Manage-Design-Engineer Pty Ltd
PO Box 44
LENNOX HEAD NSW 2478
www.md-engineer.com.au

STORMWATER MANAGEMENT PLAN

PROPOSED Wee Waa High School

105-107 Mitchell Street

WEE WAA, NSW 2388

FOR:

NSW Department of Education

JULY 2021

MANAGE-DESIGN-ENGINEER PTY LTD

Project Management, Construction Management, Civil Design & Surveying Services

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PO Box 44
LENNOX HEAD NSW 2478
www.md-engineer.com.au

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AUTHOR: Jimmy Costaganna

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1 INTRODUCTION

1.1 BACKGROUND

Manage-Design-Engineer Pty Ltd have been engaged to undertake a Stormwater Management Plan (SWMP) for a proposed school development at 105-107 Mitchell Street Wee Waa. The site consists of the following Lots:

Lot 125 DP:757125
Lot 124 DP:757125
Lot 2 DP:550633
Lot 1 DP:577294

The total area of the site is 60,300m^2 with the proposed development involving the construction of a school, sports fields, warm up areas and landscaped surrounds.

1.2 REGULATORY AND TECHNICAL GUIDELINES

The strategies proposed in this SWMP have also been prepared in accordance with the following guidelines:

- Australian Standards 3500.3
- Queensland Urban Drainage Manual (QUDM) – Fourth Edition (IPWEAQ, 2017)
- Best Practice Erosion and Sediment Control (IECA, 2008)

1.3 SCOPE

This SWMP has been developed in accordance with item 3 (Page 3) of Narrabri Shire Council Report No: 1870945:CS/DLA, which references Australian Standards AS3500. The requirements set out under these documents for the on-site detention of stormwater are addressed in this report.

Narrabri Shire Council development control plans are limited with regards to design standards for stormwater management solutions. As such other NSW local council common practices and objectives have been applied. That is:

- Protect the quality of surface and ground waters during construction and operation of the new development,
- Avoid the creation of nuisance flow or hazard problems,
- Maintain the natural hydraulic behaviour of catchments,

- Protect existing natural features and ecological processes,
- Integrate stormwater management infrastructure carefully in the urban and natural landscape.

The above-mentioned objectives have been achieved and this SWMP addresses the following:

- Site details including location
- existing land use and topography
- Erosion and Sediment
- Best Practice Erosion and Sediment Control Measures (IECA 2008) for the construction phase of the development
- stormwater quality and stormwater quantity.

2 EXISTING SITE CHARACTERISTICS

2.1 LOCATION

105-107 Mitchell Street Wee Waa, has a total site area of 60,300m^2 and is bounded by residential lots to the north, Mitchell Street (Kamilaroi Hwy) to the south, Charles Street to the East and George Street to the West. The Legal Point of Discharge for the site is considered to be the north-western corner, which feeds into an existing pipe culvert council asset. This stormwater culvert outlets to the north-west into an open channel, which outlets into the Namoi River.

The below aerial shows the location of the subject site:

FIGURE 1 - SITE LOCALITY AERIAL IMAGE (SIXMAPS, 2021)

The table below summarises the existing site and its catchment characteristics:

EXISTING SITE CHARACTERISTICS	
SURFACE	**CATHMENT AREA (m2)**
Landscaped	60,300
Total	60,300
Percentage Impervious	0%

The site has multiple stormwater channels passing through the approximate centre of the site, with connecting channels linking to the south which service stormwater culverts from Mitchell Street and as such direct stormwater flows through the site.

2.2 VEGETATION AND LAND USE

The site is vacant land with minimal tree cover and is predominately bounded by residential lots with minimal tree cover.

The cleared vegetation areas are currently stabilised with grass cover. Stormwater channels connect nearby street pipe culvert systems to the approximate centre of the site and discharge to the north-west low point.

FIGURE 2 - AERIAL IMAGE OF SITE (SIXMAPS, 2021)

2.3 TOPOGRAPHY

The subject site is relatively flat, varying from a maximum elevation of 191.1 AHD to 189.9 m AHD at its lowest point. Proposed stormwater channels grade toward the north-wester corner of the site at a designed grade of 0.1%.

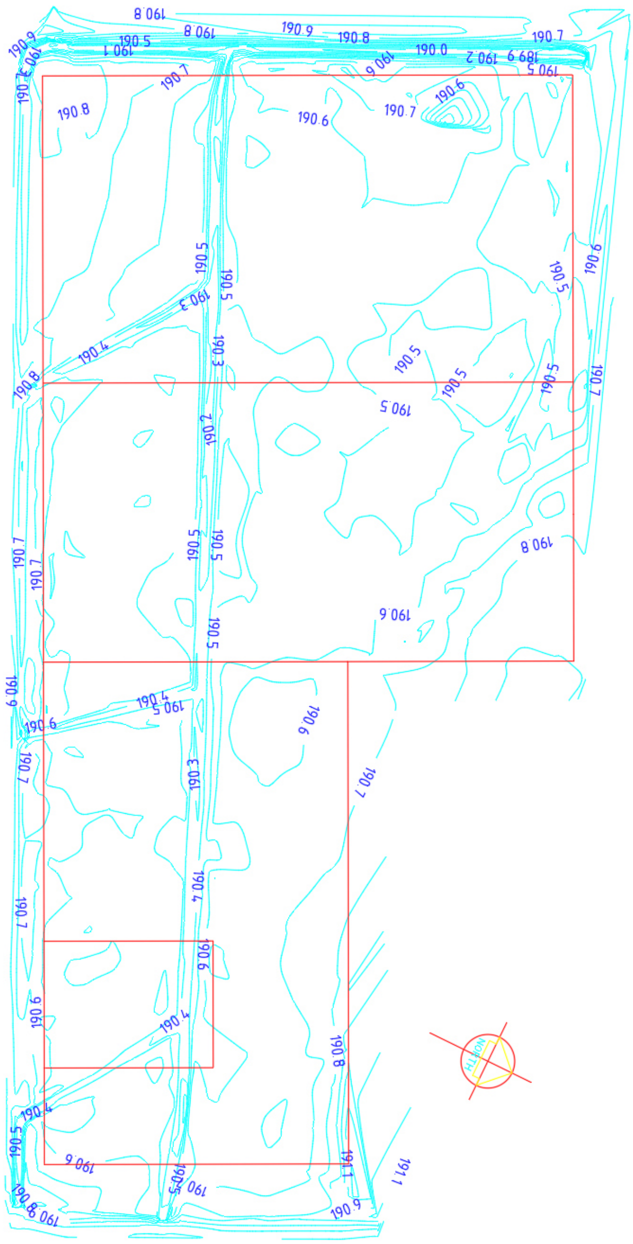

FIGURE 3 – SITE SURVEY & CONTOURING

2.4 DOWNSTREAM ENVIRONMENT

Stormwater runoff originating from the subject site drains toward the north-western, where it is conveyed via a stormwater culvert into an open channel before discharging into the Namoi River. The channel is considered to be inundated with sediment and silt in areas based on desktop studies. The ability of the channel to convey sufficient flows is considered unsatisfactory.

Please refer to Lyall & Associates flood modelling downstream channel upgrades.

FIGURE 3 - DOWNSTREAM ENVIRONMENT (SIXMAPS, 2021)

2.5 RAINFALL

The mean annual rainfall for the site has been estimated at 450 mm (conservative) from the data set obtained from the Bureau of Meteorology (BOM) and World Weather Online.

