12	2.17	0.34	0.21	0.86	

Soil analysis

% sand (faction 0.02 to 2.00 mm							Soil texture should be assessed through mechanical dispersion only. Dispersing agents (e.g. Calgon) should not be used
% silt (fraction 0.002 to 0.02 mm)							
% clay (fraction finer than 0.002 mm)							
Dispersion percentage							E.g. enter 10 for dispersion of 10%
% of whole soil dispersible							See Section 6.3.3(e)
Soil Texture Group							See Section 6.3.3(c), (d) and (e)

Rainfall data

Design rainfall depth (days)	5	5	5	5	5	5	See Sections 6.3.4 (d) and (e)
Design rainfall depth (percentile)	85	85	85	85	85	85	See Sections 6.3.4 (f) and (g)
x-day, y-percentile rainfall event	62.5	62.5	62.5	62.5	62.5	62.5	See Section 6.3.4 (h)
Rainfall intensity: 2-year, 6-hour storm	15.9	15.9	15.9	15.9	15.9	15.9	See IFD chart for the site

RUSLE Factors

Rainfall erosivity (*R*-factor)	5750	5750	5750	5750	5750	5750	Automatic calculation from above data
Soil erodibility (*K*-factor)	0.015	0.015	0.015	0.015	0.015	0.015	RUSLE data can be obtained from Appendixes A, B and C
Slope length (m)	173	103	106	55	52	85	
Slope gradient (%)	6.36	13.9	4.9	25	7.1	18.8	
Length/gradient (*LS*-factor)	2.38	5.42	1.36	6.8	1.31	7.29	
Erosion control practice (*P*-factor)	1.3	1.3	1.3	1.3	1.3	1.3	
Ground cover (*C*-factor)	1	1	1	1	1	1	

Calculations

Soil loss (t/ha/yr)	267	608	152	762	147	817	
Soil Loss Class	3	5	2	6	1	6	See Section 4.4.2(b)
Soil loss (m^3/ha/yr)	205	467	117	587	113	629	
Sediment basin storage volume, m^3	66	248	43	34	4	92	See Sections 6.3.4(i) and 6.3.5 (e)

4. Volume of Sediment Basins, *Type D* and *Type F* Soils

Basin volume = settling zone volume + sediment storage zone volume

Settling Zone Volume

The settling zone volume for *Type F* and *Type D* soils is calculated to provide capacity to contain all runoff expected from up to the y-percentile rainfall event. The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle and can be determined by the following equation:

$$V = 10 \times C_v \times A \times R_{x\text{-day, y-\%ile}} \ (m^3)$$

where:

10 = a unit conversion factor

C_v = the volumetric runoff coefficient defined as that portion of rainfall that runs off as stormwater over the x-day period

$R_{x\text{-day, y-\%ile}}$ = is the x-day total rainfall depth (mm) that is not exceeded in y percent of rainfall events. (See Sections 6.3.4(d), (e), (f), (g) and (h)).

A = total catchment area (ha)

Sediment Storage Zone Volume

In the detailed calculation on Soil Loss Classes 1 to 4 lands, the sediment storage zone can be taken as 50 percent of the settling zone capacity. Alternately designers can design the zone to store the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(ii)). However, on Soil Loss Classes 5, 6 and 7 lands, the zone must contain the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(iii).

Place an "X" in the box below to show the sediment storage zone design parameters used here:

	50% of settling zone capacity,
X	2 months soil loss calculated by RUSLE

Total Basin Volume

Site	C_v	$R_{x\text{-day, y-\%ile}}$	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)
1	0.70	62.5	1.9	831.25	66	897.25
2	0.70	62.5	3.12	1365	248	1613
3	0.70	62.5	2.17	949.375	43	992.375
4	0.70	62.5	0.34	148.75	34	182.75
5	0.70	62.5	0.21	91.875	4	95.875
6a	0.70	62.5	0.86	376.25	92	468.25

Note: These "Detailed Calculation" spreadsheets relate only to high erosion hazard lands as identified in figure 4.6 or where the designer chooses to use the RUSLE to size sediment basins. The "Standard Calculation" spreadsheets should be used on low erosion hazard lands as identified by figure 4.6 and where the designer chooses not to run the RUSLE in calculations.

