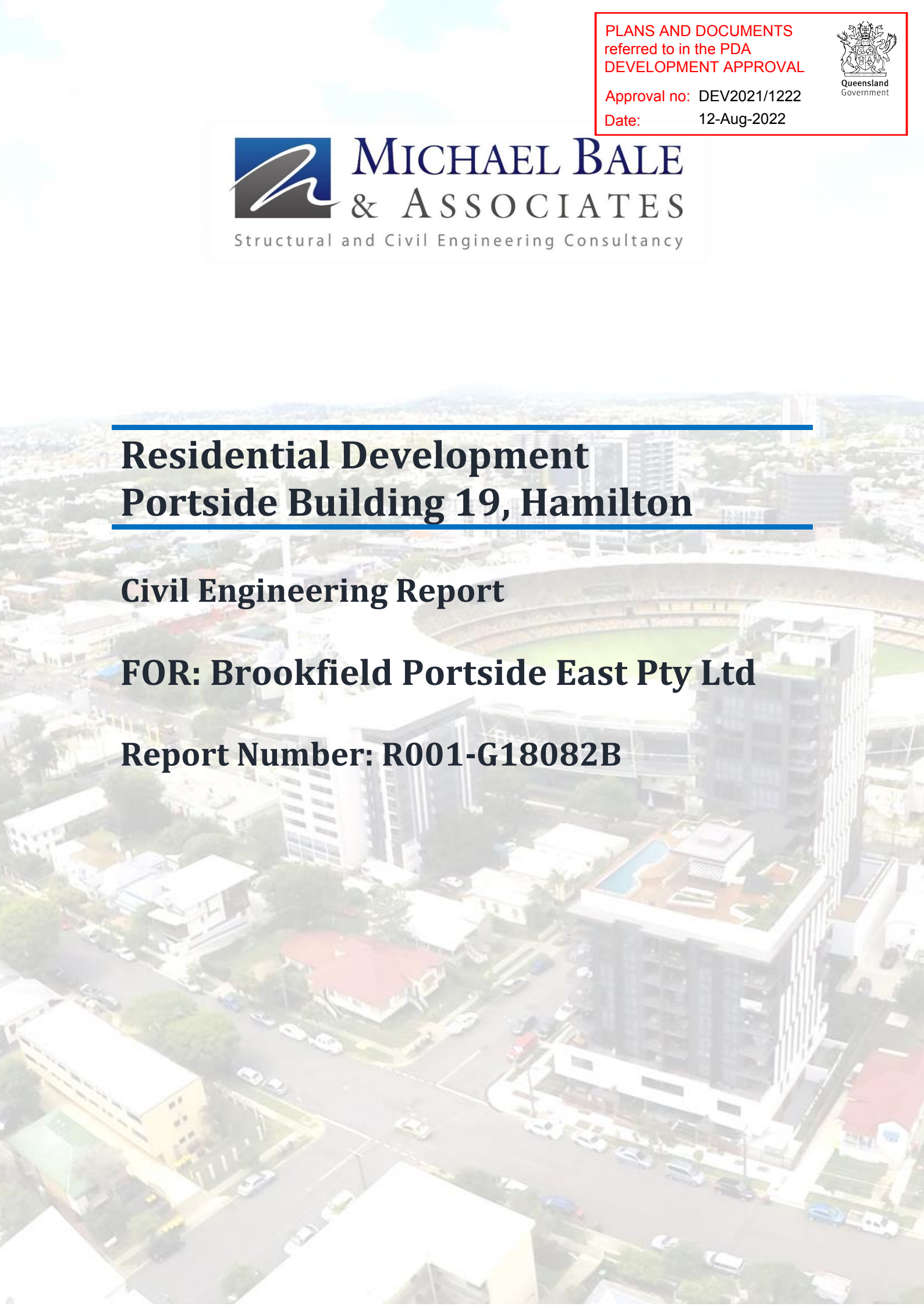
MICHAEL BALE & ASSOCIATES
Structural and Civil Engineering Consultancy

Residential Development
Portside Building 19, Hamilton

Civil Engineering Report

FOR: Brookfield Portside East Pty Ltd

Report Number: R001-G18082B



This document has been approved by the following appropriately qualified and experienced professional civil engineer:

Alex Rowlands
Registered Professional Engineer of Queensland No. 24572

Revision Status

Revision	Author	Reviewed By	Description	Date
A	Alex Rowlands	Chanel Handel	Lodgement Issue	10/09/2021

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1. Introduction

This report has been prepared to support the lodgement of a development application to approve the construction of a new residential apartment tower, comprising a total of one hundred and eighty-six (186) apartments. The development is proposed over the following parcel of land:

Property Address:	11 Macarthur Avenue
Property Description:	Lot 705 on SP287529
Client:	Brookfield Portside East Pty Ltd
Council:	Brisbane City Council
Registered Site Area:	3,385m^2

This report intends to demonstrate that the proposed development can be suitably serviced with all engineering services described and supports the type and scale of development that is proposed.

This report intends to assess the likely impact of the proposed development in relation to stormwater quantity and quality, and the adequacy of the existing stormwater infrastructure to accommodate the proposed development. This report addresses other civil engineering issues associated with the development of the proposed land and includes discussion on the following key engineering items:

- Stormwater Quantity;
- Stormwater Quality;
- Earthworks;
- Erosion and Sediment Control;
- Water Connection, and;
- Sewer Connection.

1.1 Previous Approvals

This report addresses the civil engineering constraints for the proposed "Building 19" of the master plan development. "Portside East" as referenced in this application will ultimately contain five separate developments, being Buildings 16a, 16b, 17, 18 and 19.

Building 18 is to be constructed prior to the proposed Building 19 and is currently undergoing detailed design.

Building 17 is a planned future stage of the combined master plan. Stormwater management for this site has been addressed in separate reports specific to Building 17. Construction of Building 17 will commence imminently at the time of writing this report.

Building 16a and 16b are currently under construction immediately south of the proposed Building 19 site. Building 16 underwent a separate application process and has a Stormwater Management Plan, prepared by Bornhorst and Ward (Project no. 14294). The Building 16a and 16b design and construction is approved under the Economic Development Act 2012. No approvals beyond this govern the stormwater management of Building 19. Construction of Building 16A and Building 16B was completed in 2019.

2. Property Description

2.1 Site Locality

The proposed development is situated on the existing lot located at 11 Macarthur Avenue, Hamilton, described as Lot 705 on SP287529. The proposed development is over a total area of 3,385m^2. The property is located within the Economic Development Queensland's Northshore Hamilton Priority Development Area.

The site is centrally located in the suburb of Hamilton and is in close proximity to local commercial and retail centres.

The proposed development is bounded by the Hercules Street road reserve to the north, Building 18 of the Portside development to the east, Building 16 of the Portside development to the south and existing residential/commercial structures to the west. The registered area of the existing allotments in this proposal is 3,385m^2.

A general locality plan is presented in Figure 2.1 below:

Figure 2.1 - Site Locality

2.2 Land Usage

The development site has historically been developed as the Brisbane Cruise Terminal. The existing development contains predominantly hardstand land uses, comprising roofed, road and paved surfaces. The pre-developed fraction impervious has therefore been adopted as 100%.

A copy of the site survey attached as Appendix B. Contractors should be aware of existing services on-site and avoid any damage during construction.

2.3 Topography and Drainage

Inspection of the development site shows that the site ultimately grades towards the south-east, with flows discharging through the existing carpark area which will ultimately contain the Portside Building 18 development. Flows are expected to discharge through the carpark allotment and into the stormwater infrastructure contained in Wharf Close.

The stormwater management plan prepared for Building 16 of the Portside development, prepared by Bornhorst and Ward (Project no. 14294), proposes to convey stormwater from Building 19 of the Portside development in culverts which run beneath Building 18, to ultimately discharge towards stormwater infrastructure in Wharf Close.

The topography around the development site is extremely flat and grades towards the south. The average slope across the development site has been adopted at 0.5%.

2.4 Upstream Catchment

The proposed development is bounded by Macarthur Avenue to the north. Flows from this catchment are expected to be captured in existing stormwater drainage and are not anticipated to enter the development site.

The allotment to the west (Portside Wharf) is an earlier stage of the Brookfield Multiplex development and has been designed to discharge stormwater to an underground culvert running through the development site.

The development site is therefore not expected to receive overland flows from any significant upstream catchments.

3. Proposed Development

The proposed development consists of:

- A new residential apartment tower comprising a total of one hundred and eighty-six (186) dwellings;
- The construction of a single level of underground carparking and two levels of podium level carparking;
- The construction of a new vehicular accessway into the proposed development;

The total impervious area of the development has been measured from proposed architectural plans to cover approximately 97% of the net developable area.

Construction works for the site will consist of bulk earthworks, with controlled excavation works, areas of localized filling and general lot shaping.

Additional works on site shall include the construction of water reticulation, sewer reticulation, electrical and telecommunications services and stormwater management works.

External works for the development will consist of verge works with Hercules Street, including the removal of existing redundant crossovers and driveways. No further external works are proposed as part of this development.

Erosion and sediment control measures shall be implemented in accordance with the latest version of the Best Practices Guidelines prepared by the International Erosion Control Association Australia (IECA Aust) and the Brisbane City Council Planning Scheme Policy.

4. Lawful Point of Discharge

In the existing case, the development site is expected to discharge towards the existing carpark to the east, and ultimately discharges towards the stormwater infrastructure in Wharf Close.

