29/04/2020

Project Number: 200337

STORMWATER MANAGEMENT REPORT

at

FINLEY SOLAR FARM | 231 BROOCKMANNS ROAD FINLEY NSW

for

PROVIDENCE ASSET GROUP c/- KDC Pty Ltd

Project No. 200337

Revision: B – DA Submission

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1. Introduction

DRB Consulting Engineers (DRB) were engaged by KDC Pty Ltd, on behalf of Providence Asset Group to undertake a Stormwater Management Plan for the proposed Finley Solar Farm, located at 231 Broockmanns Road, Finley.

This report will provide commentary on the impact the proposed development will have on the existing site with regard to stormwater quantity and stormwater quality.

It should be noted that, this report has been prepared to a level suitable for Development Application only. Additional information and/or reports may need to be developed prior to lodgement of the Construction Certificate submission.

This report should be read in conjunction with the Concept Stormwater Management plans 200337/CIV01-05.

2. Site Description & Proposed Development

The site is located at 231 Broockmanns Road, Finley. The site is located on the southern side of Broockmanns Road and is identified as Lot 61 DP 1053533.

The proposed Finley Solar Farm will be located in the South-East portion of the site, known as the Investigation Area (IA).

At the time of this investigation, the IA was a vacant rural parcel of land approximately 14.97 Ha in area. The IA was very flat, with slopes from the east to the northwest and southwest corners of approximately 0.1%.

Figure 1 below shows the existing site and investigation area.

Figure 1 – Existing Site Boundaries

It is proposed that the Finley Solar be constructed within the Investigation Area. The proposed Solar Farm layout can be seen in Figure 2 below.