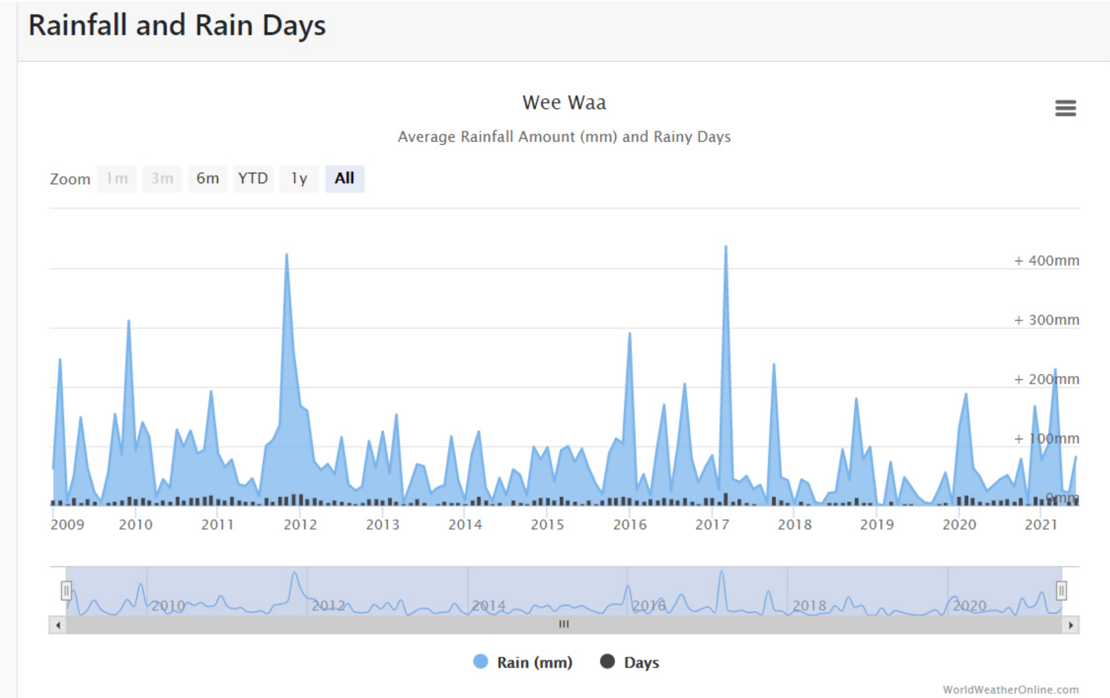

FIGURE 4 - YEARLY RAINFALL DATA (SOURCE: WORLD WEATHER ONLINE)

2.6 OVERLAND FLOW PATHS

Overland flow paths can be determined in the flood modelling plans that were undertaken by Lyall & Associates. Due to the site being in a low point, sheet flows from neighbouring streets are directed via pipe culverts and open drains to the site and then are directed by existing open channels to the north-western corner where it is conveyed to the Namoi River. Due to the overall site grade of approximately 0.1% the existing site conditions is not efficiently allowing for free draining, but rather pooling stormwater flows until they gradually outlet through the site low point.

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3 Stormwater Quantity Management Plan

3.1 Development Characteristics

The proposed development is for the construction of a school, sports fields, play areas, and a stormwater channel upgrade (designed by Lyall & Associates), with a site area of 60,300m2 and an approximate catchment of 45.672ha. It is noted that an approximate 16.4% around the school buildings will remain as an undeveloped landscaped area, and 64.3% across the site will be sports fields and play areas which will be grassed based on the architectural design, and as such has been excluded from the on-site detention calculations provided in **Appendix A** of this report.

Site stormwater runoff will be collected from the building roof areas, conveyed to water tanks and then directed to the pit and pipe network detailed in **Appendix B**. The proposed pavements and carparks will allow sheet flows to pass over the impermeable surfaces, where runoff will then filter through neighbouring grassed areas, before entering nearby channels for further filtering.
All site stormwater will ultimately discharge to the proposed stormwater channels.

The table below summarises the developed site characteristics:

DEVELOPED SITE CHARACTERISTICS	
SURFACE	**AREA**
Play areas and sports fields	64.3%
Landscaped area	16.4%
Percentage Impervious	19.3%
Total Site	6.030 ha
CATCHMENT AREA	45.672 ha (Approx)

3.2 Development Characteristics

The proposed development consists of two main crown fill areas, which allows stormwater to sheet flow to the adjacent proposed stormwater channels. The two crowns area located in the central area of the proposed school buildings and the sport field oval.

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FIGURE 5 - SITE RUNOFF

3.3 Proposed Stormwater Channels Plan & Cross Sections

The below site plan depicts the proposed stormwater channel locations and their chainage lengths. Refer to **Appendix C** for the cross sections which depicts the amount of additional cut and extended batter slopes in the existing and new channels.

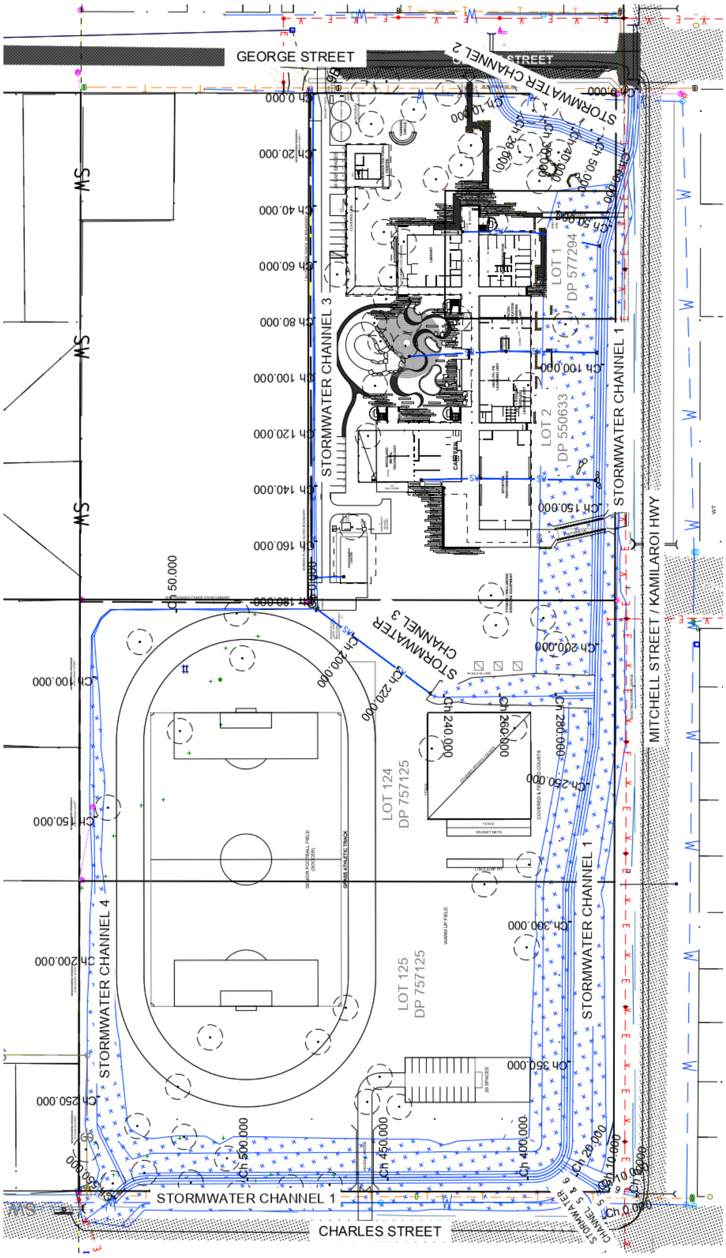

FIGURE 6 - STORMWATER CHANNEL LOCATIONS

4 SITE STORMWATER MANAGEMENT

4.1 ON-SITE DETENTION

Due to the site constraints of a general 0.25% grading of the proposed stormwater channels from the site, on-site detention of stormwater will be achieved through the provision of rainwater tanks only.

Calculations for the volume of required on-site detention and permissible site discharge have been undertaken using a standard on-site stormwater detention design summary sheet. The results from this analysis are included in **Appendix A**.

The total roof area has been broken up into small areas, in order to size adjacent water tanks accordingly. The below Figure provides the subsequent breakdown.

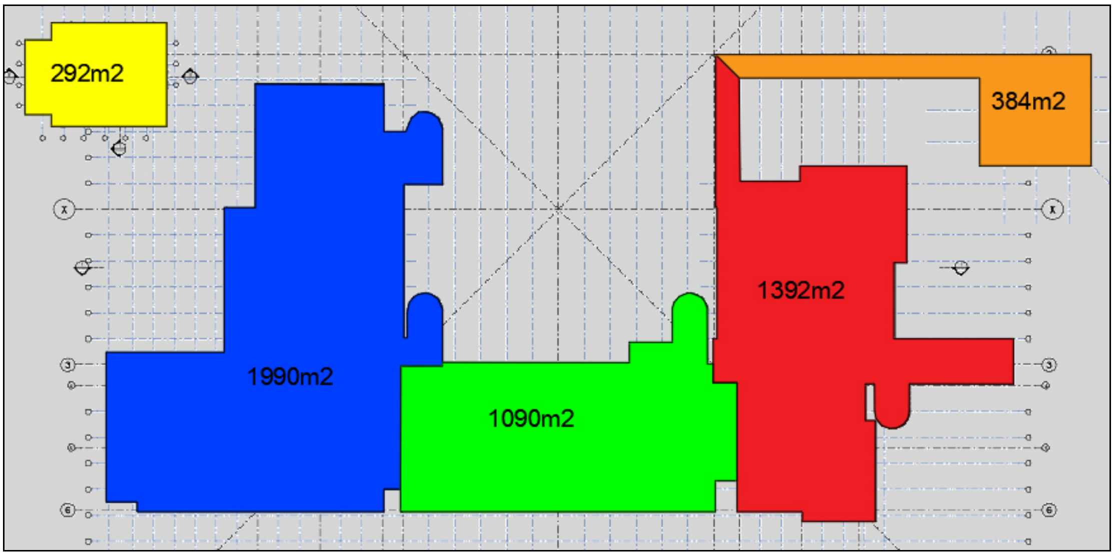

FIGURE 7 - ROOF AREAS

Based on the results presented in **Appendix A**, a total of 37.7m3 of on-site stormwater detention is required for this development with a permissible site discharge rate of 321 l/s to meet the predevelopment flows.