In the developed case, it is proposed to maintain the existing discharge arrangement by discharging stormwater flows from the development site to a culvert system which will convey flows beneath Portside Building 18 and discharge towards the stormwater infrastructure in Wharf Close. This discharge arrangement will require a volumetric easement beneath the Portside Building 18 development to service the proposed culverts which will allow flows from Building 19 to reach Wharf Close.

The proposed discharge arrangement is considered to comply with the requirements of a lawful point of discharge and will be maintained following the development of the site. It is not anticipated that any stormwater will be directed towards any adjacent properties.

QUDM (2017) provides a three-part framework for the identification of a lawful point of discharge for a development site. The first assessment item is to consider if the proposed development will alter the site's stormwater discharge characteristics in a manner that may substantially damage a third-party property. As the proposed development is not considered likely to worsen the flows received by the stormwater infrastructure in Wharf Close, the proposed point of discharge is considered to satisfy the requirements set out in Section 3.9.1 – Lawful Point of Discharge Test.

This compliance is further demonstrated in the following pages where it is shown that the proposed development will result in no worsening of peak flows from the development site.

5. Site Specific Hydrology

5.1 Introduction

The proposed development will involve the construction of a residential apartment tower and additional hardstand surfaces including footpaths and access driveways. The construction of these hardstand surfaces will alter the flow characteristics of the development site. This includes the fraction impervious and the volume of rainfall converted to runoff.

This section of the report addresses peak stormwater discharge resulting from the site, identifies whether attenuation measures are necessary to ensure "no-worsening" of the peak flows from the site and provides sizing information for any required attenuation measures.

5.2 Methodology

The Rational Method has been utilised to estimate the peak flow of event hydrographs for both the existing and developed case scenarios.

The results of the Rational Method calculations are used in the following sections to:

i) Evaluate the impact of the proposed development on the surrounding infrastructure, and;

ii) Quantify the discharge of stormwater from the site and surrounding catchments for the proposed future development.

5.3 Site Specific Rational Method Calculations

Time of Concentration

The development site is highly developed in both the existing and proposed cases. A 5-minute time of concentration has therefore been adopted, in accordance with QUDM (2013) Table 4.6.3.

C_{10} Value

The C_{10} values for the proposed site have been based on measured Fraction Impervious (f_i) areas from the site survey and the proposed architectural layouts. Measured imperviousness on the site has been compared to the values in QUDM (2013) Table 4.5.3 for determination of the C_{10} value, which is presented in Table 5.1 below.

Table 5.1: C_{10} Values

	f_i	C_{10}
Pre-development	1.00	0.900
Post-development	0.97	0.895

Summary of Flow – Rational Method

The Rational Method was used to calculate runoff from the site in the pre-developed and post developed scenario. The anticipated peak discharge is detailed in Table 5.2 below.

Table 5.2: Development Runoff Calculations –

	Q_2 (m^3/s)	Q_5 (m^3/s)	Q_{10} (m^3/s)	Q_{20} (m^3/s)	Q_{50} (m^3/s)	Q_{100} (m^3/s)
Pre-development	0.113	0.154	0.178	0.211	0.255	0.279
Post-development	0.111	0.151	0.174	0.211	0.255	0.279
Difference	**-0.002**	**-0.003**	**-0.004**	**-0.000**	**0.000**	**0.000**

Table 5.2 above shows that the development will result in relatively minor changes to the runoff volume generated on the subject site. The development site is therefore not required to provide a detention volume to ensure no worsening of peak flow rates.

6. Stormwater Quality

6.1 Introduction

This section of the report aims to identify the requirements for stormwater quality management resulting from the proposed development, and identify suitable stormwater treatment devices to comply with relevant requirements of the State Planning Policy and the Brisbane City Council Planning Scheme.

6.2 State Planning Policy Assessment

An assessment has been undertaken to determine whether the development proposal necessitates compliance with the State Planning Policy (SPP) objectives. The following trigger questions are used to determine whether SPP compliance is required.

Table 6.1- State Planning Policy Trigger Questions

Trigger Question	Development Response
Material Change of Use for Urban Purposes with a land area greater than 2,500m^2 that:	**Yes**
Will result in an impervious area greater than 25% of the net developable area	**Yes**
Will result in 6 or more dwellings	**Yes**
Reconfiguration of Lot for Urban Purposes that involves a land area greater than 2,500m^2, and will result in 6 or more lots	**Yes**
Operational Work for Urban Purposes that involve disturbing more than 2,500m^2 of land	**Yes**

As the above trigger questions are applicable to this development, the site is required to achieve the design objectives of the State Planning Policy.

6.3 Water Quality Objectives and Methodology

The proposed development triggers state interests for water quality as described in the State Planning Policy (SPP). The proposed development will include a Material Change of Use (MCU) application which will result in six or more dwellings.

As such, the development must demonstrate compliance with the stormwater management design objectives stated in Appendix 3, Table B of the SPP. Specifically, the development must demonstrate the following minimum reductions in mean annual pollutant loads from the unmitigated development:

Table 6.2: Water Quality Objectives

Pollutant	Minimum Reduction in Mean Load (%)
Total Suspended Solids (kg/yr)	80
Total Phosphorus (kg/yr)	60
Total Nitrogen (kg/yr)	45
Gross Pollutants (kg/yr)	90

To design and assess the achievement of these stormwater quality objectives the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) Version 6.2.0 has been utilised to size suitable stormwater quality improvement devices as described in the following sections.

6.4 Catchment Areas & Source Nodes

The catchment areas used for the water quality assessment are limited to the subject site, and reflects the proposed lawful point of discharge arrangement. The subject site has been separated into pollutant source nodes for MUSIC modelling using the "split catchment" approach as follows:

Net Developable Area:

- Roof Area = 1332m^2 (100% Impervious);
- Landscaped Area = 95m^2 (0% Impervious);
- Hardstand Area = 1360m^2 (100% Impervious);
- Driveway Area = 598m^2 (100% Impervious).

NOTE: As part of a sensitivity analysis against future changes to the architectural and landscaping plans for the site, the site has also been tested with all landscaped areas replaced with impervious ground areas to ensure compliance in the event of minor changes to catchment areas. The results show that the treatment train proposed in the following sections is effective in reaching minimum pollutant load reductions in this worst-case scenario.

6.5 Recorded Rainfall Data – Brisbane Aero

Rainfall data for the site was taken from the Brisbane Aero station (ID 40223) using the dates 1/1/1980 – 31/12/1989 in accordance with the Water By Design – MUSIC Modelling Guidelines (2010) using a 6 minute time step.

The mean average rainfall over the period is 1,149mm.

Rainfall over this time period was modelled using MUSIC to calculate the pollutant generation and treatment effectiveness of the proposed systems.

6.6 Rainfall-Runoff Parameters

Rainfall-runoff parameters were taken in accordance with the Water by Design – MUSIC Modelling Guidelines (2010) using *Commercial* land use, as tabulated in Table 6.3 below:

Table 6.3: MUSIC Modelling Parameters

Parameter	Value
Rainfall threshold (mm)	1.00
Soil storage capacity (mm)	18
Initial storage (%)	10
Field capacity (mm)	80
Infiltration capacity coefficient a	243
Infiltration capacity exponent b	0.6
Initial depth (mm)	50
Daily recharge rate (%)	0
Daily baseflow rate (%)	31
Daily deep seepage rate	0

6.7 Pollutant Export Parameters

Pollutant export parameters were taken in accordance with Water by Design – MUSIC Modelling Guidelines (2010) using *Commercial* land use.

The split catchment approach was utilised for each surface type, with the input parameters shown in Table 6.4 below:

Table 6.4: Pollutant Export Parameters

Flow Type	Surface	TSS log^{10} values		TP log^{10} values		TN log^{10} values	
Baseflow	Roof	N/A	N/A	N/A	N/A	N/A	N/A
	Roads	0.78	0.39	-0.60	0.50	0.32	0.30
	Ground	0.78	0.39	-0.60	0.50	0.32	0.30
Stormflow	Roof	1.30	0.38	-0.89	0.34	0.37	0.34
	Roads	2.43	0.38	-0.30	0.34	0.37	0.34
	Ground	2.16	0.38	-0.39	0.34	0.37	0.34

6.8 Proposed Treatment Device Details

The proposed stormwater quality treatment system includes a Stormwater 360 cartridge system to treat stormwater flows. Flows from the entire building envelope are proposed to be directed towards the stormwater treatment chamber to be constructed within the basement carpark area, as shown on the engineering drawings attached as Appendix B.

Proprietary Treatment Device (Stormwater360 Product)

The proposed stormwater quality treatment system for the development has been designed using Proprietary Stormater360 Products. The StormFilter EnviroPod (SFEP) treatment train is a compact implementation of multiple stormwater treatment elements. It is comprised of an EnviroPod gully pit insert pre-treatment filter (Figure 6.1) and a Stormwater Management StormFilter radial cartridge filter with PSORB media (Figure 6.2). The SFEP is typically designed to provide stormwater treatment

in ultra-urban environment by meeting water quality standard whilst increasing yield and hence cost effectiveness for developers.