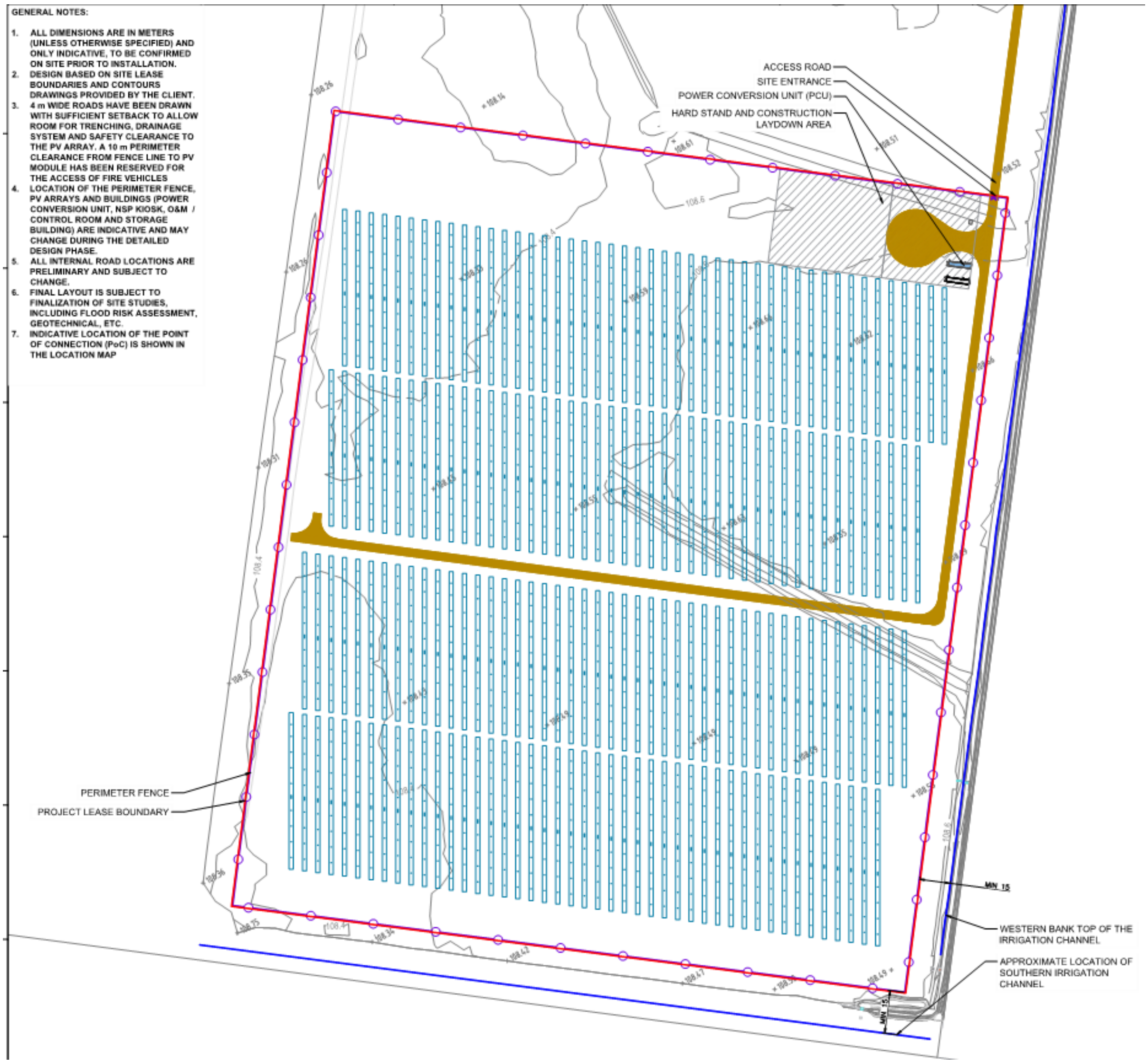

Figure 2 – Proposed Solar Farm

3. Pre-Lodgement Meeting and Council Correspondence

A Pre-Lodgement Meeting was undertaken with Berrigan Shire Council, and further discussions were undertaken over the phone with Berrigan Shire Council's Development Engineers. The following items relevant to the civil aspects of this project were discussed:

- *The proposed development must detain stormwater runoff using a Detention Basin, and the Basin outlet must be designed to bring the discharge rate Post-Development back to Pre-Development flow rates.*

- *The proposed development must be designed to bring the water quality discharging from the site back to Pre-Development levels.*

4. Water Quantity Analysis

4.1. Overview

The proposed development area has been split into three separate catchments for the assessment of Stormwater Quantity; the Photovoltaic Array, the Gravel / Hardstand and the Remaining Road catchments. Figure 3 below shows the proposed catchment boundaries.