1. Site Data Sheet

Site Name: **TWEED VALLEY HOSPITAL**

Site Location: **TWEED VALLEY HOSPITAL CUDGEN ROAD KINGSCLIFF**

Precinct: **HEALTH**

Description of Site:

Site area	Site						Remarks
	6b	7	8	9	10	11	
Total catchment area (ha)	0.19	0.34	1.46	0.83	0.88	1.06	
Disturbed catchment area (ha)	0.19	0.34	1.46	0.83	0.88	1.06	

Soil analysis

% sand (faction 0.02 to 2.00 mm							Soil texture should be assessed through mechanical dispersion only. Dispersing agents (e.g. Calgon) should not be used
% silt (fraction 0.002 to 0.02 mm)							
% clay (fraction finer than 0.002 mm)							
Dispersion percentage							E.g. enter 10 for dispersion of 10%
% of whole soil dispersible							See Section 6.3.3(e)
Soil Texture Group							See Section 6.3.3(c), (d) and (e)

Rainfall data

Design rainfall depth (days)	5	5	5	5	5	5	See Sections 6.3.4 (d) and (e)
Design rainfall depth (percentile)	85	85	85	85	85	85	See Sections 6.3.4 (f) and (g)
x-day, y-percentile rainfall event	62.5	62.5	62.5	62.5	62.5	62.5	See Section 6.3.4 (h)
Rainfall intensity: 2-year, 6-hour storm	15.9	15.9	15.9	15.9	15.9	15.9	See IFD chart for the site

RUSLE Factors

Rainfall erosivity (*R*-factor)	5750	5750	5750	5750	5750	5750	Automatic calculation from above data
Soil erodibility (*K*-factor)	0.015	0.015	0.015	0.015	0.015	0.15	RUSLE data can be obtained from Appendixes A, B and C
Slope length (m)	64	98	76	124	82	188	
Slope gradient (%)	1.5	2.9	19.7	5.3	1.95	3.4	
Length/gradient (*LS*-factor)	0.25	0.71	7.1	1.6	0.41	1.3	
Erosion control practice (*P*-factor)	1.3	1.3	1.3	1.3	1.3	1.3	
Ground cover (*C*-factor)	1	1	1	1	1	1	

Calculations

Soil loss (t/ha/yr)	28	80	796	179	46	1458	
Soil Loss Class	1	1	6	2	1	6	See Section 4.4.2(b)
Soil loss (m^3/ha/yr)	22	61	612	138	35	1121	
Sediment basin storage volume, m^3	1	4	152	19	5	202	See Sections 6.3.4(i) and 6.3.5 (e)

4. Volume of Sediment Basins, *Type D* and *Type F* Soils

Basin volume = settling zone volume + sediment storage zone volume

Settling Zone Volume

The settling zone volume for *Type F* and *Type D* soils is calculated to provide capacity to contain all runoff expected from up to the y-percentile rainfall event. The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle and can be determined by the following equation:

$$V = 10 \times C_v \times A \times R_{x\text{-day, y-\%ile}} \ (m^3)$$

where:

10 = a unit conversion factor

C_v = the volumetric runoff coefficient defined as that portion of rainfall that runs off as stormwater over the x-day period

$R_{x\text{-day, y-\%ile}}$ = is the x-day total rainfall depth (mm) that is not exceeded in y percent of rainfall events. (See Sections 6.3.4(d), (e), (f), (g) and (h)).

A = total catchment area (ha)

Sediment Storage Zone Volume

In the detailed calculation on Soil Loss Classes 1 to 4 lands, the sediment storage zone can be taken as 50 percent of the settling zone capacity. Alternately designers can design the zone to store the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(ii)). However, on Soil Loss Classes 5, 6 and 7 lands, the zone must contain the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(iii).