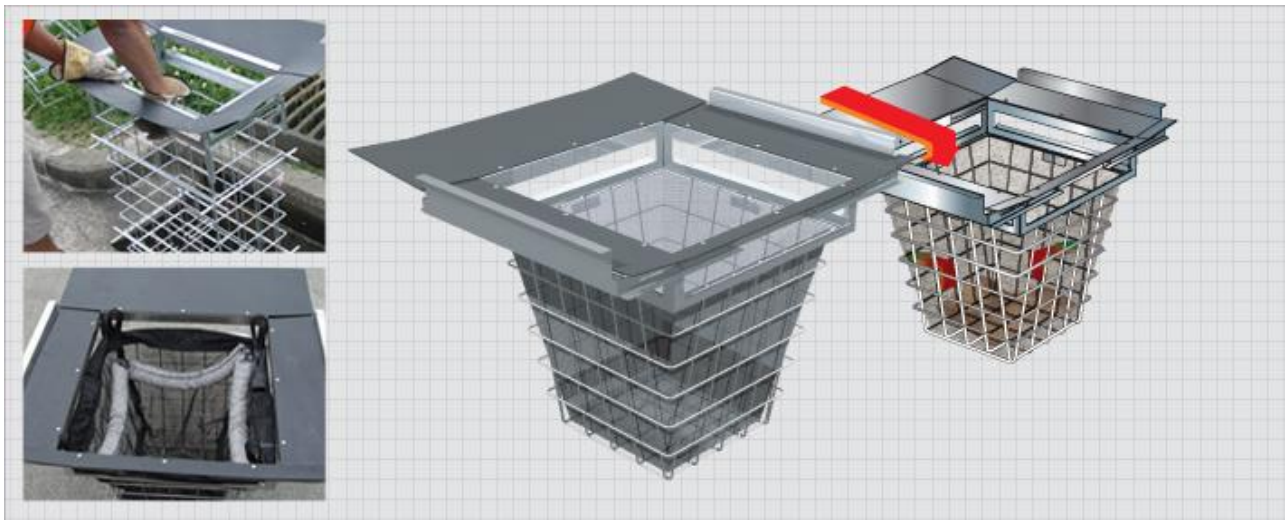

Figure 6.1: EnviroPod Gully Insert Pre-Treatment Filters

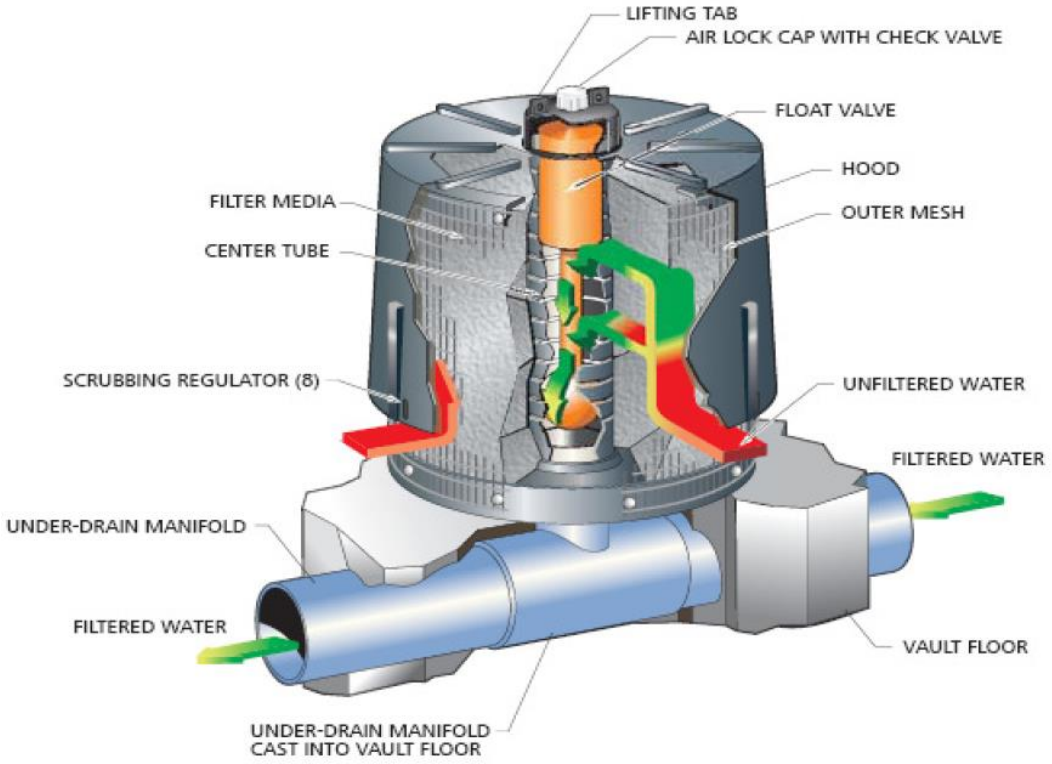

Figure 6.2: StormFilter radial cartridge filter with PSORB media

Both the EnviroPod and the StormFilter systems have proven compliance with the South-East Queensland Water by Design Music Modelling Guidelines requirements (2010). This compliance has been demonstrated via 2nd and 3rd party independent verification.

For the subject site, the total requirement for "tall" treatment device configurations is presented in Table 6.5 below:

Table 6.5: Stormwater360 Specifications

Device Type	Proposed Number of Devices
EnvirpoPod Inserts	1
StormFilter Cartridges (690mm PSorb)	8

The proposed location for the Stormwater360 device is shown on the Engineering Drawings attached as Appendix B. The Stormwater 360 devices are to be located within the proposed underground detention tank.

Detailed plans and certification of compliance with the relevant stormwater quality objectives will be provided to Council with the Operational Works application.

6.9 MUSIC Model Diagram

A diagrammatic layout of the MUSIC model interface used to model the proposed development with the proposed treatment devices incorporated is presented in Figure 6.3 below:

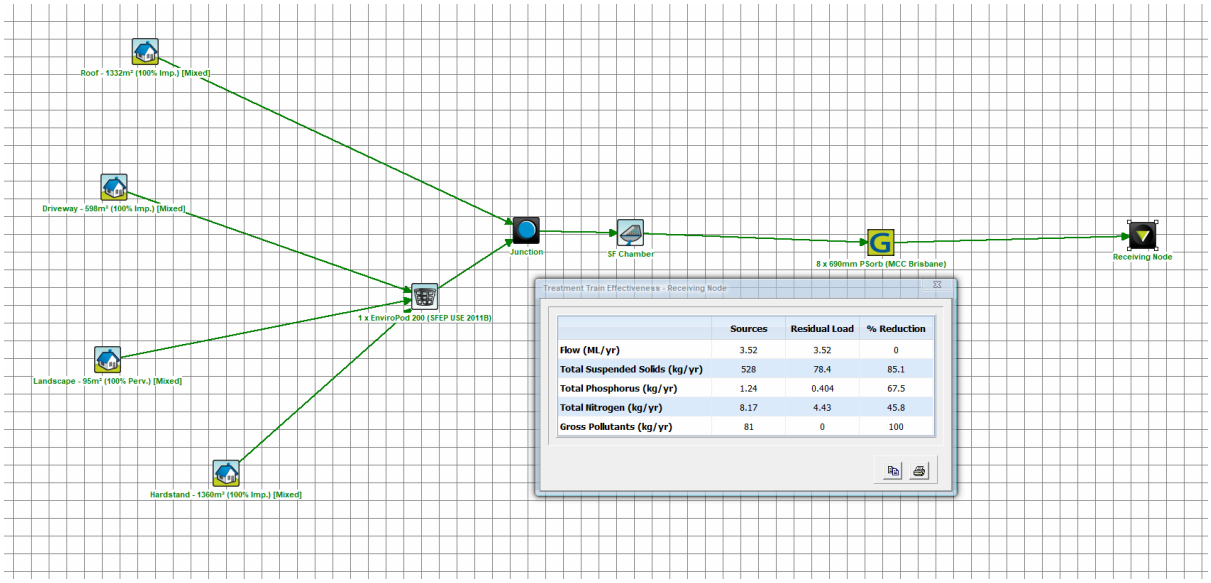

Figure 6.3 – MUSIC Model Results

6.10 MUSIC Modelling Results

MUSIC was used to model the treatment train effectiveness in terms of the percentage of pollutants being removed from the system using the proposed treatment devices.

The results of the MUSIC modelling compared to the stated Water Quality Objectives (WQO's) are presented below:

Table 6.6: MUSIC Modelling Results

Potential Pollutant	Target WQO's	MUSIC Results
Total Suspended Solids (kg/yr)	80%	85.1%
Total Phosphorus (kg/yr)	60%	67.5%
Total Nitrogen (kg/yr)	45%	45.8%
Gross Pollutants (kg/yr)	90%	100%

The results indicate that the proposed treatment devices are efficient in achieving the water quality objectives and exceeds the minimum required pollutant reduction targets.

7. Engineering Constraints

7.1 Earthworks

The development will involve earthworks excavation to reshape the current surface, provide infrastructure trenches, and facilitate the construction of a single underground basement levels.

The area subject to earthworks exaction involves an area greater than 2,500m^2, and the area of disturbance will generally encompass the total area of the site.