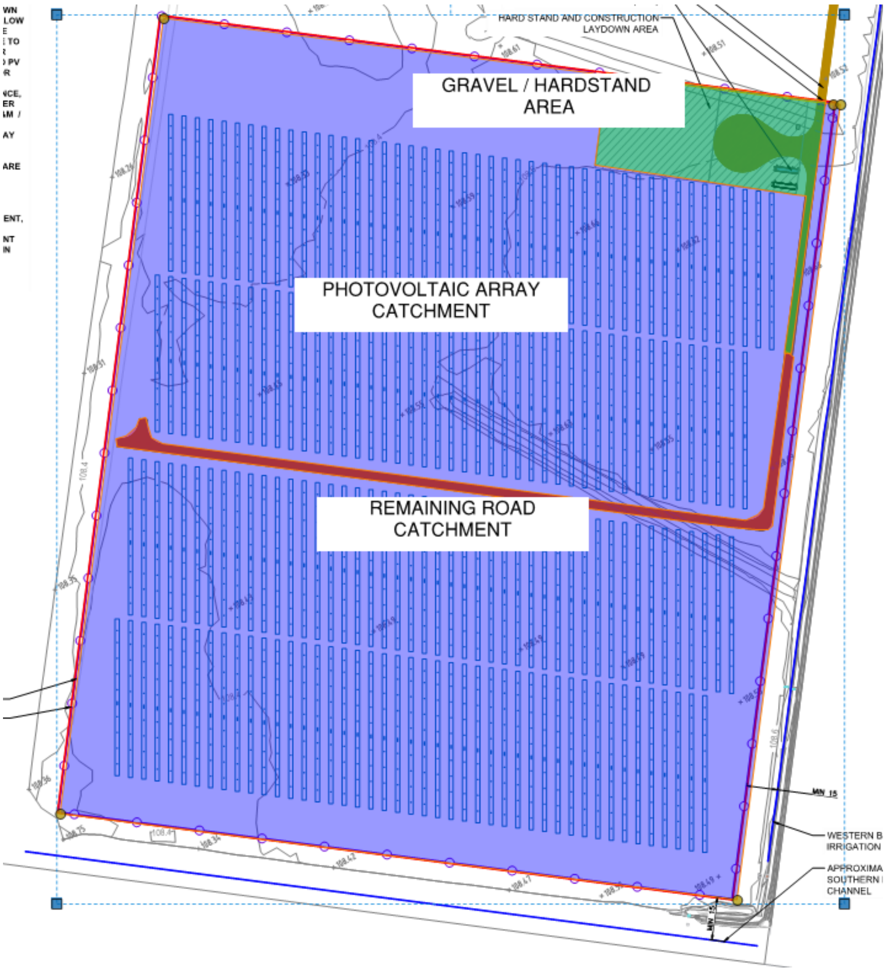

Figure 3 – Proposed Catchment Boundaries

4.2. *Photovoltaic Array*

The Photovoltaic Array will consist of 182 x Ground Mounted Single Axis Trackers. The array structure will be steel pile supported and will have approximately 600mm clearance above the existing ground surface.

4.2.1. *Pre-Development Peak Flows*

The catchment characteristics for the Pre-Development catchment area can be seen in Table 1 below:

Catchment	***Parameter***	
North	Sub-Catchment Area	50,263.8 m^2
	Percentage Impervious	0 %
	Flowpath Length	367 m
	Flowpath Slope	0.11 %
	Retardance Coefficient ‘n’	0.075
South	Sub-Catchment Area	50,245.7 m^2
	Percentage Impervious	0 %
	Flowpath Length	348 m
	Flowpath Slope	0.1 %
	Retardance Coefficient ‘n’	0.075

Table 1 – Existing Catchment Parameters

A DRAINs model was developed to determine the pre-development peak flow rates. The DRAINs model used the *ARR 2019 Initial loss - Continuing loss (IL-CL) hydrological model* and 2016 IFD data. The Hydrological model parameters were determined using the ARR data hub and can be seen in Figure 4 below.

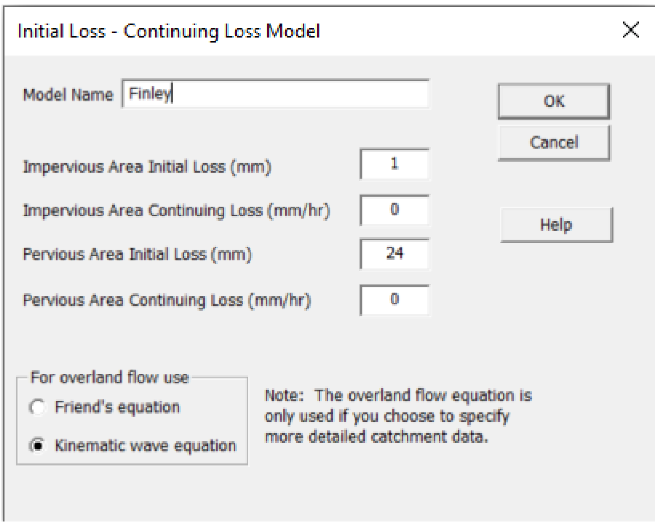

Figure 4 – Hydrological Model Parameters

The model was developed for the 1 EY (Exceedances per year), 10% AEP (Annual Exceedance Probability) and 1% AEP events and analysed the following storm durations.