Place an "X" in the box below to show the sediment storage zone design parameters used here:

	50% of settling zone capacity,
X	2 months soil loss calculated by RUSLE

Total Basin Volume

Site	C_v	$R_{x\text{-day, y-\%ile}}$	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)
6b	0.70	62.5	0.19	83.125	1	84.125
7	0.70	62.5	0.34	148.75	4	152.75
8	0.70	62.5	1.46	638.75	152	790.75
9	0.70	62.5	0.83	363.64375	19	382.64375
10	0.70	62.5	0.88	385	5	390
11	0.70	62.5	1.06	463.75	202	665.75

LEGEND

- SITE BOUNDARY
- SEDIMENT FENCE
- SECURITY FENCE
- SITE GATE
- TEMPORARY STOCKPILE (LOCATION TBC ON-SITE)
- TEMPORARY SEALED HAUL ROAD PA (PART OF STAGED CONSTRUCTION, S BE CONFIRMED BY CONTRACTOR)
- NEW ROAD PAVEMENT (SEPARATE PACKAGE) - REFER 400 AND 500 SERIES FOR DOCUMENTATION
- STORMWATER PIPE
- STORMWATER PIT
- GEOTEXTILE PIT FILTER
- EXTENT OF WETLAND
- OVERLAND FLOW PATH
- PMF

SEDIMENT BASIN SPECIFICATIONS

BASIN	CATCMENTS	VOL REQ.(m3)	BASE RL	WEIR CREST RL	TOP BUND RL	BASE AREA (m2)
1	1, 2, 3	3503	7	8.85	9.6	1942
2	4, 5	279	7.6	9.45	10.2	73
3	6a, 6b, 7	705	8.6	10.45	11.2	250
4	8, 9, 11	1839	5.5	7.35	8.1	657
5	10	390	24.1	25.8	26.1	167

Rev	Description	Date	By	App
P3	RESPONSE TO SUBMISSION	28.02.19	JH	-
P2	DA ISSUE	16.01.18	DB	-
P1	ISSUED FOR EARLY WORKS DA	11.01.19	CS	-

PLAN SCALE 1:1250 A1SHEET

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Project Name: TWEED VALLEY HOSPITAL DEVELOPMENT, CUDGEN STAGE 1 EARLY WORKS