To achieve this level of detention, it is proposed that approximately 5148m^2 of the roof water drainage is directed to six rainwater tanks located at the locations illustrated in Shac's proposed site plan.

Stormwater tank detention will provide a total of 37.7m^3 of available detention volume spread out over the six tanks.

The location of the tanks is to be sized suitable to the intended locations, with options to also place the detention tanks under buildings.

Tank sizes are as follows:

TABLE 1 - STORMWATER TANK SIZING

Area	**292m²**	**1990m²**	**1090m²**	**1392m²**	**384m²**
Size Tank	**2.1m³**	**2x 7.3m³**	**8.0m³**	**10.2m³**	**2.8m³**

Due to the small amount of remaining impermeable pavements, sheet flows from these surfaces are to be directed to the proposed stormwater channels via pit and pipe culverts or by direct sheet flows across pavement surfaces into neighbouring stormwater channels. Due to the limitations of the flat site, stormwater detention for driveway surfaces would be difficult to achieve.

Sheet flows from carparking areas and driveways will incorporate edge restraint flush kerbs that allow stormwater to sheet flow directly to the grassed verge, before being directed to the proposed stormwater channels. The grassed verge provides filtering and sediment capture.

Permissible site discharge rates are achieved through the provision of orifices fitted to the outlet of each rainwater tank. The post development discharge rate of 173 l/s provides a much better outcome to the pre-development rate of 231 l/s, which provides a buffer for the driveway and other impermeable areas not having detention.

4.2 Conveyance of Site Flows

Pre-developed conditions do not allow for the existing stormwater channels to drain freely, as the site is generally flat with multiple open drainage channels connecting the site from the south-east corner to north-western corner resulting in the current channel system generally holding water.

In the post-developed scenario, it is proposed to convey stormwater via four main stormwater channels.

Proposed school building roof runoff stormwater will be directed to localised above ground water tanks, which will limit stormwater discharge to the proposed stormwater channels.

Overland flow from the paved/concrete pavement areas will be directed to the pit and pipe culverts, or via direct sheet flows and conveyed directly to the proposed stormwater channels.

Overland flows from the surrounding landscape areas, sports fields, play areas will be conveyed directly to the proposed stormwater channels via sheet flows and pit and pipe networks.

4.3 Lawful Point of Stormwater Discharge

The Lawful Point of Discharge (LPD) is located to be in the north-western corner. This is represented by the site contours identifying a flow paths to this location.
It is proposed to maintain the LPD in the post-developed scenario.

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5 Erosion and Sediment Control Plan

5.1 Best Practices

Stormwater runoff during the construction phase of this development shall be managed in accordance with Best Practice Erosion and Sediment Control (IECA, 2008), which is the current recognised construction industry best management practice (BMP) for erosion and sediment control. Erosion and Sediment Control (ESC) plans are required to be implemented during the construction phase to minimise environmental harm to on-site stormwater treatment devices and downstream receiving waters. Refer below for appropriate plans.

The low flow channel in stormwater channel 1 is to be grassed lined immediately after construction, and or in stages as works progress along the swale. All other stormwater channels are to be grassed lined with the above process. If the entire site is not being turfed, batters within 10m of any stormwater channel are to be hydro-mulched or soil binders applied to ensure sediment runoff does not enter the channel, and also to protect the batters from riling and erosion.

During construction rock checks in the invert of the channels are to be used to capture any sediment. Rock checks are to be maintained by the civil contractor throughout the construction process.

Sediment fences are also positioned across the site to ensure sheet flows in heavy rainfall events do not allow excessive sediment from reaching the channels.

Hay bales at the downstream end (before stormwater water enters the pipe culvert), are to be used to further filter discoloured water and fine sediments before water continues downstream.

5.2 Erosion and Sediment Control Plans

Please refer to Manage-Design-Engineer Erosion and Sediment Control Plans (ERSED).

Until sufficient grass cover is achieved, ERSED controls are to remain in place.
Operational phases will not require ERSED controls, as it is assumed that full grass cover will have been accomplished, and any minor siltation will be filtered out by the size and length of the proposed stormwater channels, acting as filters.

6 Stormwater Quality Management Plan

6.1 State Environment Planning Policy

The direct downstream environment from the development consists of a flood channel & pipe conveyance system that directs stormwater flows to the Namoi River.

The overall intended outcome is to achieve no net deterioration in water quality to the downstream environment. To achieve this, the proposed stormwater channel is considered to provide the best ability to filter pollutants.

The following pollution reductions targets are as follows:

TABLE 2 - POLLUTION REDUCTION TARGETS

Pollutant	Reduction Target (% of the typical urban annual load)		
	A	B	C
Total Suspended Solids (TSS)[1]	80%	80%	90%
Gross Pollutants	85%	90%	95%
Total Nitrogen (TN)[2]	30%	45%	60%
Total Phosphorus (TP)[2]	30%	60%	70%
Total Petroleum Hydrocarbons[3]	60%	90%	90%
Free Oils[3]	90%	90%	98%

Notes:

1 Load based on the following particulate size distribution (by mass): 20% <20 μm; 20% 20-60 μm; 20% 60-150 μm; 20% 150-400 μm; 20% 400-2000 μm.

2 Load includes particulate and dissolved fraction.

3 This requirement is not applicable where the site contains less than a total of 200m^2 of uncovered areas where vehicles are likely to transit and/or park e.g. roads, loading docks, refuelling bays, car parking etc.

6.2 Stormwater Treatment Train and Approach

The ensure the above reduction targets are satisfied, a treatment model was created for the site using the Model for Urban Stormwater Conceptualisation (MUSIC software). The model has been designed for the operational phase of the development and is presented schematically in the below figure.

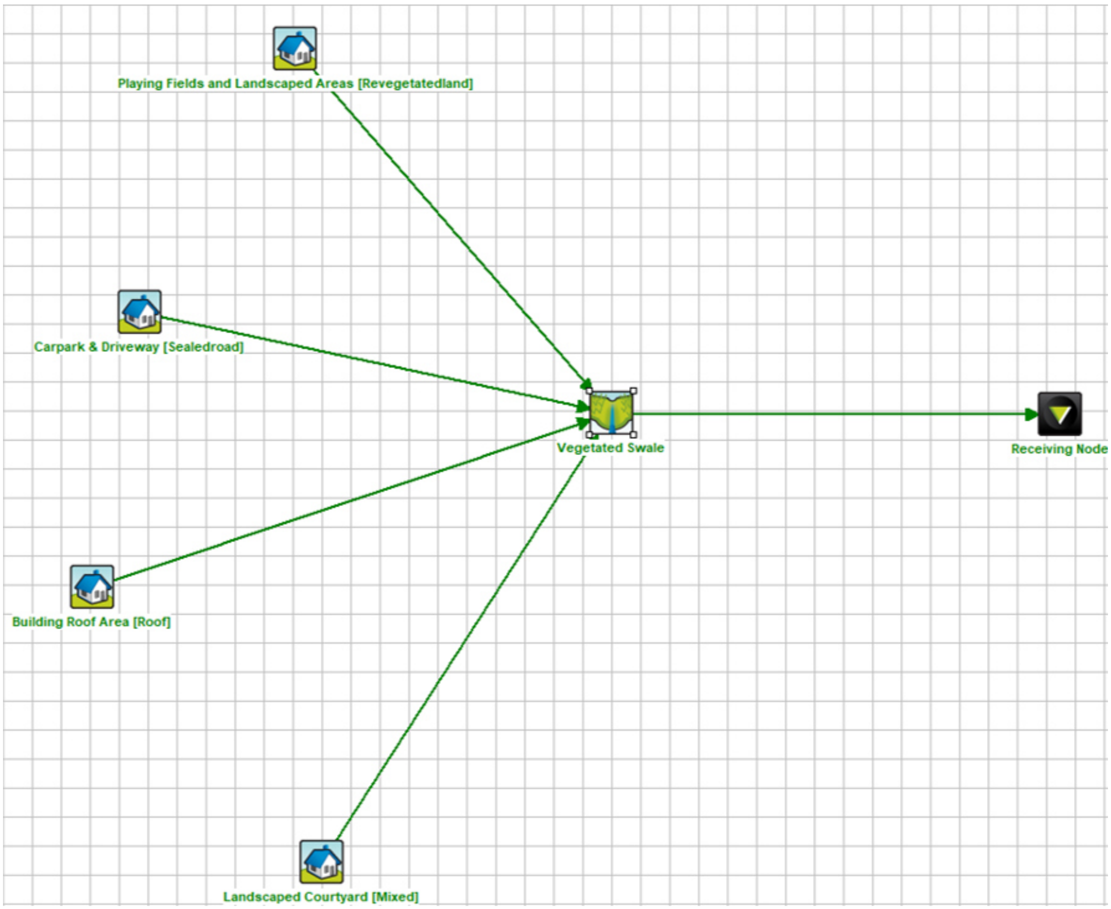


FIGURE 8 - MUSIC SOFTWARE MODELLING

6.2.1 Stormwater Quality Analysis

MDE took a conservative approach for the modelling analysis, and thus the water quality objectives achieved through the proposed channel is with a length of 325m long as highlighted blue in Figure 18. The ultimate scenario will further exceed the targets.