5 minutes	30 minutes	6 hours
10 minutes	45 minutes	9 hours
15 minutes	1 hour	12 hours
20 minutes	2 hours	18 hours
25 minutes	4.5 hours	24 hours

The Results of the DRAINs model can be seen below in Table 2.

Catchment	***Storm Event (Exceedance Probability / Annual Exceedance Probability)***	***Peak Flow***
North	1EY	0.036 m^3/s
	10% AEP	0.151 m^3/s
	1% AEP	0.374 m^3/s
South	1EY	0.035 m^3/s
	10% AEP	0.151 m^3/s
	1% AEP	0.374 m^3/s

Table 2 – Pre-Development Peak Flow

4.2.2. Post-Development Peak Flows

The Post-Development site conditions can be summarised below:

(i) The proposed arrays will be at varying angles, however, in a worst-case runoff scenario, it is assumed the arrays are horizontal to the existing ground surface level.

(ii) Runoff from the proposed arrays will fall immediately on to the untouched natural ground surface. With the exception of the removal of some of the existing earth berms to reinstate the natural flow direction.

(iii) The pervious area under the arrays will not receive direct rainfall, however, it will be available for both initial and continuing loss for the runoff of the array immediately upslope.

The catchment characteristics for the Post-Development catchment area can be seen in Table 3 below:

Catchment	***Parameter***	
North	Sub-Catchment Area	50,263.8 m^2
	Percentage Impervious	31.40 %
	Flowpath Length	367 m
	Flowpath Slope	0.11 %
	Retardance Coefficient ‘n’	0.075
South	Sub-Catchment Area	50,245.7 m^2
	Percentage Impervious	31.40 %
	Flowpath Length	348 m
	Flowpath Slope	0.1 %
	Retardance Coefficient ‘n’	0.075

Table 3 – Proposed Development Catchment Parameters

To replicate the proposed site conditions and consider the available pervious areas located underneath the proposed arrays, the Pervious Area Initial and Continuing Loss was factored up by 1.453. This allowed the total pervious area to be included in the assessment.

The Hydrological model parameters used in the Post-Development model can be seen in Figure 5 below.

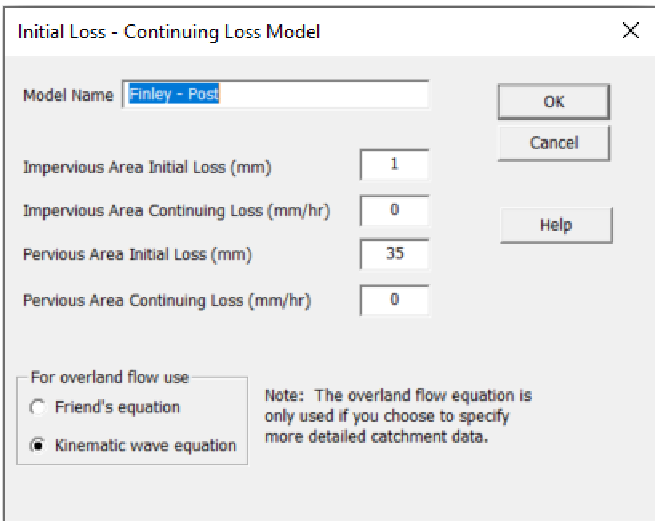

Figure 5 – Hydrological Model Parameters

The Results of the DRAINs model can be seen below in Table 4.

Catchment	***Storm Event (Exceedance Probability / Annual Exceedance Probability)***	***Pre-Development Peak Flow***	***Post-Development Peak Flow***	***Difference***
North	1EY	0.036 m³/s	0.033 m³/s	- 0.003 m³/s
	10% AEP	0.151 m³/s	0.133 m³/s	- 0.018 m³/s
	1% AEP	0.374 m³/s	0.339 m³/s	- 0.035 m³/s
South	1EY	0.035 m³/s	0.033 m³/s	- 0.002 m³/s
	10% AEP	0.151 m³/s	0.133 m³/s	- 0.018 m³/s
	1% AEP	0.374 m³/s	0.339 m³/s	- 0.035 m³/s

Table 4 – Post-Development Peak Flow

4.2.3. Conclusion

By discharging the runoff from proposed Photovoltaic Array's directly to the existing ground surface and maintaining the existing natural surface levels and travel paths the proposed development area catchment limited the increase to peak runoff to negligible values, and reduced the peak runoff during the 1% AEP.