Drawing Title: SOIL AND WATER CATCHMANET PLAN

DEVELOPMENT APPLICATION

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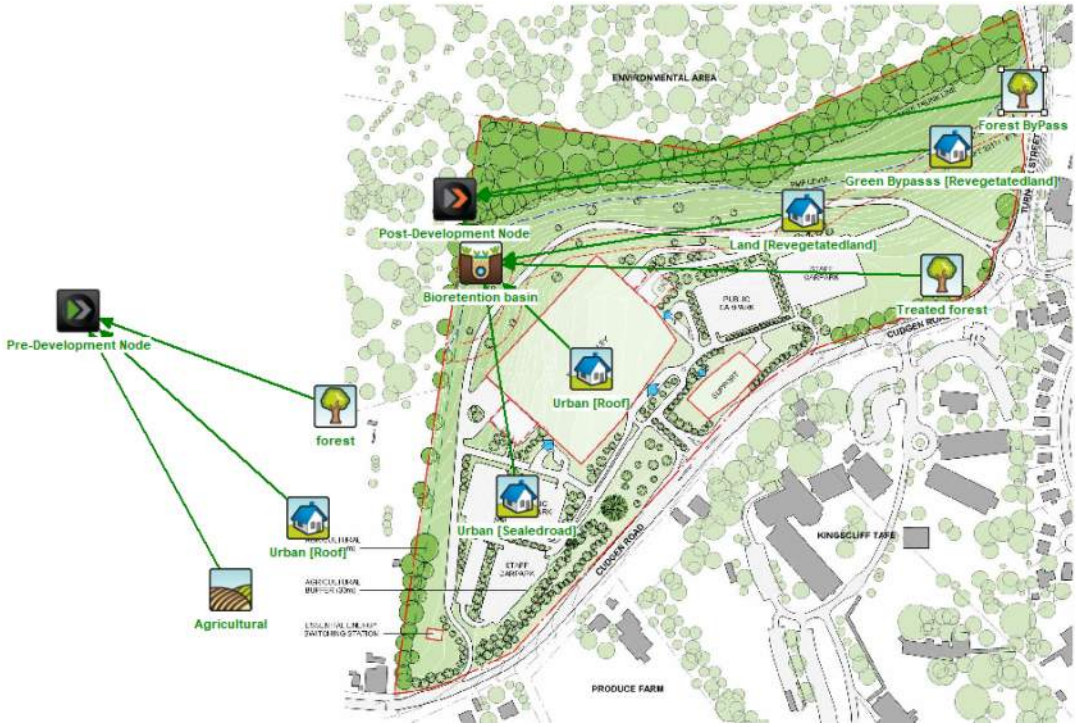
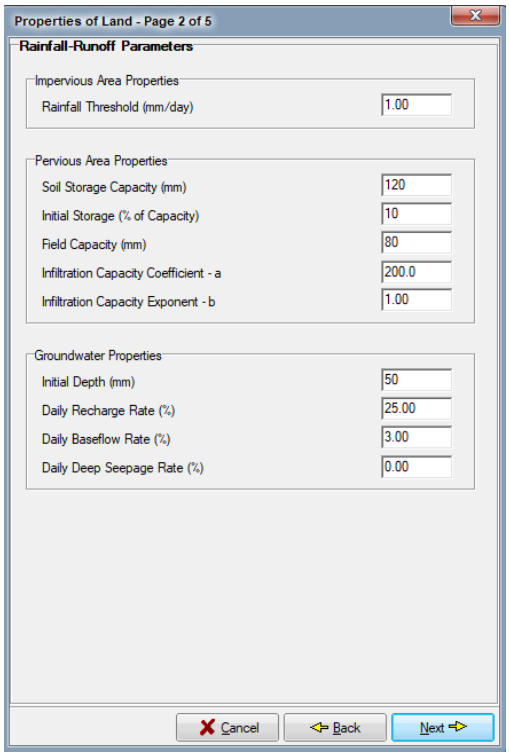
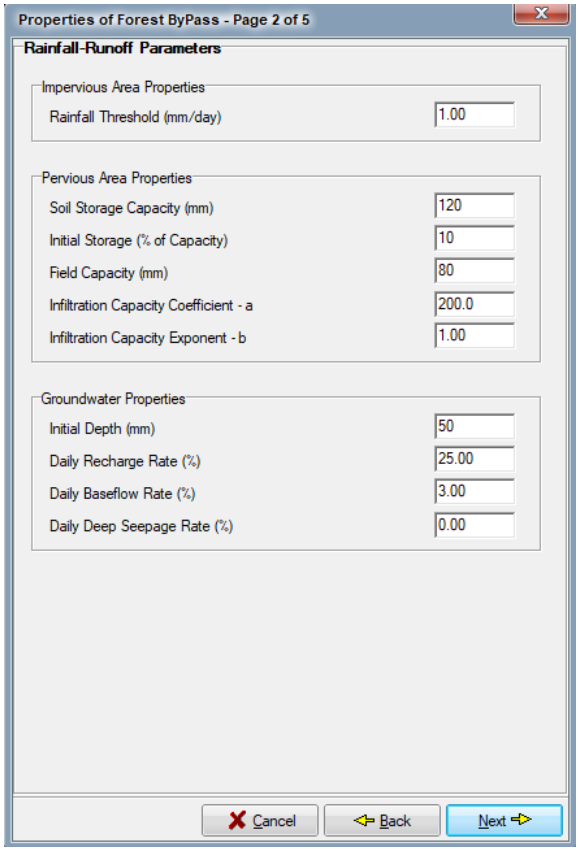
4. Appendix B – Updated MUSIC Model