The development site is shown as being potentially affected by Acid Sulfate Soils on Brisbane City Council's ePlan Mapping service, as shown in Figure 7.1 below:

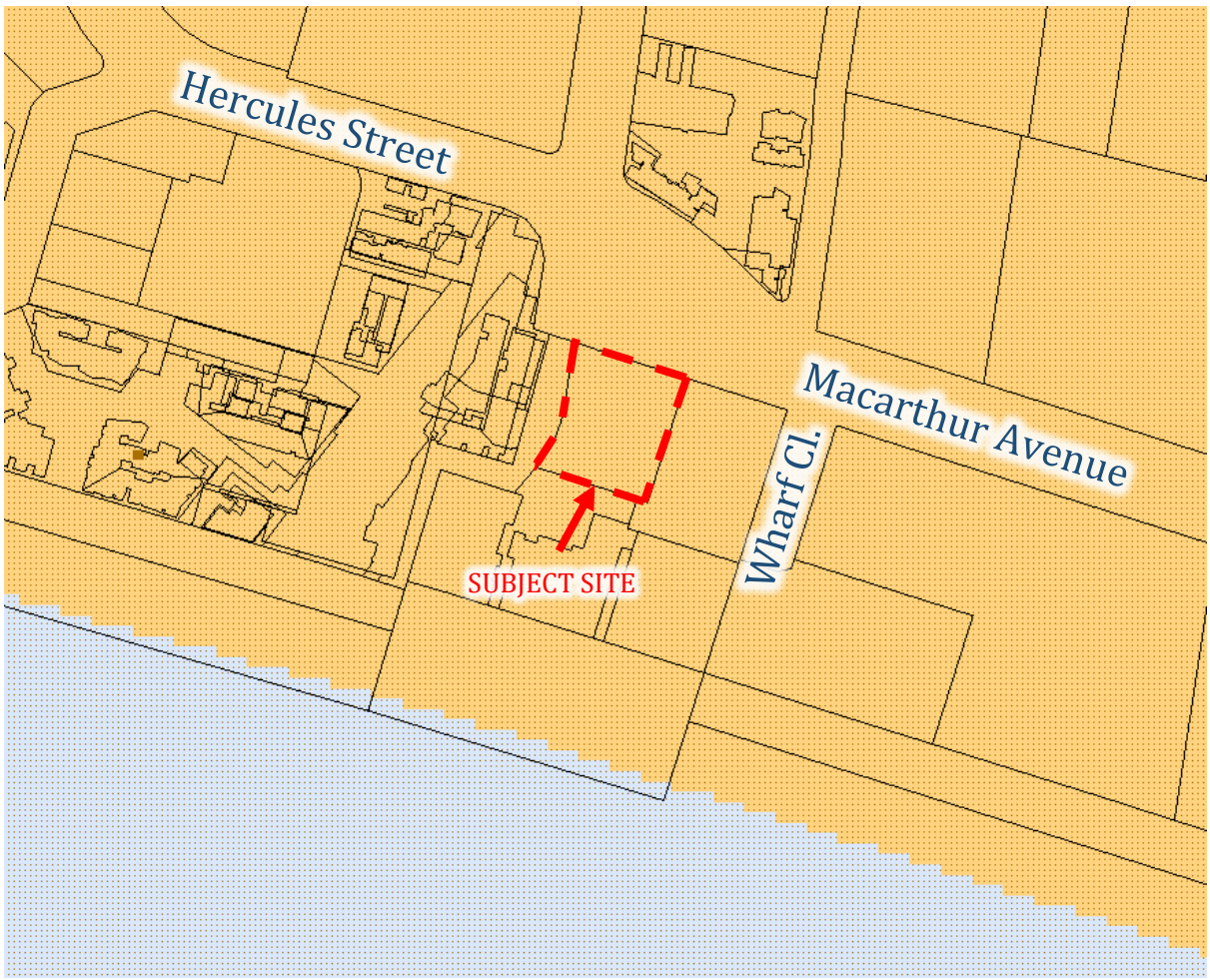

Figure 7.1 - Excerpt from BCC's ePlan – Potential Acid Sulfate Soils

An acid sulfate assessment will therefore be conducted by a suitably qualified professional geotechnical engineer in accordance with the current State Planning Policy.

Detailed earthworks plans will be prepared and lodged with the Operational Works submission for the proposed development.

7.2 Erosion and Sediment Control

During earthworks, there will be inevitable areas of exposed earth, stripped areas and stockpiles. Appropriate methods to manage this process and ensure minimal impacts to surrounding properties, infrastructure and receiving waters will therefore be required.

The current Brisbane City Council Erosion Hazard Assessment form is attached in Appendix D of this report.

The resulting hazard risk rating is **medium risk.**

The development will therefore require the preparation of an Erosion and Sediment Control Program and Plan with supporting documentation, certified by a Registered Professional Engineer or Certified Professional in Erosion and Sediment Control. It is anticipated that the development conditions will reflect these requirements and require compliance prior to the commencement of construction.

7.3 Water and Sewer Connection and Capacity

The proposed development will require connections to the existing sewer and water services within Hercules Street. The proposed connection locations are detailed within the Engineering Drawings located within Appendix B. The detailed design of stormwater, water and sewer connections will be undertaken at the operational works phase of the development.

A Services Advice Notice has been lodged with Queensland Urban Utilities. A response is anticipated to confirm the existing sewer and water infrastructure in Wharf Close has sufficient capacity to support the development.

7.4 Other Services

This report has specifically addressed the connection of water, sewer and stormwater services for the proposed development. The proposed development will also require connection to electrical, communication and gas services located within the site's frontage with Macarthur Avenue. The connection of these services are subject to instruction from their respective contractors.

8. Conclusion

This report has been prepared to support the lodgement of a development application to approve the construction of a new residential apartment tower, comprising a total of one hundred and eighty-six (186) apartments. The development is proposed over the following parcel of land:

Property Address:	11 Macarthur Avenue
Property Description:	Lot 705 on SP287529
Client:	Brookfield Portside East Pty Ltd
Council:	Brisbane City Council
Registered Site Area:	3,385m^2

This report has addressed the management of stormwater quantity and quality, and demonstrated that the no additional works are required to ensure that the proposed development complies with all necessary state and local government policies. It has and demonstrated that the existing stormwater infrastructure has the capacity to accommodate the proposed development.

An Ocean Protect cartridge system has been sized for the proposed development and comprises eight (8) 690mm "tall" cartridges and a single OceanGuard pit insert.

There are no apparent significant constraints on the execution of earthworks, sediment and erosion control, provision of vehicular access, or the drainage of stormwater from the site. Is has been assumed that the surrounding sewer and water infrastructure in Wharf Close has sufficient capacity to support the proposed development. This will be confirmed through a Service Advice Notice which has been lodged with QUU.

It is the opinion of this report that the proposed stormwater quantity and quality management systems are suitable for a development of this scale.

MICHAEL BALE & ASSOCIATES
Structural and Civil Engineering Consultancy

Appendix A
Site Survey

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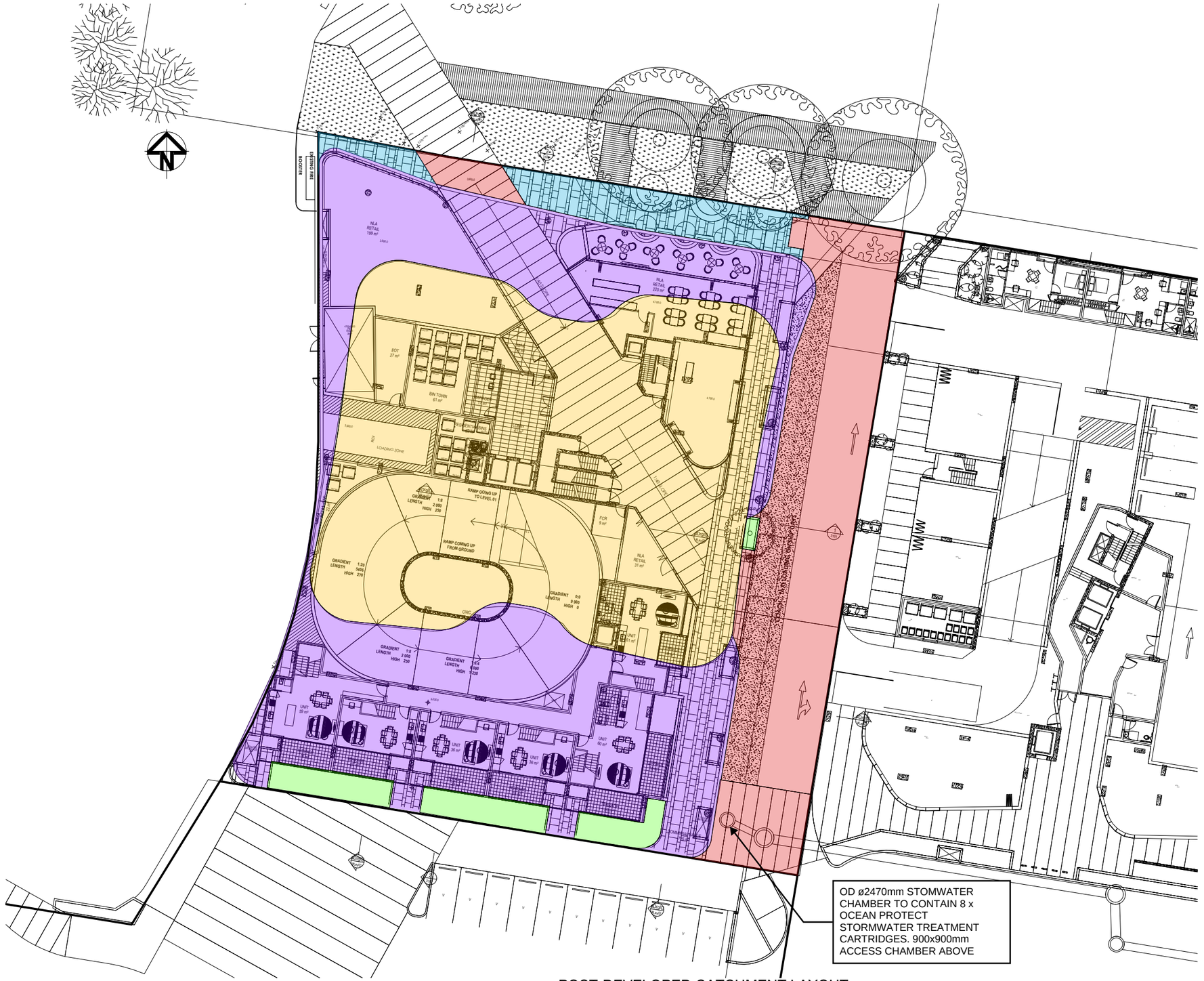
Appendix B
Engineering Drawings