4.3. *Gravel / Hardstand Area and Remaining road area*

The Gravel / Hardstand Area includes a gravel laydown area, temporary buildings and a section of the proposed roads located within the Investigation Area.

It is proposed that runoff from this area will generally follow the existing contours, with a road-side swale and a swale on the low side of the hardstand area capturing and conveying these flows to a new above ground onsite stormwater detention basin.

The Remaining road area includes the majority of the proposed road located within the Investigation Area.

It is proposed that the runoff from this area will be conveyed in a roadside swale that will also be designed as a basin to limit the post development flows.

4.3.1. *Pre-Development Peak Flows*

The catchment characteristics for the Pre-Development catchment area can be seen in Table 5 below:

Catchment	***Parameter***	
Gravel / Hardstand Area	Sub-Catchment Area	6005 m^2
	Percentage Impervious	0 %
	Flowpath Length	300 m
	Flowpath Slope	0.1 %
	Retardance Coefficient ‘n’	0.075
Remaining Road Area	Sub-Catchment Area	1839 m^2
	Percentage Impervious	0 %
	Flowpath Length	400 m
	Flowpath Slope	0.1 %
	Retardance Coefficient ‘n’	0.075

Table 5 – Existing Catchment Parameters

A DRAINs model was developed to determine the pre-development peak flow rates. The DRAINs model used the *ARR 2019 Initial loss - Continuing loss (IL-CL) hydrological model* and 2016 IFD data. The Hydrological model parameters were determined using the ARR data hub (see Figure 4 above) and was developed for the 1 EY (Exceedances per year), 10% AEP (Annual Exceedance Probability) and 1% AEP events.

The Results of the DRAINs model can be seen below in Table 6.

Catchment	***Storm Event (Exceedance Probability / Annual Exceedance Probability)***	***Peak Flow***
Gravel / Hardstand Area	1EY	0.004 m^3/s
	10% AEP	0.018 m^3/s
	1% AEP	0.051 m^3/s
Remaining Road Area	1EY	0.001 m^3/s
	10% AEP	0.005 m^3/s
	1% AEP	0.013 m^3/s

Table 6 – Pre-Development Peak Flow

4.3.2. *Post-Development Peak Flows*

The catchment characteristics for the Post-Development catchment area can be seen in Table 7 below:

Catchment	***Parameter***	
Gravel / Hardstand Area	Sub-Catchment Area	6005 m^2
	Percentage Impervious	100 %
	Flowpath Length	260 m
	Flowpath Slope	0.1 %
	Retardance Coefficient 'n'	0.075
Remaining Road Area	Sub-Catchment Area	1839 m^2
	Percentage Impervious	100 %
	Flowpath Length	400 m
	Flowpath Slope	0.1 %
	Retardance Coefficient 'n'	0.075

Table 7 – Proposed Development Catchment Parameters

The Gravel / Hardstand Catchment drained directly into an above ground Onsite Stormwater Detention Basin. The Remaining Road Catchment drained directly into a roadside basin. The two Basins characteristics can be seen in Table 8 below.

Basin Catchment	***OSD Basin***	
Gravel / Hardstand Area	Basin Invert	108.30m AHD
	Basin – Top of Bank	108.60m AHD
	Weir Width	0.3 m
	Weir Level	108.44m AHD
	Basin Volume	252.24.m^3
	Outlet Pipe (@ base)	150mm diam
	Outlet Pipe Orifice	70mm diam
Remaining Road Area	Basin Invert	108.50m AHD
	Basin – Top of Bank	108.70m AHD
	Weir Width	0.2 m
	Weir Level	108.6m AHD
	Basin Volume	82.605 m^3
	Outlet Pipe (@ base)	4 x 100mm diam
	Outlet Pipe Orifice	32mm diam

Table 8 – Proposed OSD Basin Characteristics

The Results of the DRAINs model can be seen below in Table 9.

