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Engineering

Working Beyond Expectations

Stormwater and Drainage Assessment

To accompany a Development Application for Stage 2 of Ivanhoe Estate - A State Significant Development

Property:
Lot 100 DP1262209

Applicant:
Frasers Property Australia on behalf of NSW Land and Housing Corporation

Date:
30th July 2021

Document Control Sheet

Issue No.	Amendment	Date	Prepared By	Checked By
A	DRAFT	22nd June 2021	BMY	IB
B	Issued for DA	9th July 2021	BMY	BMY
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Executive Summary

This report supports a Development Application for Stage 2 of the Ivanhoe Estate redevelopment, a State Significant Development (SSD) submitted to the Department of Planning and Environment (DPE) pursuant to Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). It has been prepared for Frasers Property on behalf of NSW Land and Housing Corporation.

As a part of the Stage 2 development application, a Stormwater and Drainage Assessment of the proposed development is required. This report has undertaken an assessment of the proposed development to determine compliance with the requirements set out in both the Secretary's Environmental Assessment Requirements (SEAR's) and Ryde Council's DCP 2014 in regards to stormwater drainage.

The Stage 2 development application includes lots C2, C3 and C4 only. All works associated with the road network has been covered under the Stage 1 DA.

Ryde Council's DCP 2014 requires the development to comply with requirements for onsite detention, water sensitive urban design and flooding. This report considers both the onsite detention and water quality aspects with the flooding impact assessment been done by a third party.

As detailed in the previous submission for the Ivanhoe Estate Masterplan, onsite detention (OSD) and water sensitive urban design (WSUD) requirements only need to apply to areas within the site that are to remain in private ownership. As such, all OSD and WSUD control measures were provided on lot prior to flows entering the public drainage system. A concept drainage plan was developed on this basis and consisted of an on lot private system and a public drainage system located within the proposed public road reserves.

Using the XP-RAFTS software, an onsite detention model was created, using a combination of rainwater tanks and designated detention tanks to attenuate peak flows to meet Council's requirements. It was found that a total of 320.2m^3 of dedicated detention storage was required, along with 70m^3 of storage within the rainwater tanks to meet the requirements set out by Ryde Council.

A water quality model was created in the MUSIC software to determine the required water quality treatment measures to meet Council's water quality targets. A treatment train of rainwater tanks, gross pollutant traps, media filtration and bioretention devices was proposed for the development. An analysis of the MUSIC model indicated that the proposed treatment train not only met but exceeded the targets set by Council.

A water balance model was developed to determine the reduction in potable water for each building within Stage 2 of the development. This development proposes to reuse captured stormwater for irrigation and car washing purposes.

Indicative erosion and sedimentation control plans were prepared to show how the external infrastructure could be protected during construction works associated with the buildings. It was noted that the building contractor would be required to prepare a detailed plan prior to commencing works onsite.

This report shows that from a stormwater management perspective, the proposed development can adequately meet the requirements set out by both Ryde City Council and the SEAR's and as such, should be approved.

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1.0 Introduction

This report supports a Development Application for Stage 2 of the Ivanhoe Estate redevelopment, a State Significant Development (SSD) submitted to the Department of Planning and Environment (DPE) pursuant to Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). It has been prepared for Frasers Property Australia on behalf of NSW Land and Housing Corporation.

1.1 BACKGROUND

In September 2015, the Ivanhoe Estate was rezoned by DPE as part of the Macquarie University Station (Herring Road) Priority Precinct, to transform the area into a vibrant centre that benefits from the available transport infrastructure and the precinct's proximity to jobs, retail and education opportunities within the Macquarie Park corridor.

The Ivanhoe Estate is currently owned by NSW Land and Housing Corporation and comprises 259 social housing dwellings. The redevelopment of the Ivanhoe Estate is part of the NSW Government Communities Plus program, which seeks to deliver new communities where social housing blends with private and affordable housing, with good access to transport, employment, improved community facilities and open space.

The Communities Plus program seeks to leverage the expertise and capacity of the private and non-government sectors. As part of this program, Aspire Consortium, comprising Frasers Property Australia and Mission Australia Housing, were selected as the successful proponent to develop the site in July 2017.

In April 2020, both the Masterplan and Stage 1 Development Applications were approved by the Department of Planning. This report has been prepared to accompany the Development Application for Stage 2 of the development.