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Rainfall-Runoff Parameters
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Initial Storage (% of Capacity)
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Field Capacity (mm)
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Infiltration Capacity Exponent - b
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Groundwater Properties
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Daily Deep Seepage Rate (%)
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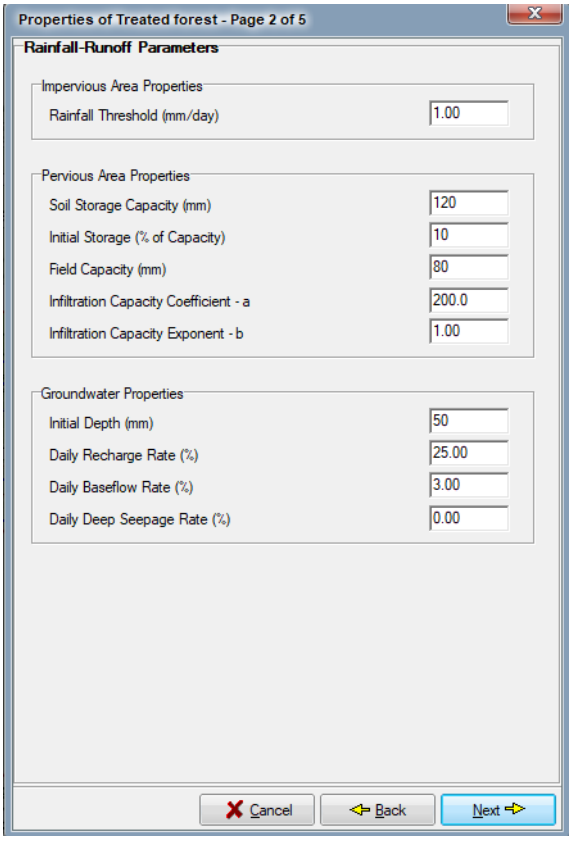
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Pervious Area Properties
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Daily Deep Seepage Rate (%)
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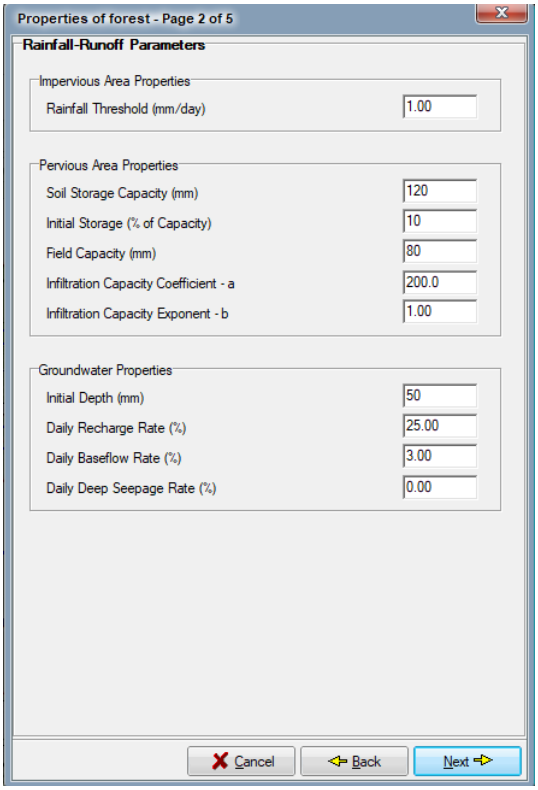