Catchment	***Storm Event***	***Pre-Dev. Peak Flow***	***Post-Dev. Peak Flow***	***Post-Dev. Peak Flow - Mitigated***	***Difference***	***Top Water Level***
Gravel / Hardstand Area	1EY	0.004 m^3/s	0.014 m^3/s	0.003 m^3/s	- 0.001 m^3/s	108.45m AHD
	10% AEP	0.018 m^3/s	0.039 m^3/s	0.016 m^3/s	- 0.002 m^3/s	108.52m AHD
	1% AEP	0.051 m^3/s	0.078 m^3/s	0.035 m^3/s	- 0.016 m^3/s	108.60m AHD
Remaining Road Area	1EY	0.001 m^3/s	0.003 m^3/s	0.002 m^3/s	+ 0.001 m^3/s	108.59m AHD
	10% AEP	0.005 m^3/s	0.009 m^3/s	0.005 m^3/s	- 0.030 m^3/s	108.64m AHD
	1% AEP	0.013 m^3/s	0.019 m^3/s	0.010 m^3/s	- 0.003 m^3/s	108.70m AHD

Table 9 – Post-Development Peak Flow

4.3.3. Conclusion

By discharging the runoff from proposed Gravel / Hardstand and Remaining Road Area through the proposed OSD basins, the Post-development peak flows for the entire Investigation Area are reduced back to the Pre-development peak flow values.

5. Water Quality Analysis

5.1. Model Development and Council Requirements

A stormwater quality analysis was undertaken using the software MUSIC.

As discussed in Section 3 above, following a discussion with Berrigan Shire Council's Development Engineers, it was confirmed that the proposed development must be designed to bring the water quality discharging from the site back to Pre-Development levels.

Further to above, a review of Council's documents did not identify any Water Quality Reduction Targets that may also need to be met. On sites of this nature, reduction targets may impose a more onerous requirement for the development.

As such, the reduction targets presented in Table 10 below were also adopted for the site. These targets were considered 'best practice'.

Nutrient	***Reduction Target***
Total Suspended Solids (TSS)	90 %
Total Phosphorous (TP)	60 %
Total Nitrogen (TN)	45 %
Gross Pollutants (GP)	90 %

Table 10 – Reduction Targets

The model was developed using the MUSIC supplied Albury-Wodonga rainfall and PET files.

A screen shot of the MUSIC model can be seen in Figure 6 below.