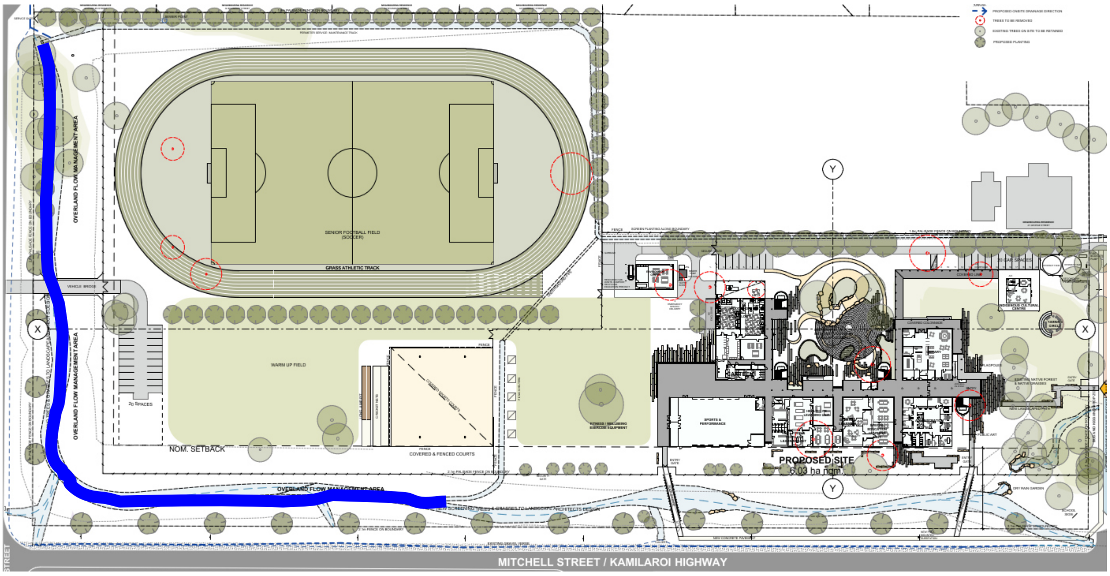
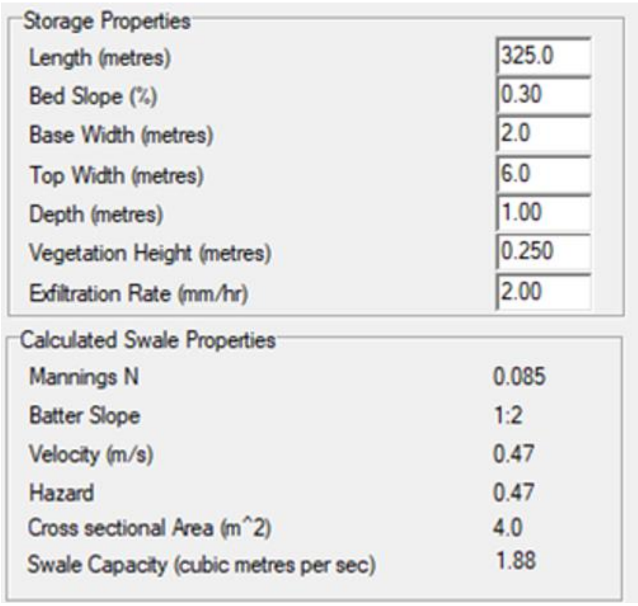


FIGURE 9 - MUSIC ANALYSIS CHANNEL LENGTH



Storage Properties	
Length (metres)	325.0
Bed Slope (%)	0.30
Base Width (metres)	2.0
Top Width (metres)	6.0
Depth (metres)	1.00
Vegetation Height (metres)	0.250
Exfiltration Rate (mm/hr)	2.00

Calculated Swale Properties	
Mannings N	0.085
Batter Slope	1:2
Velocity (m/s)	0.47
Hazard	0.47
Cross sectional Area (m^2)	4.0
Swale Capacity (cubic metres per sec)	1.88

FIGURE 10 - CHANNEL PARAMETERS

6.2.2 Pollutant Reductions

Results from the MUSIC modelling for the treatment effectiveness are summarised below.
As noted previously, the conservative approach to the downstream treatment channel length provides clear justification that the complete system will overachieve the requirements set out in TABLE 2 - POLLUTION REDUCTION TARGETS.

TABLE 3 - TREATMENT EFFECTIVENESS

	Sources	Residual Load	% Reduction
Flow (ML/yr)	6.72	4.75	29.3
Total Suspended Solids (kg/yr)	735	88.5	88
Total Phosphorus (kg/yr)	1.71	0.652	61.9
Total Nitrogen (kg/yr)	14.2	7.72	45.7
Gross Pollutants (kg/yr)	166	0	100

6.2.3 Further Measures to Filter Pollutants

Additional measures could be added such as first flush devices on rainwater tanks and stormwater pit inserts. Although they are not warranted, due to the nature of the development being a school, it is anticipated that higher levels of litter are going to inevitably be conveyed by the stormwater system to the stormwater channels. It is therefore recommended to installed pit inserts to provide additional capture litter.
For the minimal cost of installing first flush devices, it is highly recommended for a water re-use perspective and to further remove pollutants from the tanks and the downstream channel.

Manage-Design-Engineer Pty Ltd
PO Box 44
LENNOX HEAD NSW 2478
www.md-engineer.com.au

7 CONCLUSION

This SWMP prepared by Manage-Design-Engineer Pty Ltd demonstrates compliance with local and state government requirements.

On site detention of 37.7m^3 of site discharge will be achieved through the provision of 6 x rainwater tanks. The post development discharge rate of 173 l/s provides a much better outcome to the pre-development rate of 231 l/s, which provides a buffer for the driveway and other impermeable areas not having stormwater detention systems.

Furthermore, driveways and carparks will be graded to allow sheet flows to pass over the pavement, across grass areas before entering adjacent stormwater channels.

Stormwater quality objectives are being achieved primarily through the provision of vegetated swales/channels, with additional water quality measures being utilised via stormwater pit inserts and first flush devices on rainwater tanks.

Jimmy Costaganna
RPEng | RPEQ
Manage-Design-Engineer Pty Ltd

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Manage-Design-Engineer Pty Ltd
PO Box 44
LENNOX HEAD NSW 2478
www.md-engineer.com.au