Properties of forest - Page 2 of 5
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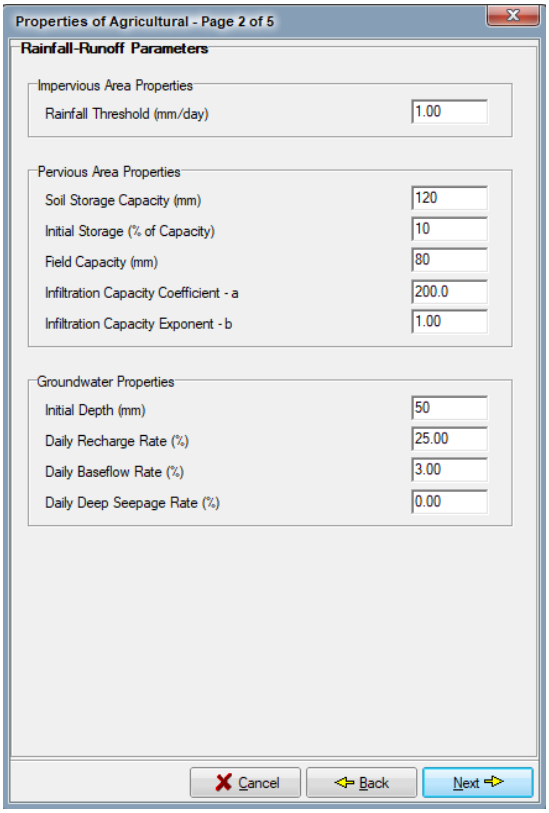
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Rainfall-Runoff Parameters
Impervious Area Properties
Rainfall Threshold (mm/day)
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Pervious Area Properties
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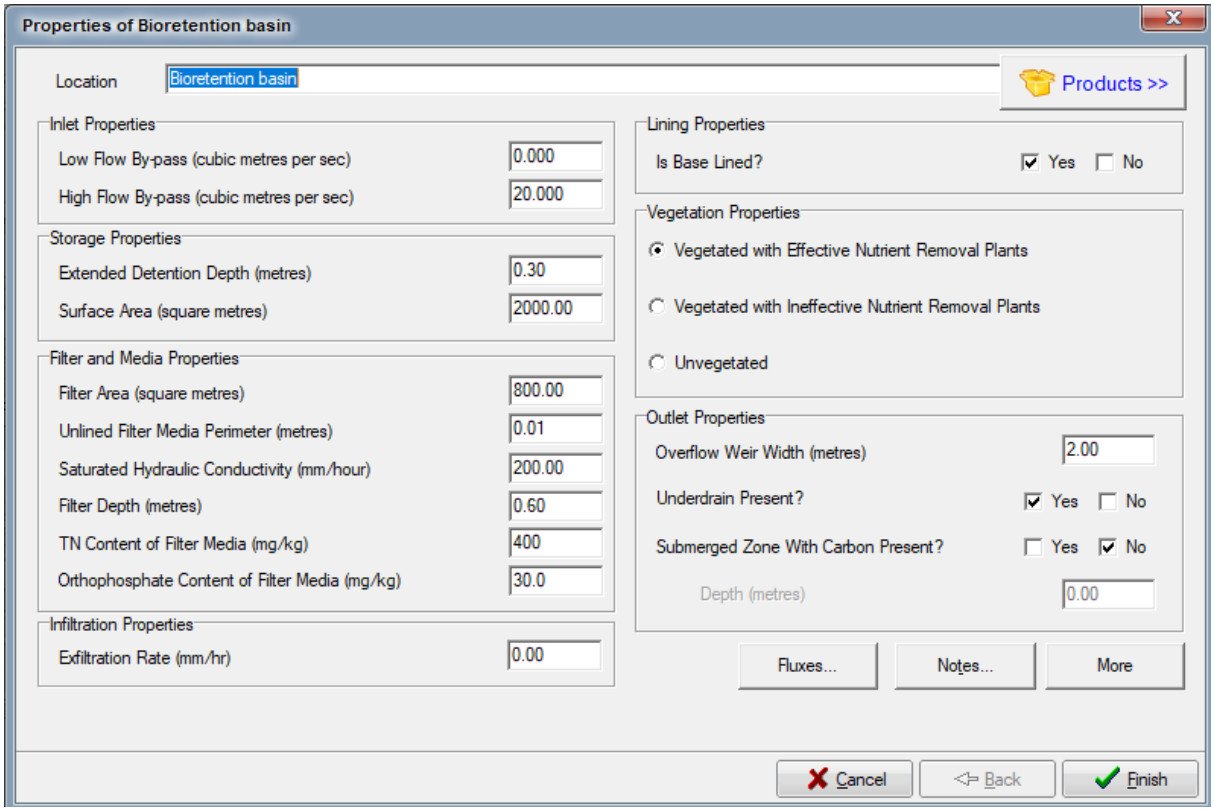
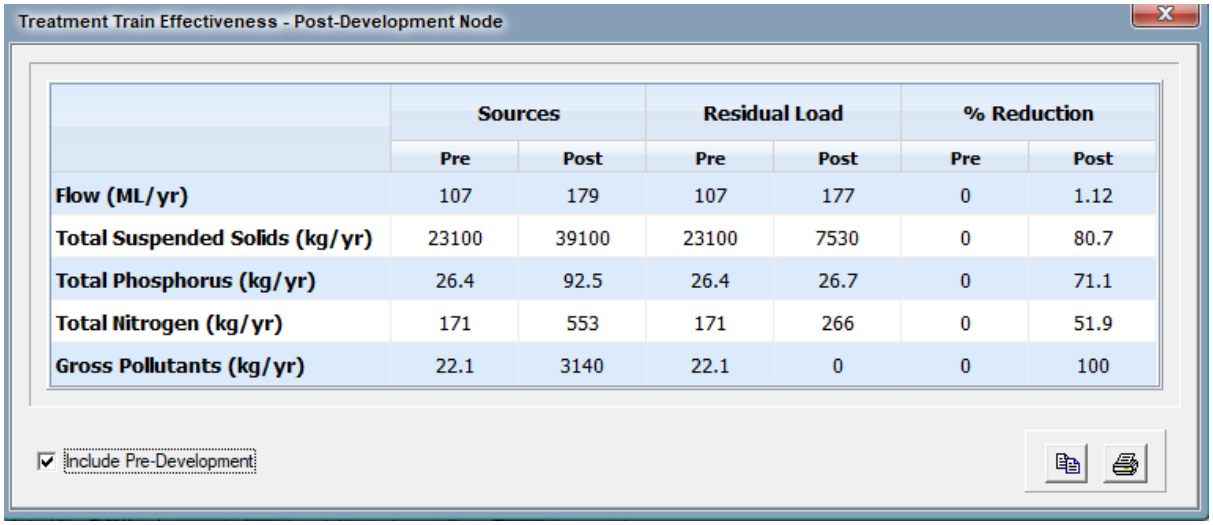
Initial Storage (% of Capacity)
10
Field Capacity (mm)
80
Infiltration Capacity Coefficient - a
200.0
Infiltration Capacity Exponent - b
1.00
Groundwater Properties
Initial Depth (mm)
50
Daily Recharge Rate (%)
25.00
Daily Baseflow Rate (%)
3.00
Daily Deep Seepage Rate (%)
0.00
Cancel
Back
Next