POST-DEVELOPED CATCHMENT LAYOUT
SCALE 1:200

LEGEND

———	SITE BOUNDARY
⬡ 1	CATCHMENT LABELS

NOTES / WARNINGS

1. THESE DRAWINGS ARE FOR DA PURPOSES ONLY AND NOT TO BE USED FOR CONSTRUCTION

STAGE 1 POST-DEVELOPED CATCHMENT AREAS

LEGEND	NAME	AREA (M^2)	DESCRIPTION	TOTAL AREA (M^2)	PERCENT IMPERVIOUS
	CATCHMENT 1	1332	CATCHMENT 1 - ROOF	3385	97%
		1232	CATCHMENT 1 - PODIUM		
		598	CATCHMENT 1 - DRIVEWAY		
		128	CATCHMENT 1 - HARDSTAND		
		95	CATCHMENT 1 - LANDSCAPE		

Issue	Description	Author	Date
01	ORIGINAL ISSUE	JM	09.09.21

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Scale: SCALE 2 1 0 2 4 6 8 10 1:200

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Filename: DA02-G18082-POSTDEVELOPED CATCHMENT PLAN.DWG

Client: Brookfield Residential

Status: FOR DA APPROVAL
NOT FOR CONSTRUCTION

Certified:

R.P.E.Q No :		Project Team	
Height Datum	AHD	Designer	MH
Grid	LOCAL	Checker	RR
Original Size	A1	Approver	RR

Project Title: PORTSIDE DEVELOPMENT
BUILDING 19
MACARTHUR AVE, HAMILTON

Drawing Title: POST-DEVELOPED STORMWATER CATCHMENT LAYOUT PLAN

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Drawing No.	Project No.	Revision
DA02	G18082	01

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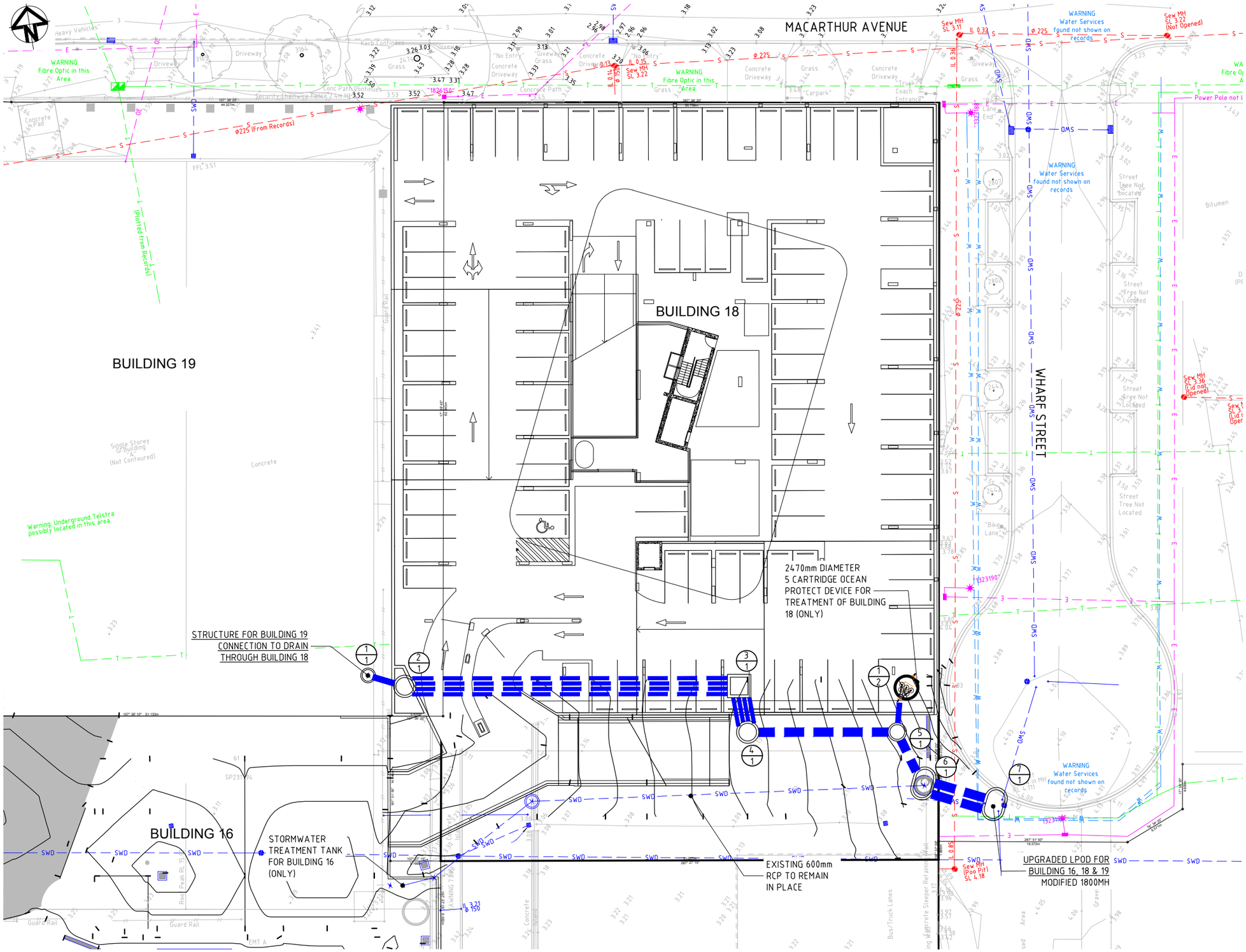
Appendix C
Building 18 Stormwater Drawings



LEGEND

- SITE BOUNDARY
- PROPOSED STORMWATER LINE
- PROPOSED STORMWATER PIT
- PROPOSED STORMWATER MANHOLE
- 1/2 STRUCTURE LABELS
- S — EXISTING SEWER
- W — EXISTING WATER
- SWD — EXISTING STORMWATER
- E — EXISTING UNDERGROUND ELECTRICAL
- OE — EXISTING OVERHEAD ELECTRICAL
- T — EXISTING TELSTRA
- G — EXISTING GAS

NOTES / WARNINGS

1. UNDERGROUND SERVICES EXISTING IN THIS AREA.
2. CONTRACTOR IS RESPONSIBLE FOR THE LOCATION AND PROTECTION OF ALL UNDERGROUND SERVICES PRIOR TO COMMENCEMENT OF WORKS.

Issue	Description	Author	Date
01	ORIGINAL ISSUE	MH	14.11.19

Architect: COTTEE PARKER

Scale: SCALE 2 1 0 2 4 6 8 10 1:200

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Filename C400-G18081-STORMWATER DRAINAGE LAYOUT PLAN.DWG

Client: Brookfield Residential

Status: FOR APPROVAL
NOT FOR CONSTRUCTION

Certified:

R.P.E.Q No :		Project Team	
Height Datum	AHD	Designer	MH
Grid	LOCAL	Checker	RR
Original Size	A1	Approver	RR