APPENDIX A – ON-SITE STORMWATER DETENTION DESIGN SUMMARY SHEETS

On-site Stormwater Detention Design Summary Sheet

Wee Waa High School

Rainfall Region:		**Wee Waa**		
Developed Area	=	292	m^2	**Environment Centre**
Pre Development				
Catchment Areas	(Must be shown on engineering drawings)			
Roof Area (A_r)	=	0	m^2	(coefficient of runoff, c_r = 1.0)
Paved Area (A_p)	=	0	m^2	(coefficient of runoff, c_p = 0.9)
Vegetated Area (A_v)	=	292	m^2	(coefficient of runoff, c_v = 0.66)
Total Area	=	292	m^2	(Must equal post development area)
Site Pre Dev A x C (AC_{EX})	=	$A_r \times c_r + A_p \times c_p + A_v \times c_v$		
Stormwater Flows				
Duration	=	5	min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity ($^5I_5$)	=	125	mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_5)	=	$AC_{EX} \times {}^5I_5 / 3600$		
	=	7	l/s	
Post Development				
Catchment Areas	(Must be shown on engineering drawings)			
Roof Area (A_r)	=	292	m^2	(coefficient of runoff, c_r = 1.0)
Paved Area (A_p)	=		m^2	(coefficient of runoff, c_p = 0.9)
Vegetated Area (A_v)	=	0	m^2	(coefficient of runoff, c_v = 0.73)
Total Area	=	292	m^2	(Must equal pre development area)
Site Post Dev A x C (AC_{PR})	=	$A_r \times c_r + A_p \times c_p + A_v \times c_v$		
Stormwater Flows	(For 20 year storm event)			
Duration	=	5	min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity ($^{20}I_5$)	=	171	mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_{20})	=	$AC_{PR} \times {}^{20}I_5 / 3600$		
	=	14	l/s	
Stormwater Detention Requirements				
Storage Volume	=	$(Q_{20} – Q_5) \times 5 \times 60 / 1000$		
	=	2.1	m^3	
PSD	=	7	l/s	(Permissible Site Discharge = Q_5)
Orifice Plate Controlled Discharge		(N/A if using choke pipe)		
Head (H)	=	1.0	m	(max. water level to orifice centre)
Orifice Diameter	=	$1000 \times \sqrt{[(0.464 \times Q_5 / 1000) / \sqrt{H}]}$		
	=	56	mm	
Outlet Pipe Diameter	=	167	mm	Use 150mm
Storage Provided				
Storage Volume	=	**2.1**	**m^3**	
Q100 check (as per NRDC SWD Handbook)				
Pre-development Q100 flow				
Duration	=	5	min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity ($^{100}I_5$)	=	237	mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_{100})	=	$(A_r c_r + A_p c_p + A_v c_v) \times {}^{20}I_5 / 3600$		(coefficient of runoff, C_r = 1.0, C_p = 1, C_v = 0.83,)
	=	16	l/s	
Post-development Q100 flow				
Duration	=	5	min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity ($^{100}I_5$)	=	237	mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_{100})	=	$(A_r c_r + A_p c_p + A_v c_v) \times {}^{20}I_5 / 3600$		(coefficient of runoff, C_r = 1.0, C_p = 1, C_v = 0.83,)
	=	19	l/s	
check				
$Q_{100\text{-dev}} - (Q_{20\text{-dev}} - Q_{5\text{-undev}})$	=	12	l/s	
		less than predev Q100 - storage sufficient		

A separate sheet is to be attached showing all workings for the storage volumes proposed on the engineering drawings and calculations for the

On-site Stormwater Detention Design Summary Sheet

Wee Waa High School

Rainfall Region:		**Wee Waa**		
Developed Area	=	384	m^2	**Indigenous Cultural Centre**
Pre Development				
Catchment Areas	(Must be shown on engineering drawings)			
Roof Area (A_r)	=	0	m^2	(coefficient of runoff, c_r = 1.0)
Paved Area (A_p)	=	0	m^2	(coefficient of runoff, c_p = 0.9)
Vegetated Area (A_v)	=	384	m^2	(coefficient of runoff, c_v = 0.66)
Total Area	=	384	m^2	(Must equal post development area)
Site Pre Dev A x C (AC_{EX})	=	$A_r \times c_r + A_p \times c_p + A_v \times c_v$		
Stormwater Flows				
Duration	=	5	min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity (${}^{5}I_{5}$)	=	125	mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_5)	=	$AC_{EX} \times {}^{5}I_{5} / 3600$		
	=	9	l/s	
Post Development				
Catchment Areas	(Must be shown on engineering drawings)			
Roof Area (A_r)	=	384	m^2	(coefficient of runoff, c_r = 1.0)
Paved Area (A_p)	=		m^2	(coefficient of runoff, c_p = 0.9)
Vegetated Area (A_v)	=	0	m^2	(coefficient of runoff, c_v = 0.73)
Total Area	=	384	m^2	(Must equal pre development area)
Site Post Dev A x C (AC_{PR})	=	$A_r \times c_r + A_p \times c_p + A_v \times c_v$		
Stormwater Flows	(For 20 year storm event)			
Duration	=	5	min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity (${}^{20}I_{5}$)	=	171	mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_{20})	=	$AC_{PR} \times {}^{20}I_{5} / 3600$		
	=	18	l/s	
Stormwater Detention Requirements				
Storage Volume	=	$(Q_{20} – Q_5) \times 5 \times 60 / 1000$		
	=	2.8	m^3	
PSD	=	9	l/s	(Permissible Site Discharge = Q_5)
Orifice Plate Controlled Discharge		(N/A if using choke pipe)		
Head (H)	=	1.0	m	(max. water level to orifice centre)
Orifice Diameter	=	$1000 \times \sqrt{[(0.464 \times Q_5 / 1000) / \sqrt{H}]}$		
	=	64	mm	
Outlet Pipe Diameter	=	192	mm	
Storage Provided				
Storage Volume	=	**2.8**	**m^3**	
Q100 check (as per NRDC SWD Handbook)				
Pre-development Q100 flow				
Duration	=	5	min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity (${}^{100}I_{5}$)	=	237	mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_{100})	=	$(A_r c_r + A_p c_p + A_v c_v) \times {}^{20}I_5 / 3600$		(coefficient of runoff, C_r = 1.0, C_p = 1, C_v = 0.83,)
	=	21	l/s	
Post-development Q100 flow				
Duration	=	5	min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity (${}^{100}I_{5}$)	=	237	mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_{100})	=	$(A_r c_r + A_p c_p + A_v c_v) \times {}^{20}I_5 / 3600$		(coefficient of runoff, C_r = 1.0, C_p = 1, C_v = 0.83,)
	=	25	l/s	
check				
$Q_{100\text{-dev}} - (Q_{20\text{-dev}} - Q_{5\text{-undev}})$	=	16	l/s	
		less than predev Q100 - storage sufficient		

A separate sheet is to be attached showing all workings for the storage volumes proposed on the engineering drawings and calculations for the

On-site Stormwater Detention Design Summary Sheet

Wee Waa High School

Rainfall Region:		**Wee Waa**		
Developed Area	=	1090	m^2	**Health / PE & Special Ed**
Pre Development				
Catchment Areas	(Must be shown on engineering drawings)			
Roof Area (A_r)	=	0	m^2	(coefficient of runoff, c_r = 1.0)
Paved Area (A_p)	=	0	m^2	(coefficient of runoff, c_p = 0.9)
Vegetated Area (A_v)	=	1090	m^2	(coefficient of runoff, c_v = 0.66)
Total Area	=	1090	m^2	(Must equal post development area)
Site Pre Dev A x C (AC_{EX})	=	$A_r \times c_r + A_p \times c_p + A_v \times c_v$		
Stormwater Flows				
Duration	=	5	min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity ($^5I_5$)	=	125	mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_5)	=	$AC_{EX} \times {}^5I_5 / 3600$		
	=	25	l/s	
Post Development				
Catchment Areas	(Must be shown on engineering drawings)			
Roof Area (A_r)	=	1090	m^2	(coefficient of runoff, c_r = 1.0)
Paved Area (A_p)	=		m^2	(coefficient of runoff, c_p = 0.9)
Vegetated Area (A_v)	=	0	m^2	(coefficient of runoff, c_v = 0.73)
Total Area	=	1090	m^2	(Must equal pre development area)
Site Post Dev A x C (AC_{PR})	=	$A_r \times c_r + A_p \times c_p + A_v \times c_v$		
Stormwater Flows	(For 20 year storm event)			
Duration	=	5	min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity ($^{20}I_5$)	=	171	mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_{20})	=	$AC_{PR} \times {}^{20}I_5 / 3600$		
	=	52	l/s	
Stormwater Detention Requirements				
Storage Volume	=	$(Q_{20} – Q_5) \times 5 \times 60 / 1000$		
	=	8.0	m^3	
PSD	=	25	l/s	(Permissible Site Discharge = Q_5)
Orifice Plate Controlled Discharge		(N/A if using choke pipe)		
Head (H)	=	1.0	m	(max. water level to orifice centre)
Orifice Diameter	=	$1000 \times \sqrt{[(0.464 \times Q_5 / 1000) / \sqrt{H}]}$		
	=	108	mm	Use 100mm orifice
Outlet Pipe Diameter	=	323	mm	Use 300mm
Storage Provided				
Storage Volume	=	**8.0**	**m^3**	
Q100 check (as per NRDC SWD Handbook)				
Pre-development Q100 flow				
Duration	=	5	min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity ($^{100}I_5$)	=	237	mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_{100})	=	$(A_r c_r + A_p c_p + A_v c_v) \times {}^{20}I_5 / 3600$		(coefficient of runoff, C_r = 1.0, C_p = 1, C_v = 0.83,)
	=	60	l/s	
Post-development Q100 flow				
Duration	=	5	min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity ($^{100}I_5$)	=	237	mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_{100})	=	$(A_r c_r + A_p c_p + A_v c_v) \times {}^{20}I_5 / 3600$		(coefficient of runoff, C_r = 1.0, C_p = 1, C_v = 0.83,)
	=	72	l/s	
check				
$Q_{100\text{-dev}} - (Q_{20\text{-dev}} - Q_{5\text{-undev}})$	=	45	l/s	
		less than predev Q100 - storage sufficient		