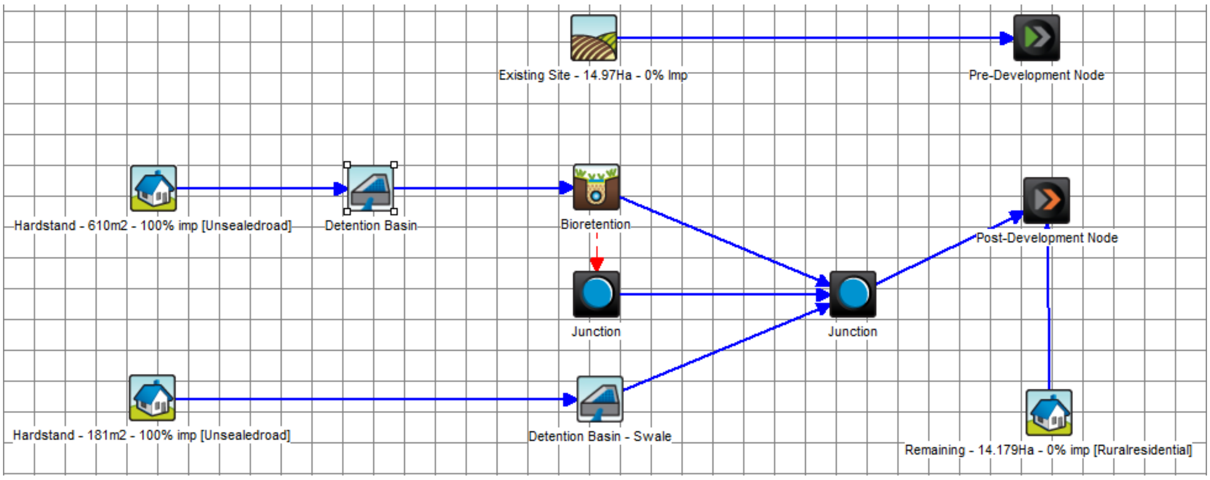

Figure 6 – Post-Development MUSIC model

5.2. *Treatment Measures*

Onsite Stormwater Detention Basin

It is proposed that the roads and gravel hardstand areas will be directed to above ground OSD basins. The model inputs for the OSD Basins can be seen in Figure 7 below.

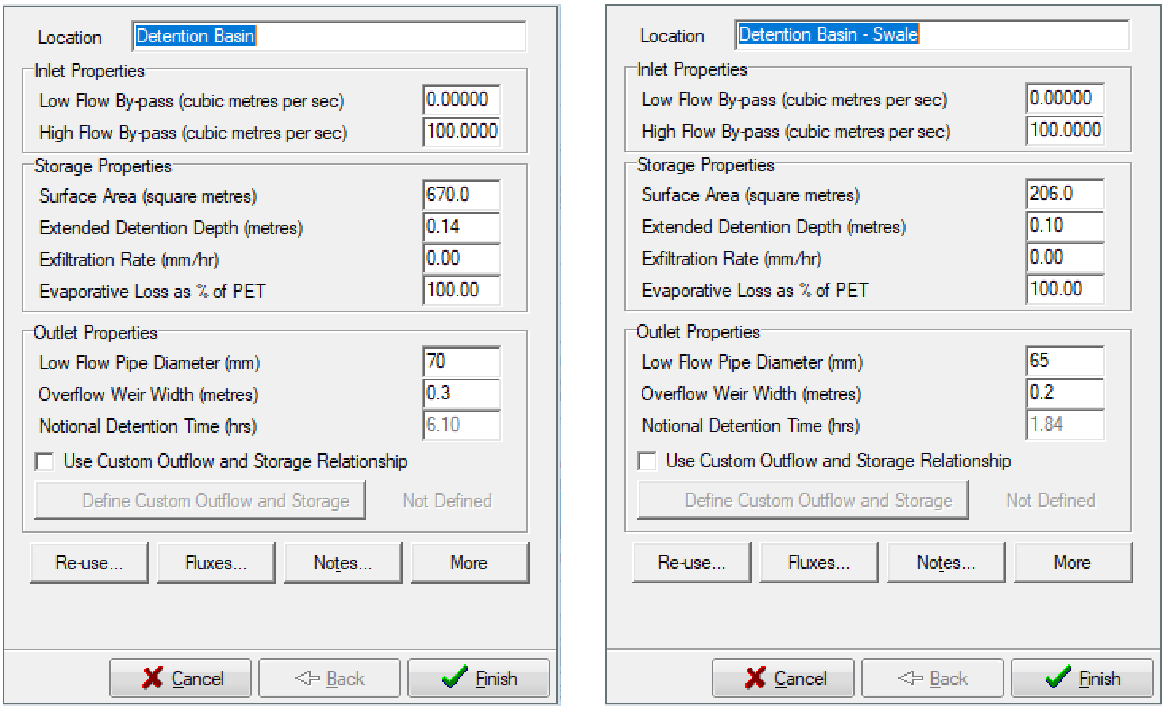

Figure 7 – OSD Basin Model Parameters

Biofiltration Basin

It is also proposed that the northern OSD basin has a Biofiltration Basin in the base to treat / infiltrate runoff. The model inputs for the Biofiltration Basin can be seen in Figure 8 below.