Project Title: PORTSIDE DEVELOPMENT
BUILDING 18
MACARTHUR AVE, HAMILTON

Drawing Title: STORMWATER DRAINAGE LAYOUT PLAN

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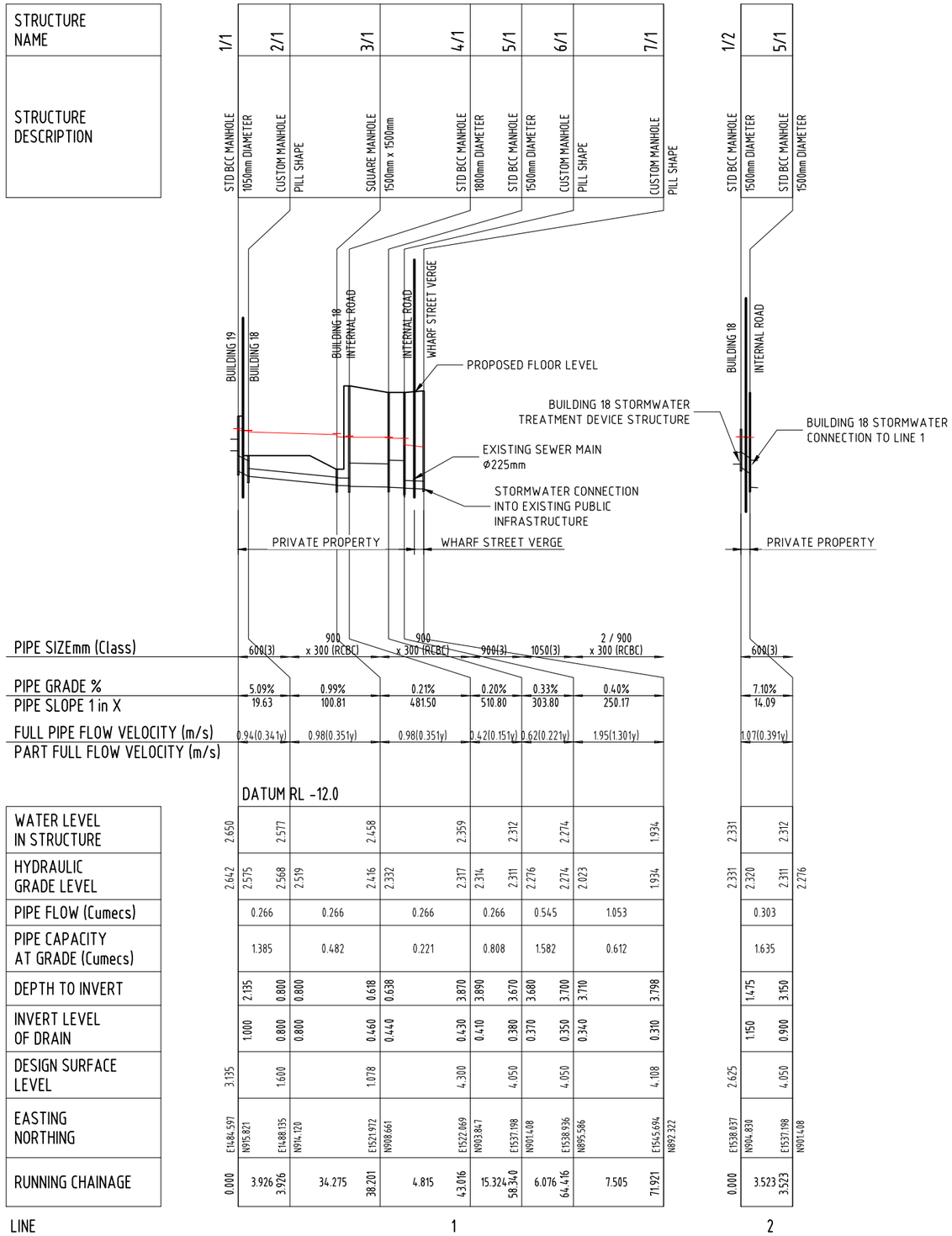
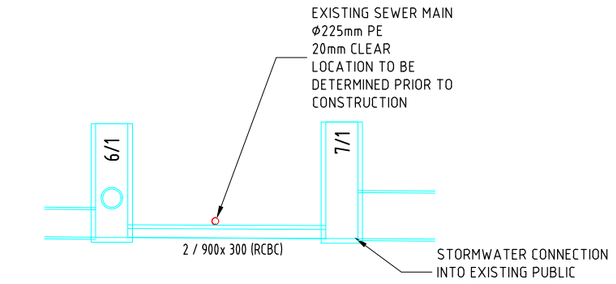
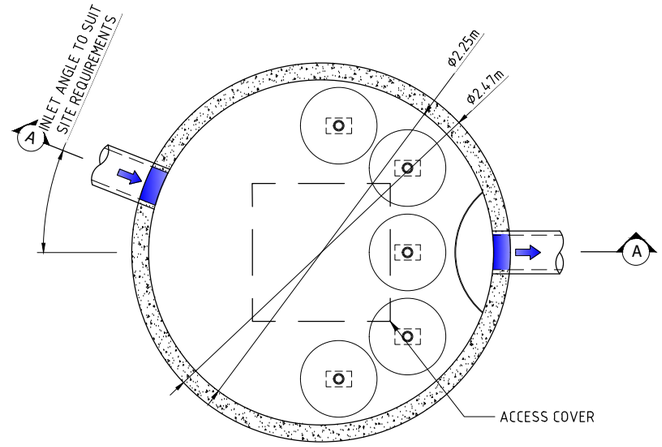
Drawing No.	Project No.	Revision
C400 —	G18081 —	01

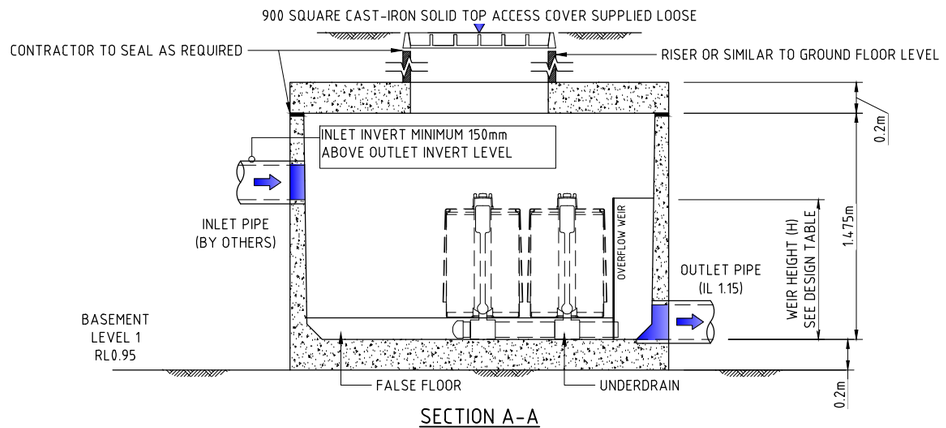




SEWER MAIN LOCATION BETWEEN STRUCTURE 6/1 TO 7/1



PLAN



SECTION A-A

Issue	Description	Author	Date
01	ORIGINAL ISSUE	MH	14.11.19

Architect: COTTEE PARKER

Scale: SCALE 0.1 0 0.1 0.2 0.3 0.4 0.5 1:10

Surveyor: RPS

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Filename: C401-G18081-STORMWATER LONGSECTIONS.DWG

Client: Brookfield Residential

Status: FOR APPROVAL
NOT FOR CONSTRUCTION

Certified:

R.P.E.Q No :		Project Team	
Height Datum	AHD	Designer	MH
Grid	LOCAL	Checker	RR
Original Size	A1	Approver	RR

Project Title: PORTSIDE DEVELOPMENT
BUILDING 18
MACARTHUR AVE, HAMILTON

Drawing Title: STORMWATER LONG SECTION

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Drawing No.	Project No.	Revision
C401 —	G18081 —	[01]