A separate sheet is to be attached showing all workings for the storage volumes proposed on the engineering drawings and calculations for the

On-site Stormwater Detention Design Summary Sheet				
Wee Waa High School				
Rainfall Region:		**Wee Waa**		
Developed Area	=	1392	m^2	**Admin & Library**
Pre Development				
Catchment Areas	(Must be shown on engineering drawings)			
Roof Area (A_r)	=	0	m^2	(coefficient of runoff, c_r = 1.0)
Paved Area (A_p)	=	0	m^2	(coefficient of runoff, c_p = 0.9)
Vegetated Area (A_v)	=	1392	m^2	(coefficient of runoff, c_v = 0.66)
Total Area	=	1392	m^2	(Must equal post development area)
Site Pre Dev A x C (AC_{EX})	=	$A_r \times c_r + A_p \times c_p + A_v \times c_v$		
Stormwater Flows				
Duration	=	5	min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity ($^5I_5$)	=	125	mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_5)	=	$AC_{EX} \times {}^5I_5 / 3600$		
	=	32	l/s	
Post Development				
Catchment Areas	(Must be shown on engineering drawings)			
Roof Area (A_r)	=	1392	m^2	(coefficient of runoff, c_r = 1.0)
Paved Area (A_p)	=		m^2	(coefficient of runoff, c_p = 0.9)
Vegetated Area (A_v)	=	0	m^2	(coefficient of runoff, c_v = 0.73)
Total Area	=	1392	m^2	(Must equal pre development area)
Site Post Dev A x C (AC_{PR})	=	$A_r \times c_r + A_p \times c_p + A_v \times c_v$		
Stormwater Flows	(For 20 year storm event)			
Duration	=	5	min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity ($^{20}I_5$)	=	171	mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_{20})	=	$AC_{PR} \times {}^{20}I_5 / 3600$		
	=	66	l/s	
Stormwater Detention Requirements				
Storage Volume	=	$(Q_{20} - Q_5) \times 5 \times 60 / 1000$		
	=	10.2	m^3	
PSD	=	32	l/s	(Permissible Site Discharge = Q_5)
Orifice Plate Controlled Discharge		(N/A if using choke pipe)		
Head (H)	=	1.0	m	(max. water level to orifice centre)
Orifice Diameter	=	$1000 \times \sqrt{[(0.464 \times Q_5 / 1000) / \sqrt{H}]}$		
	=	122	mm	
Outlet Pipe Diameter	=	365	mm	
Storage Provided				
Storage Volume	=	**10.2**	**m^3**	
Q100 check (as per NRDC SWD Handbook)				
Pre-development Q100 flow				
Duration	=	5	min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity ($^{100}I_5$)	=	237	mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_{100})	=	$(A_r c_r + A_p c_p + A_v c_v) \times {}^{20}I_5 / 3600$		(coefficient of runoff, C_r = 1.0, C_p = 1, C_v = 0.83,)
	=	76	l/s	
Post-development Q100 flow				
Duration	=	5	min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity ($^{100}I_5$)	=	237	mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_{100})	=	$(A_r c_r + A_p c_p + A_v c_v) \times {}^{20}I_5 / 3600$		(coefficient of runoff, C_r = 1.0, C_p = 1, C_v = 0.83,)
	=	92	l/s	
check				
$Q_{100\text{-dev}} - (Q_{20\text{-dev}} - Q_{5\text{-undev}})$	=	58	l/s	
		less than predev Q100 - storage sufficient		
A separate sheet is to be attached showing all workings for the storage volumes proposed on the engineering drawings and calculations for the				

On-site Stormwater Detention Design Summary Sheet

Wee Waa High School

Rainfall Region:		**Wee Waa**	
Developed Area	=	995 m^2	**Sports & Wood / Metal Rooms** Divided into two area due to two nearby tank locations TOTAL = 1990m2
Pre Development			
Catchment Areas	(Must be shown on engineering drawings)		
Roof Area (A_r)	=	0 m^2	(coefficient of runoff, c_r = 1.0)
Paved Area (A_p)	=	0 m^2	(coefficient of runoff, c_p = 0.9)
Vegetated Area (A_v)	=	995 m^2	(coefficient of runoff, c_v = 0.66)
Total Area	=	995 m^2	(Must equal post development area)
Site Pre Dev A x C (AC_{EX})	=	$A_r \times c_r + A_p \times c_p + A_v \times c_v$	
Stormwater Flows			
Duration	=	5 min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity ($^5I_5$)	=	125 mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_5)	=	$AC_{EX} \times {}^5I_5 / 3600$	
	=	23 l/s	
Post Development			
Catchment Areas	(Must be shown on engineering drawings)		
Roof Area (A_r)	=	995 m^2	(coefficient of runoff, c_r = 1.0)
Paved Area (A_p)	=	m^2	(coefficient of runoff, c_p = 0.9)
Vegetated Area (A_v)	=	0 m^2	(coefficient of runoff, c_v = 0.73)
Total Area	=	995 m^2	(Must equal pre development area)
Site Post Dev A x C (AC_{PR})	=	$A_r \times c_r + A_p \times c_p + A_v \times c_v$	
Stormwater Flows	(For 20 year storm event)		
Duration	=	5 min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity ($^{20}I_5$)	=	171 mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_{20})	=	$AC_{PR} \times {}^{20}I_5 / 3600$	
	=	47 l/s	
Stormwater Detention Requirements			
Storage Volume	=	$(Q_{20} - Q_5) \times 5 \times 60 / 1000$	
	=	7.3 m^3	
PSD	=	23 l/s	(Permissible Site Discharge = Q_5)
Orifice Plate Controlled Discharge		(N/A if using choke pipe)	
Head (H)	=	1.0 m	(max. water level to orifice centre)
Orifice Diameter	=	$1000 \times \sqrt{[(0.464 \times Q_5 / 1000) / \sqrt{H}]}$	
	=	103 mm	Use 100mm orifice
Outlet Pipe Diameter	=	309 mm	Use 300mm
Storage Provided			
Storage Volume	=	**7.3 m^3**	
Q100 check (as per NRDC SWD Handbook)			
Pre-development Q100 flow			
Duration	=	5 min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity ($^{100}I_5$)	=	237 mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_{100})	=	$(A_r c_r + A_p c_p + A_v c_v) \times {}^{20}I_5 / 3600$	(coefficient of runoff, C_r = 1.0, C_p = 1, C_v = 0.83,)
	=	54 l/s	
Post-development Q100 flow			
Duration	=	5 min	(refer AS/NZS 3500.3:2003)
Rainfall Intensity ($^{100}I_5$)	=	237 mm/hr	(select from above rainfall intensity charts)
Stormwater flow (Q_{100})	=	$(A_r c_r + A_p c_p + A_v c_v) \times {}^{20}I_5 / 3600$	(coefficient of runoff, C_r = 1.0, C_p = 1, C_v = 0.83,)
	=	66 l/s	
check			
$Q_{100\text{-dev}} - (Q_{20\text{-dev}} - Q_{5\text{-undev}})$	=	41 l/s	
		less than predev Q100 - storage sufficient	

A separate sheet is to be attached showing all workings for the storage volumes proposed on the engineering drawings and calculations for the