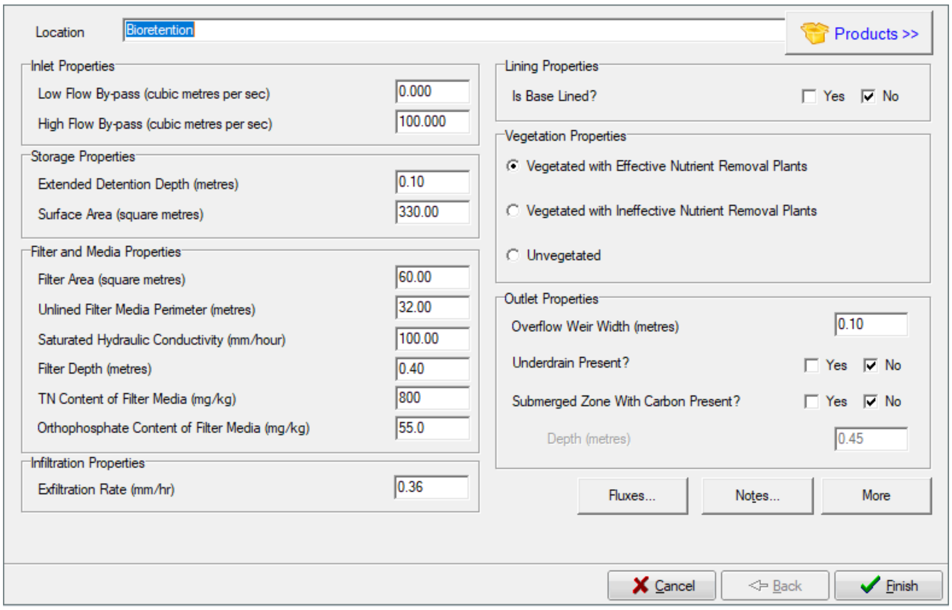

Figure 3 – Biofiltration Basin Model Parameters

5.3. MUSIC Results

The results of the MUSIC model can be split in to two separate results. Table 11 below shows the total site Pre-Development to Post-Development, whereas Table 12 shows the reduction percentages on the developed areas.

	TSS	***TP***	***TN***	***GP***
Pre-Development - Source Load (kg/yr)	572	2.38	21.1	0
Post-Development - Residual Load (kg/yr)	367	1.66	20.1	0
Difference (kg/yr)	-105	-0.72	-1.0	0
NorBE Achieved	Yes	Yes	Yes	Yes

Table 11 – MUSIC Results - NorBE

	TSS	***TP***	***TN***	***GP***
Source Load (kg/yr)	5910	2.65	10.7	151
Residual Load (kg/yr)	82.4	0.55	5.89	0
Reduction (%)	98.6	79.2	45.0	100
Target (%)	90	60	45	90
Achieved	Yes	Yes	Yes	Yes

Table 12 – MUSIC Results – Reduction Targets

As noted in Table 6 above, the proposed development achieves both NorBE for the site and ‘best practice’ Reduction Targets for the disturbed areas.

6. Conclusion

The stormwater drainage strategy for the proposed Finley Solar Farm at 231 Broockmanns Road, Finley can be summarised as:

(i) All impervious runoff from the proposed Photovoltaic Arrays will discharge to the existing ground surface where the natural flow regime will be maintained.

(ii) Runoff from the proposed gravel and hardstand areas will be conveyed via sheet flow and grass-lined swales to the proposed above ground onsite stormwater detention basins.

(iii) Discharge from the above ground onsite stormwater detention basins will be limited to the pre-development flow rates.

(iv) The water quality treatment train will reduce the post-development pollution levels to the pre-development levels, as well as achieving the 'best practice' pollution reduction targets.

Should you require any further advice or clarification of any of the above, please do not hesitate to contact us.

Yours faithfully
DRB CONSULTING ENGINEERS PTY LIMITED

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