LOCATION					TIME			SUB-CATCHMENT RUNOFF						INLET DESIGN						DRAIN DESIGN												HEADLOSSES									PART FULL						DESIGN LEVELS						
						tc	I	C10	C	A	C×A	+CA	Q					Qg	Qb		tc	I	+CA	Qt	Qm	Qs	Qp	L	S		V	T			V2/2g	Ku	hu	Kl	hl	Kw	hw	Sf	hf		Vp						
DESIGN ARI	STRUCTURE No.	DRAIN SECTION	SUB-CATCHMENTS CONTRIBUTING	LAND USE	SLOPE OF CATCHMENT	SUB-CATCHMENT TIME OF CONC.	RAINFALL INTENSITY	10yr RUNOFF CO-EFFICIENT	CO-EFFICIENT OF RUNOFF	SUB-CATCHMENT AREA	EQUIVALENT AREA	SUM OF (C x A)	SUB-CATCHMENT DISCHARGE	FLOW IN K&C (INC. BYPASS)	ROAD GRADE AT INLET	MINOR FLOW ROAD CAPACITY	INLET TYPE	FLOW INTO INLET	BYPASS FLOW	BYPASS STRUCTURE No.	CRITICAL TIME OF CONC.	RAINFALL INTENSITY	TOTAL (C x A)	MAJOR TOTAL FLOW	MAJOR SURFACE FLOW CAPACITY	MAJOR SURFACE FLOW	PIPE FLOW	REACH LENGTH	PIPE GRADE	PIPE / BOX DIMENSIONS (CLASS)	FLOW VELOCITY FULL (PIPE GRADE VELOCITY)	TIME OF FLOW IN REACH	STRUCTURE CHART No.	STRUCTURE RATIOS FOR 'K' VALUE CALCULATIONS	VELOCITY HEAD	U/S HEADLOSS COEFFICIENT	U/S PIPE STRUCT. HEADLOSS	LAT. HEADLOSS CO-EFFICIENT	LAT. PIPE STRUCT. HEADLOSS	W.S.E. CO-EFFICIENT	CHANGE IN W.S.E	PIPE FRICTION SLOPE	PIPE FRICTION HEADLOSS (L x Sf)	DEPTH	VELOCITY	OBVERT LEVELS	DRAIN SECTION H.G.L	UPSTREAM H.G.L	LAT. H.G.L	W.S.E.	SURFACE OR K&C INVERT LEVEL	STRUCTURE No.
yrs					%	min	mm/h			ha	ha	ha	l/s	l/s	%	l/s		l/s	l/s		min	mm/h	ha	l/s	l/s	l/s	l/s	m	%	mm	m/s	min			m				m			%	m	m	m/s	m	m	m	m	m	m	
BUILDING 19 ROOF WATER BUILDING 19 ROOF WATER 100 100		BUILDING 19 ROOF WATER to 1/1				5.00 5.00	325 325			0.295 0.295	0.295 0.295	0.295 0.295	266 266								5.00 5.00	325 325	0.295 0.295	266			266			450(3)																						BUILDING 19 ROOF WATER	
100 100	1/1	1/1 to 2/1	BUILDING 19 ROOF WATER						1.00 1.00	0.295 0.295	0.295 0.295	0.295 0.295	266 266				24				5.00 5.00	325 325	0.295 0.295	266			266 (Pipe flow= Sum upstr	3.926 atten flows)	5.09	600(3)	0.94(0.34ty) (4.90)	0.07		Qo 0.266 Do 600 Flow BUILDING 19 ROOF WATER made eqv grate flow CHRT 32: Vo2/2gDo 0.08 H/Do 1.63 Kg side flow 3.94 end flow 3.26 K vals above for stepped pipes as grate flow grate flow decreased by 0.266 from BUILDING 19 ROOF WATER	0.045 0.067	1.49	0.067	CHART 51 Ii 785 Do 600 theta 0 r/Do 1.31 Du 450 Du/Do 0.75 Kd 1.49 K'w 0.05 Vu 1.67 WSE 0.07 Ku 1.49 Kw 1.65 K vals step pipes as pipe flow Ku 1.49 Kw 1.65		1.65	0.075	0.19	0.007			1.600 1.400	2.575 2.568	2.642		2.650	3.135	1/1
100 100	2/1	2/1 to 3/1	BUILDING 19 ROOF WATER														27				5.07 5.07	323 323	0.295 0.295	264			266 (Pipe flow= Sum upstr	34.275 atten flows)	0.99	900 x 300 (RCBC)	0.98(0.35ty) (1.78)	0.57		Qo 0.266 Do 450 Flow 1/1 made eqv grate flow CHRT 32: Vo2/2gDo 0.16 H/Do 4.73 Kg side flow 1.95 end flow 1.85 K vals above for stepped pipes as grate flow grate flow decreased by 0.266 from 1/1	0.049	1.00	0.049	CHART 50 Du/Do1.33 alpha 17 K'w 0.28 Vu 0.94 WSE 0.06 Ku 1.00 Kw 1.19 K vals step pipes as pipe flow Ku 1.00 Kw 1.19		1.19	0.058	0.30	0.103			1.100 0.760	2.519 2.416	2.568		2.577	1.600	2/1
100 100	3/1	3/1 to 4/1	BUILDING 19 ROOF WATER														24				5.64 5.64	311 311	0.295 0.295	255			266 (Pipe flow= Sum upstr	4.815 atten flows)	0.21	900 x 300 (RCBC)	0.98(0.35ty) (0.82)	0.08		Qo 0.266 Do 450 CHART 50 Du/Do1.00 alpha 80 K'w 0.29 Vu 1.67 WSE 0.13 Ku 1.73 Kw 2.58	0.049	1.73	0.084			2.58	0.126	0.30	0.015			0.740 0.730	2.332 2.317	2.416		2.458	1.078	3/1
100 100	4/1	4/1 to 5/1	BUILDING 19 ROOF WATER														24				5.72 5.72	309 309	0.295 0.295	253			266 (Pipe flow= Sum upstr	15.324 atten flows)	0.20	900(3)	0.42(0.15ty) (1.26)	0.26		Qo 0.266 Do 900 CHART 50 Du/Do0.50 alpha 80 K'w 0.29 Vu 1.67 WSE 0.04 Ku 0.30 Kw 4.94	0.009	0.30	0.003			4.94	0.045	0.02	0.003			1.313 1.283	2.314 2.311	2.317		2.359	4.300	4/1
BUILDING 18 ROOF WATER BUILDING 18 ROOF WATER 100 100		BUILDING 18 ROOF WATER to 1/2				5.00 5.00	325 325		1.00 1.00	0.335 0.335	0.335 0.335	0.335 0.335	303 303								5.00 5.00	325 325	0.335 0.335	303			303			450(3)																						BUILDING 18 ROOF WATER	
100 100	1/2	1/2 to 5/1	BUILDING 18 ROOF WATER														27				5.00 5.00	325 325	0.335 0.335	303			303 (Pipe flow= Sum upstr	3.523 atten flows)	7.10	600(3)	1.07(0.39ty) (5.78)	0.05		Qo 0.303 Do 600 CHART 50 Du/Do0.75 alpha 0 K'w 0.05 Vu 1.90 WSE -0.07 Ku -1.42 Kw -1.26	0.058	0.20	0.011			0.20	0.011	0.24	0.009			1.750 1.500	2.320 2.311	2.331		2.331	2.625	1/2
100 100	5/1	5/1 to 6/1	BUILDING 19 ROOF WATER;BUILDING 18 ROOFWATER														27				5.98 5.98	304 304	0.630 0.630	532			545 (Pipe flow= Sum upstr	6.076 atten flows)	0.33	1050(3)	0.62(0.22ty) (1.81)	0.10		Qo 0.545 Do 1050 Routine 2.13 Equiv defln 4.3 CHART 4.9 High vel lat 1/2 Dhv 600 Qhv 0.283 Dhv/Dlv 0.7 Dhv/Do 0.57 Qhv/Qo 0.52 H 4.12 Low vel latrl 4/1 Dlv 900 Qlv 0.262 Dlv/Do 0.86 Qlv/Qo 0.48 L 0.47 H-L 3.65 No grate flow: H-L-0.2 = 3.45	0.020	1.79	0.035	Ku=Kw= 3.45 Combined pipes in line case Join Pipes: 4/1 and 1/2 Vel1 1.001 Vel2 0.411 Eq Dia 982 Angle 165 Flow 0.545 CHART 50 Du/Do0.94 alpha 0 K'w 0.05 Vu 0.72 WSE 0.00 Ku -0.02 Kw 0.05 Interpolated Ku= 1.79 Kw= 1.82		1.82	0.036	0.04	0.002			1.424 1.404	2.276 2.274	2.311		2.312	4.050	5/1
BUILDING 16A&16B ROOF WATER BUILDING 16A&16B ROOF WATER 100 100		BUILDING 16A&16B ROOF WATER to 1/3				5.00 5.00	325 325		1.00 1.00	0.606 0.606	0.606 0.606	0.606 0.606	547 547								5.00 5.00	325 325	0.606 0.606	547			547			600(3)																						BUILDING 16A&16B ROOF WATER	
100 100	1/3	1/3 to 6/1	BUILDING 16A&16 B ROOFWATER														24				5.00 5.00	325 325	0.606 0.606	547			547 (Pipe flow= Sum upstr	40.105 atten flows)	0.50	600(3)	1.93(1.93ty) (1.53)	0.35		Qo 0.547 Do 600 Flow BUILDING 16A&16B ROOFWATER made eqv grate flow CHRT 32: Vo2/2gDo 0.32 H/Do 0.78 Kg side flow 3.77 end flow 3.27 K vals above for stepped pipes as grate flow grate flow decreased by 0.547 from BUILDING 16A&16B ROOFWATER	0.190 0.341	1.80	0.341	CHART 51 Ii 790 Do 600 theta 50 r/Do 1.58 Du 600 Du/Do 1.00 Kd 1.80 K'w 0.26 Vu 1.93 WSE 0.39 Ku 1.80 Kw 2.06 K vals step pipes as pipe flow Ku 1.80 Kw 2.06		2.06	0.390	0.79	0.319			2.127 1.927	2.593 2.274	2.934		2.983	4.000	1/3
100 100	6/1	6/1 to 7/1	BUILDING 19 ROOF WATER;BUILDING 18 ROOFWATER;BUILDING 16A&16B ROOFWATER														27				6.08 6.08	303 303	1.236 1.236	1040			1053 (Pipe flow= Sum upstr	7.505 atten flows)	0.40	2 / 900 x 300 (RCBC)	1.95(1.30ty) (1.13)	0.06		Qo 1.053 Do 636 Flow 5/1 made eqv grate flow Flow 1/3 made eqv grate flow CHRT 32: Vo2/2gDo 0.65 H/Do 4.60 Kg side flow 1.83 end flow 1.77 K vals above for stepped pipes as grate flow grate flow decreased by 0.543 from 5/1 grate flow decreased by 0.510 from 1/3 Routine 2.19 CHART 52 B 1500 In line 1/3 Latrl 5/1 Determine Kl Dl/Do 1.65 B/Do 2.36 Qu/Qo 0.48 Do/Du 1.06 Do/Dl 0.61 K'l 1.29 Ml 0.55 Kl=K'l×Ml= 0.71	0.194	1.30	0.251	Determine Ku K'u 1.33 Mu 0.74 Ku=K'u×Mu= 0.98 Kw=Ku= 0.98 Combined pipes in line case Join Pipes: 5/1 and 1/3 Vel1 1.804 Vel2 0.627 Eq Dia 1058 Angle 194 Flow 1.053 CHART 50 Du/Do1.66 alpha 0 K'w 0.05 Vu 1.20 WSE 0.20 Ku 1.00 Kw 1.02 Interpolated Ku= 0.98 Kw= 0.98 K vals step pipes as pipe flow Ku 0.98 Kw 0.98 Averaged Ku 1.30 Kw 1.30		1.30	0.251	1.18	0.089			0.640 0.610	2.023 1.934	2.274		2.274	4.050	6/1

CALCULATIONS TABLE

Issue	Description	Author	Date
01	ORIGINAL ISSUE	MH	14.11.19

Architect: COTTEE PARKER

Scale:

Surveyor: RPS

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Filename: C402-G18081-STORMWATER CALCULATIONS.DWG

Client: Brookfield Residential

Status: FOR APPROVAL
NOT FOR CONSTRUCTION

Certified:

R.P.E.Q No :