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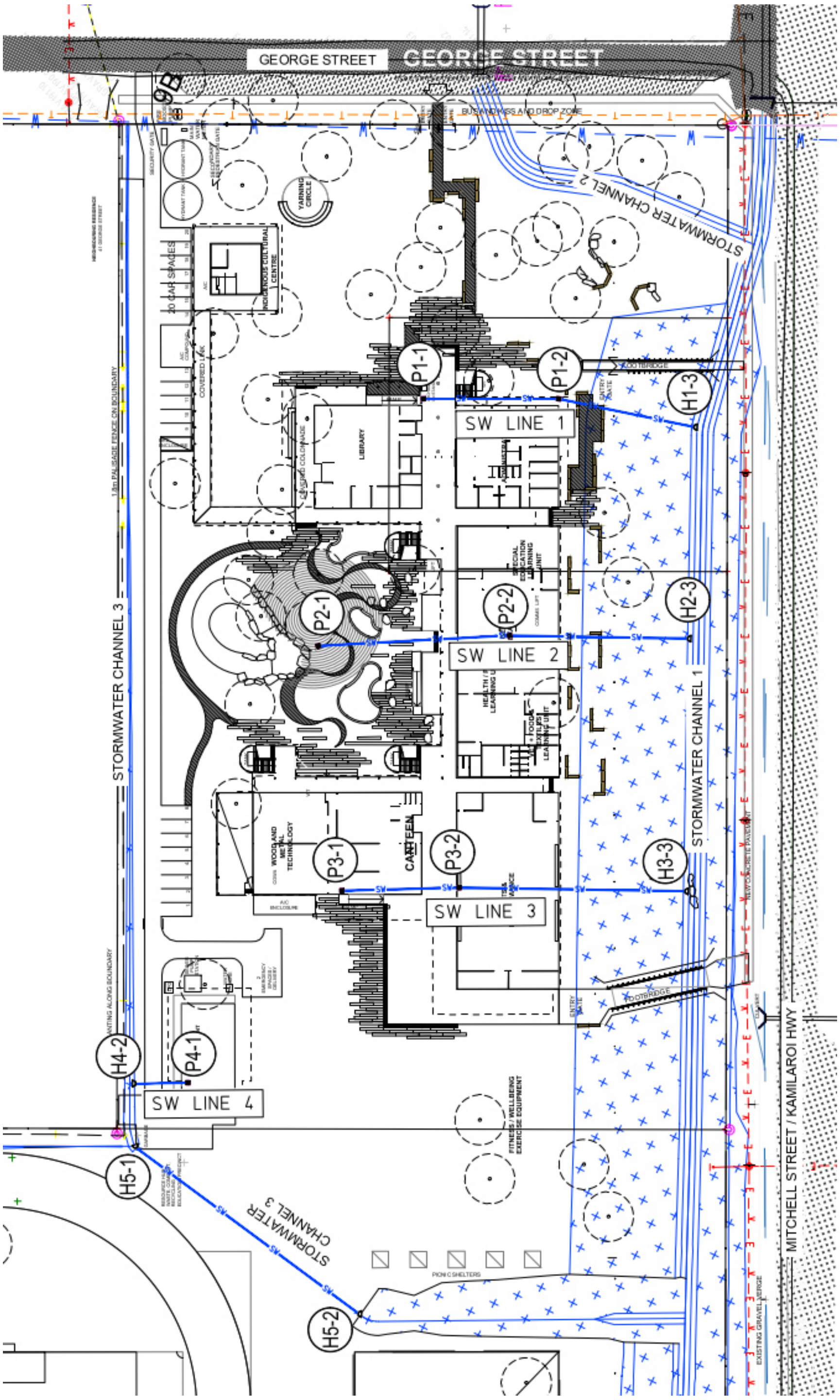
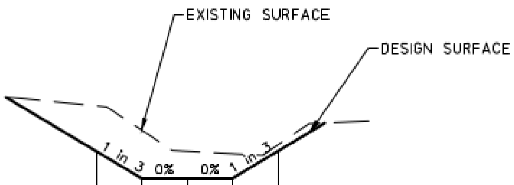
APPENDIX B – CIVIL ENGINEERING STORMWATER PLANS



APPENDIX C – CIVIL ENGINEERING STORMWATER CROSS SECTIONS

7.1.1 STORMWATER CHANNEL 1 - CROSS SECTIONS

The following cross sections illustrate the proposed depth and width of stormwater channels based off flood modelling catchment analysis and mitigated solutions to reduce onsite and neighbouring areas flooding (analysis done by others).



DATUM R.L.188.0

DESIGN SURFACE LEVEL		190.493	190.193	190.193	190.193	190.493
EXISTING SURFACE LEVEL		190.993	190.727	190.493	190.466	190.563
OFFSET		-2.000	-1.000	0.000	1.000	2.000

CH 0.000

FIGURE 11 - STORMWATER CHANNEL 1 - CH0

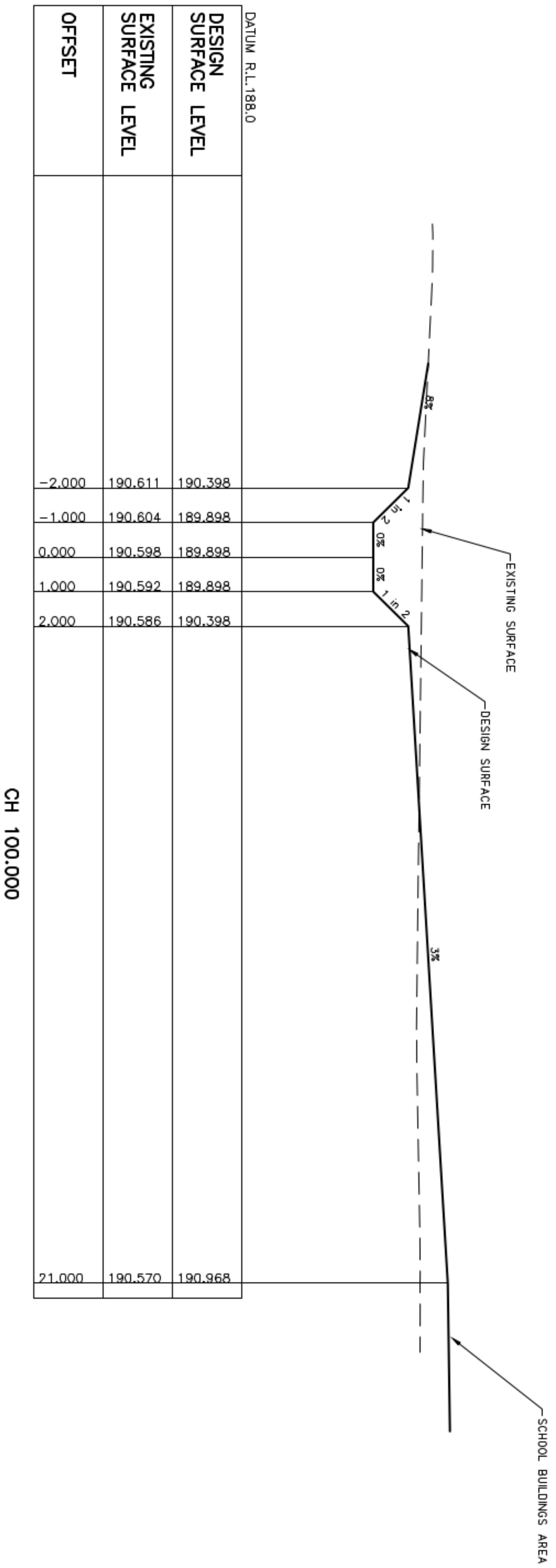


FIGURE 12 - STORMWATER CHANNEL 1 - CH100

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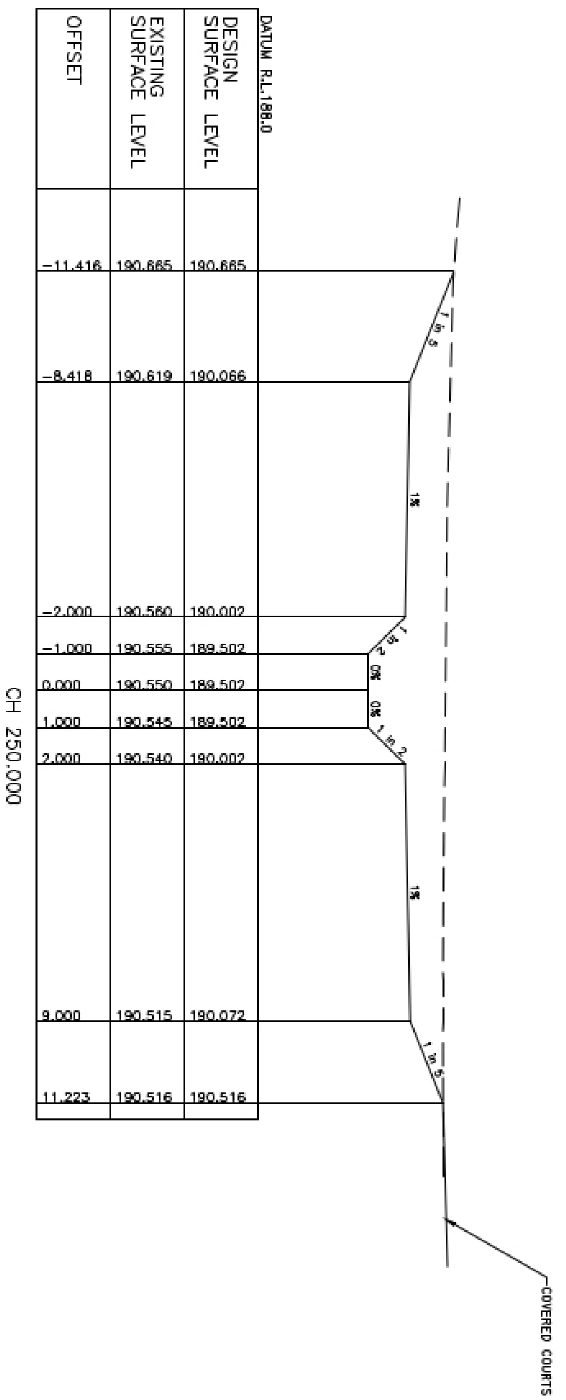
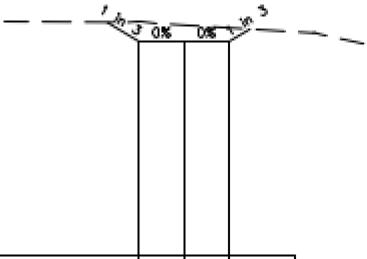