1.2 SITE DESCRIPTION

The Ivanhoe Estate site is located in Macquarie Park near the corner of Epping Road and Herring Road within the Ryde Local Government Area (LGA). The site is approximately 8.2 hectares and, through demolition works undertaken by LAHC and construction works associated with Stage 1, is mostly cleared with small pockets of vegetation remaining.

An aerial photo of the current site is provided at **Figure 1** overleaf.

Immediately to the north of the site are a series of four (4) storey residential apartment buildings. On the north-western boundary, the site fronts Herring Road and a recently developed lot. Epping Road runs along the south-western boundary of the site and Shrimptons Creek, an area of public open space, runs along the south-eastern boundary. Vehicle access to the site is via Herring Road.

Figure 1: Ivanhoe Estate Site

1.2.1 Site Topography

The topography of the subject site in the vicinity of lots C2, C3 and C4 will be governed by the levels of the proposed surrounding road network. Lots C2 and C3 generally fall to the east towards the future Main Street, whilst the C4 lot falls towards Shrimpton's Creek in the south.

The existing topography, including the proposed road network grading can be seen in **Exhibit 1.**

1.2.2 Existing Stormwater Infrastructure

As mentioned in Section 1.2, construction works associated with Stage 1 have commenced on site. As part of the works approved under Stage 1, the entire public road network, including stormwater infrastructure, will be constructed with stormwater connection points being left for all future buildings, including those covered under the Stage 2 application. The works being constructed under the Stage 1 approval can be seen in **Exhibit 1**.

1.3 PROPOSED DEVELOPMENT

The Stage 2 Development Application seeks approval for:

- The construction and use of Buildings C2, C3 and C4 comprising residential uses (including social housing), and retail / community spaces.

It is noted that the previously approved C1 building has been combined on the same lot as the C2 building and therefore their stormwater impacts are now to be assessed together. Refer to Sections 3 and 4 for details.

An image of the Masterplan, identifying Buildings C2, C3 and C4 is provided at **Figure 2** below.