Project Team

Height Datum	AHD	Designer	MH
Grid	LOCAL	Checker	RR
Original Size	A1	Approver	RR

Project Title: PORTSIDE DEVELOPMENT
BUILDING 18
MACARTHUR AVE, HAMILTON

Drawing Title: STORMWATER CALCULATION TABLE

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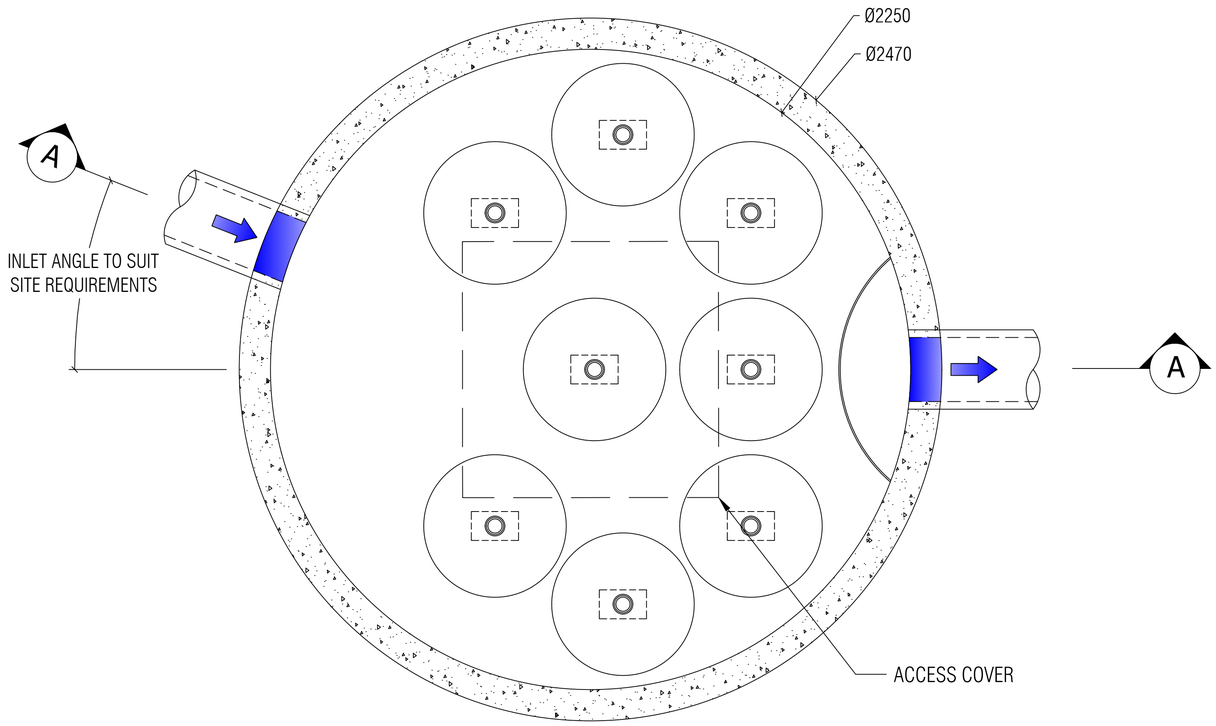
Drawing No.	Project No.	Revision
C402 —	G18081 —	[01]

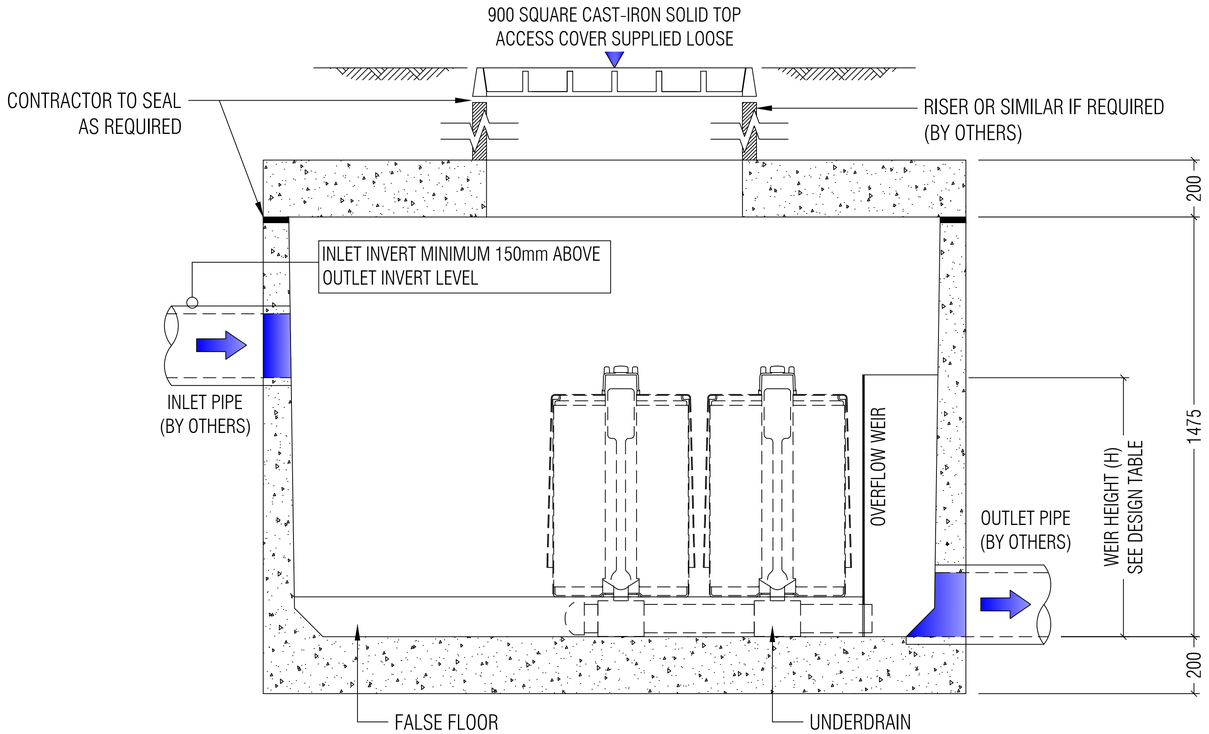
MICHAEL BALE & ASSOCIATES
Structural and Civil Engineering Consultancy

Appendix D
Stormwater 360 Details

NOT FOR CONSTRUCTION



PLAN

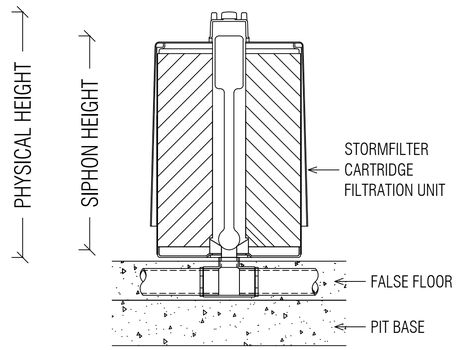


SECTION A-A

STORMFILTER DESIGN TABLE

- STORMFILTER TREATMENT CAPACITY VARIES BY NUMBER OF FILTER CARTRIDGES INSTALLED.
- THE STANDARD CONFIGURATION IS SHOWN. ACTUAL CONFIGURATION OF THE SPECIFIED STRUCTURE(S) PER CERTIFYING ENGINEER WILL BE SHOWN ON SUBMITTAL DRAWING(S).
- FILTER CARTRIDGES SHALL BE MEDIA-FILLED, PASSIVE, SIPHON ACTUATED, RADIAL FLOW, AND SELF-CLEANING. RADIAL MEDIA DEPTH SHALL BE 178mm.

CARTRIDGE NAME / SIPHON HEIGHT (mm)	690	460	310
CARTRIDGE PHYSICAL HEIGHT (mm)	840	600	600
TYPICAL WEIR HEIGHT [H] (mm)	920	690	540
CARTRIDGE FLOW RATE FOR ZPG MEDIA (L/s)	1.6	1.1	0.7
CARTRIDGE FLOW RATE FOR PSORB MEDIA (L/s)	0.9	0.46	0.39



STORMFILTER CARTRIDGE DETAIL

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	[ ]
NUMBER OF CARTRIDGES REQ'D	8
SIPHON HEIGHT (310 / 460 / 690)	[ ]
MEDIA TYPE (ZPG / PSORB)	[ ]
WATER QUALITY FLOW RATE (L/S)	[ ]
HYDRAULIC CAPACITY (L/S)	90

PIPE DATA:	I.L.	MATERIAL	DIAMETER
INLET PIPE #1	[ ]	[ ]	[ ]
INLET PIPE #2	[ ]	[ ]	[ ]
INLET PIPE #3	[ ]	[ ]	[ ]
OUTLET PIPE	[ ]	[ ]	[ ]

PRECAST MANHOLE WEIGHT	6500kg
PRECAST LID WEIGHT	2000kg

GENERAL NOTES

1. PRECAST STRUCTURE SUPPLIED WITH CORE HOLES TO SUIT OUTER DIAMETER OF NOMINATED PIPE SIZE / MATERIAL.
2. PRECAST STRUCTURE SHALL MEET W80 WHEEL LOAD RATING ASSUMING A MAXIMUM EARTH COVER OF 2.0m AND A GROUND WATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. CERTIFYING ENGINEER TO CONFIRM ACTUAL GROUNDWATER ELEVATION. PRECAST STRUCTURE SHALL BE IN ACCORDANCE WITH AS3600.
3. IF THE PEAK FLOW RATE, AS DETERMINED BY THE SITE CERTIFYING ENGINEER, EXCEEDS THE PEAK HYDRAULIC CAPACITY OF THE SYSTEM, AN UPSTREAM BYPASS STRUCTURE IS REQUIRED.
4. ALL WATER QUALITY TREATMENT DEVICES REQUIRE PERIODIC MAINTENANCE. REFER TO OPERATION AND MAINTENANCE MANUAL FOR GUIDELINES AND ACCESS REQUIREMENTS.
5. SITE SPECIFIC PRODUCTION DRAWING WILL BE PROVIDED ON PLACEMENT OF ORDER.
6. DRAWING NOT TO SCALE.

INSTALLATION NOTES

1. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY CERTIFYING ENGINEER.
2. CONTRACTOR TO PROVIDE ALL EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STORMFILTER STRUCTURE (LIFTING DETAIL PROVIDED SEPARATELY).
3. CONTRACTOR TO APPLY SEALANT TO ALL JOINTS AND TO PROVIDE, INSTALL AND GROUT INLET AND OUTLET PIPES.

OCEAN PROTECT
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OCEAN PROTECT
8 CARTRIDGE STORMFILTER SYSTEM
DN2250 MANHOLE
SPECIFICATION DRAWING

LAST MODIFIED: 09-11-18