FIGURE 13 - STORMWATER CHANNEL - CH250

7.1.2 STORMWATER CHANNEL 2 - CROSS SECTIONS

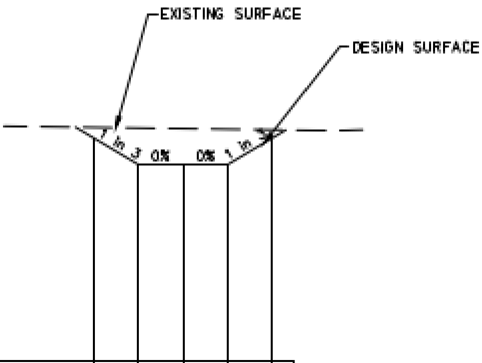


DATUM R.L.188.0

DESIGN SURFACE LEVEL	190.380	190.380	190.380
EXISTING SURFACE LEVEL	190.592	190.562	190.531
OFFSET	-1.000	0.000	1.000

CH 10.000

FIGURE 14 - STORMWATER CHANNEL 2 - CH10



DATUM R.L.188.0

DESIGN SURFACE LEVEL	190.484	190.184	190.184	190.184	190.484
EXISTING SURFACE LEVEL	190.602	190.595	190.588	190.582	190.575
OFFSET	-2.000	-1.000	0.000	1.000	2.000

CH 50.000

FIGURE 15 - STORMWATER CHANNEL 2 - CH50

7.1.3 STORMWATER CHANNEL 3 - CROSS SECTIONS

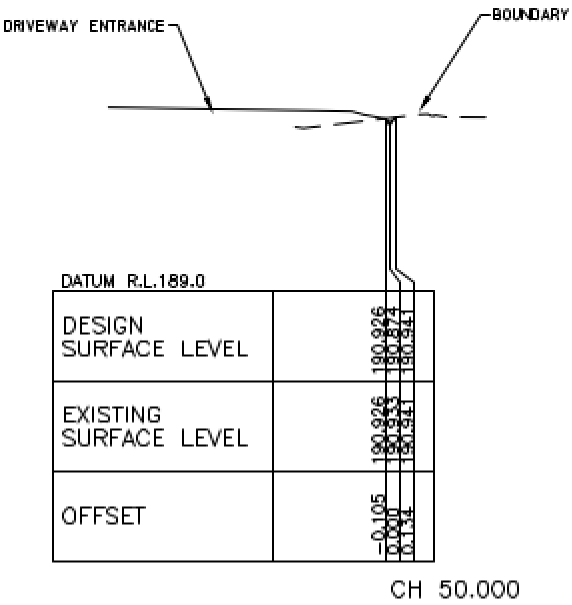


FIGURE 16 - STORMWATER CHANNEL 3 - CH50

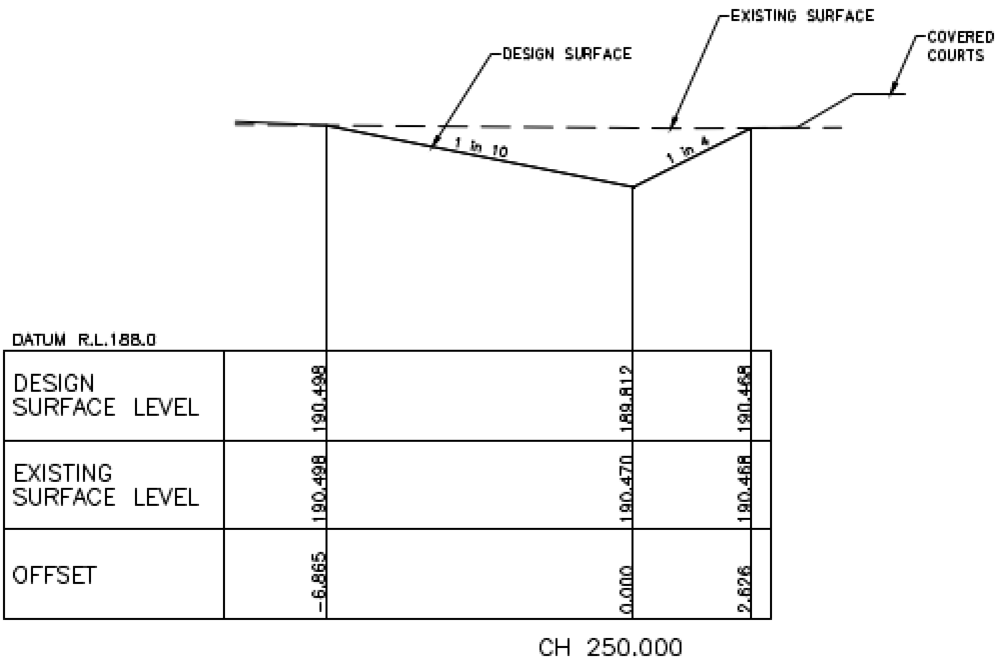


FIGURE 17 - STORMWATER CHANNEL 3 - CH250

7.1.4 Stormwater Channel 4 – Cross Sections

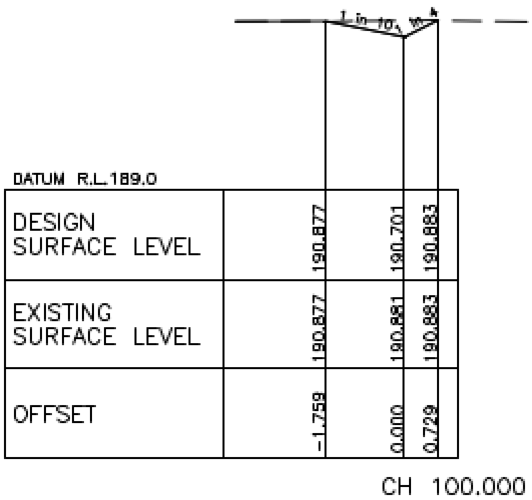


FIGURE 18 - STORMWATER CHANNEL 4 - CH100

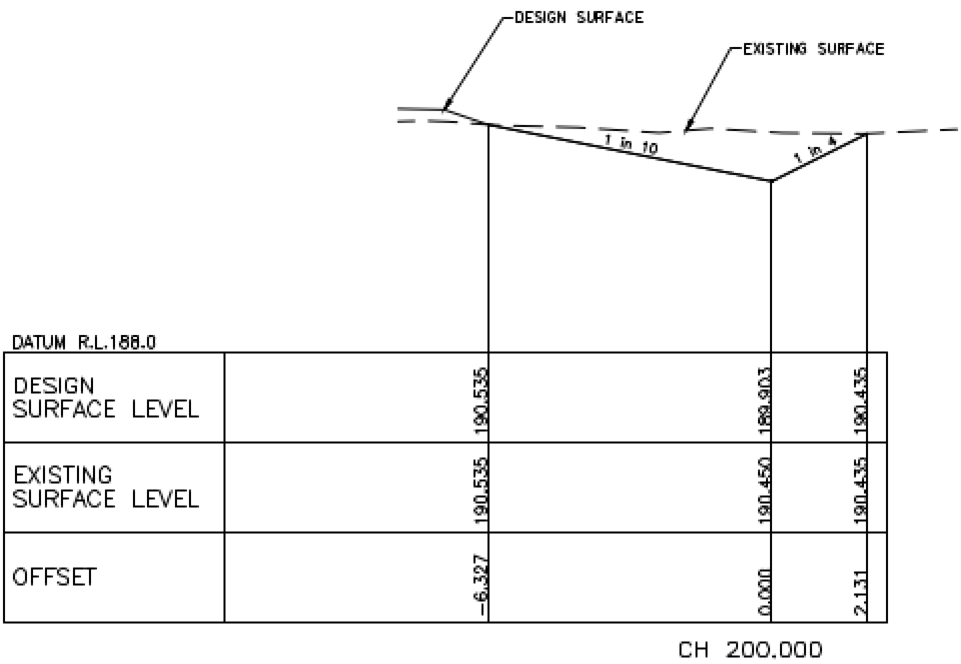


FIGURE 19 - STORMWATER CHANNEL 4 - CH200