	Sources		Residual Load		% Reduction	
	Pre	Post	Pre	Post	Pre	Post
Flow (ML/yr)	107	179	107	177	0	1.12
Total Suspended Solids (kg/yr)	23100	39100	23100	7530	0	80.7
Total Phosphorus (kg/yr)	26.4	92.5	26.4	26.7	0	71.1
Total Nitrogen (kg/yr)	171	553	171	266	0	51.9
Gross Pollutants (kg/yr)	22.1	3140	22.1	0	0	100

5. Appendix C – MUSIC Catchment Plans

NORTHERN AREA IS EXISTING WETLAND THAT IS NOT TO BE DISTURBED - THIS HAS BEEN EXCLUDED FROM THE MUSIC MODEL AND ACCOUNTS FOR DIFFERENCE BETWEEN TOTAL SITE AREA AND SUM OF MUSIC CATCHMENTS

REMAINING AREA IS EXISTING AGRICULTURAL LAND

PURPLE AREAS ARE EXISTING "FOREST" FROM SURVEY, SITE INSPECTION AND AERIAL PHOTO. THIS INCLUDES REMNANT VEGETATION THAT IS NOT BEING USED FOR AGRICULTURAL PURPOSE

TAN AREAS ARE EXISTING ROOF

EXISTING MUSIC CATCHMENT PLAN

PROPOSED MUSIC CATCHMENT

NATURE RESERVE

GREY AREA AND AREA TO NORTH OF ROAD IS REVEGTATED LAND - NORTHEAST PORTION BYPASSES BIO-RETENTION (2.577Ha)

LIGHT PURPLE AREA IS REMNANT FOREST - NORTHEAST PORTION BYPASSES BIO-RETENTION (0.202Ha)

WHITE AREA IS REVEGETATED LAND THAT IS DIRECTED TO BIO-RETENTION (6.648Ha). NOTE THAT THIS IS NOT 100% IMPERVIOUS TO ALLOW FOR PAVED AREAS TO FRONT OF HOSPITAL, PATHS ETC

DARK PURPLE AREA IS ROADS/CARPARK THAT IS DIRECTED TO BIO-RETENTION (4.349Ha).

WHITE AREA IS REVEGETATED LAND THAT IS DIRECTED TO BIO-RETENTION (6.648Ha). NOTE THAT THIS IS NOT 100% IMPERVIOUS TO ALLOW FOR PAVED AREAS TO FRONT OF HOSPITAL, PATHS ETC

TAN AREA IS ROOF AREA THAT IS DIRECTED TO BIO-RETENTION (2.313Ha). NOTE THAT THIS IS ENVELOPE AND ROOF AREA IS ACTUALLY LESS THAN THIS

DARK PURPLE AREA IS ROADS/CARPARK THAT IS DIRECTED TO BIO-RETENTION (4.349Ha).

TURNOCK STREET

CUDGEN ROAD

TAFE

A

B

C