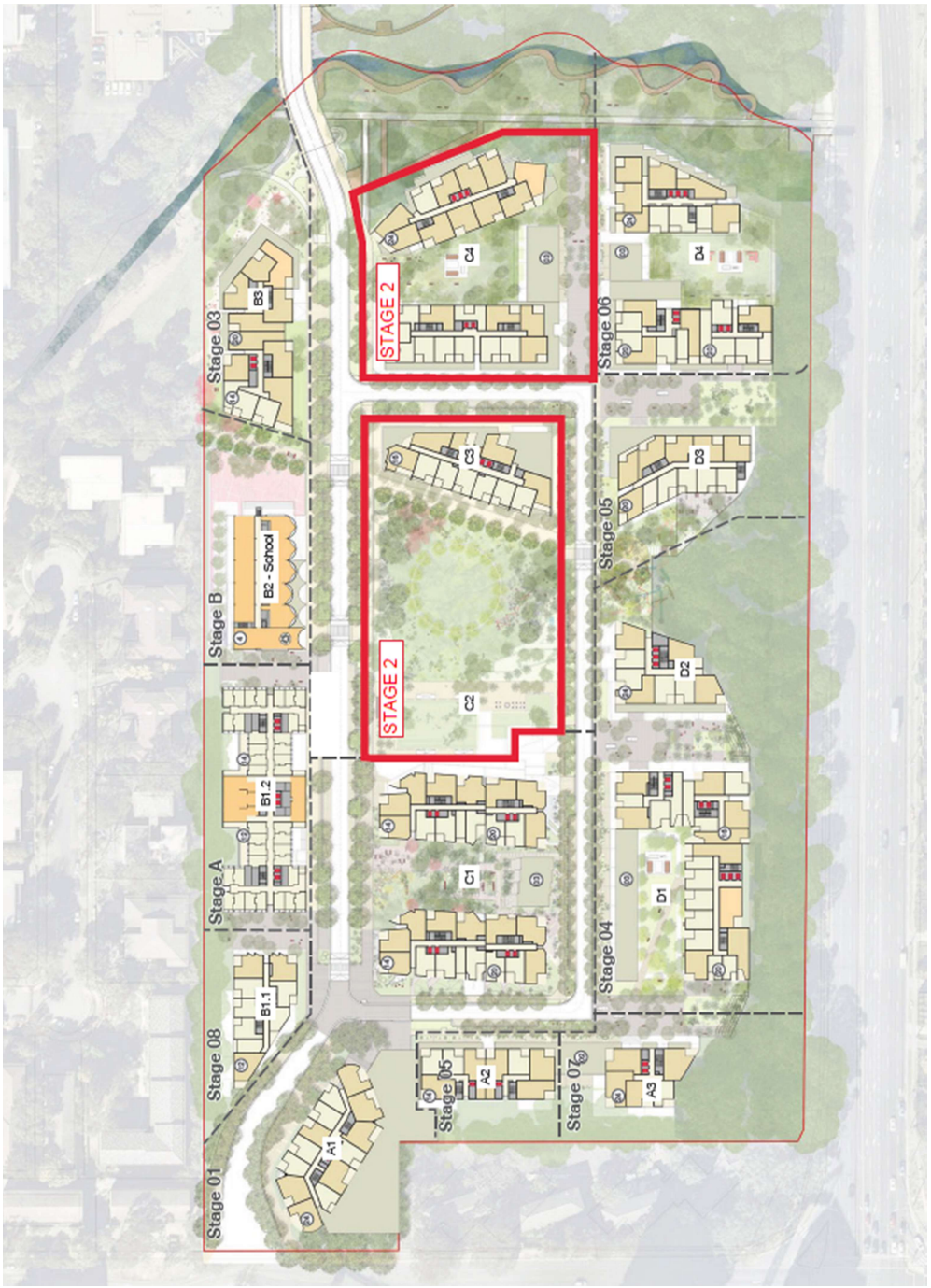

Figure 2: Ivanhoe Estate Masterplan (Stage 1)

2.0 Authority Requirements

The proposed development is within the Ryde Council LGA and therefore Council's controls have been addressed, noting that the DCP does not typically apply to State Significant Development – but does in the instance of condition C8 of the masterplan consent. Part 8.2 of Council's DCP contains specific information relating to the management of stormwater and contains the following documents:

- Stormwater Management Technical Manual;
- Water Sensitive Urban Design Guideline.

The proposed development is to satisfy the requirements of these documents and the broader Ryde Council DCP.

The development must also comply with the Secretary's Environmental Assessment Requirements (SEARs) provided by the NSW Department of Planning. A summary of the key SEARs requirements relating to this report can be seen below:

- *Prepare a Stormwater, Groundwater and Drainage Assessment;*
- *Detail Erosion, sediment and stormwater management controls during construction;*
- *Identify appropriate water quality management measures;*
- *Identify any water licensing requirements or other approvals;*
- *Prepare and integrated water management plan/drainage concept.*

The development is aiming to achieve a six (6) star Green Star communities rating and as such, is required to meet a number of stormwater objectives that are separate to the requirements of the SEAR's and Ryde Council's DCP 2014. Details of the proposed measures to achieve the Green Star rating can be found in the Masterplan stormwater report.

2.1 STORMWATER QUANTITY

Ryde Council adopts a major/minor stormwater drainage philosophy for stormwater management throughout the LGA.

The minor drainage system is required to cater for runoff generated from all storm events up to and including the minor storm event without any surcharging within the system and minimising flow widths and ponding within the road carriageway. In accordance with the stormwater technical manual, the minor storm event for an urban residential development is the 20 year ARI storm event.

The road network and dedicated overland flow paths are to be provided to safely convey flows which exceed the capacity of the minor storm event up to and including the 100 year ARI storm event.

2.1.1 Onsite Detention (OSD)

Onsite detention systems are designed to minimise the effect of increased runoff from developments by attenuating peak stormwater flows leaving the site.

In accordance with Ryde Council's Stormwater Technical Manual, OSD systems are to be designed to ensure that the peak discharge in the **post developed 100 year ARI** storm event does not exceed the peak discharge in the **post developed five (5) year ARI** storm event.

As outlined in the Stormwater and Drainage Assessment for the Ivanhoe Estate Masterplan development application submission, a meeting was held with Council to discuss the OSD requirements for the proposed development. Council advised that the detention requirements outlined within Ryde Council's Stormwater Technical Manual are only required to apply to the areas within the development that are to remain in private ownership. Given this, it is not proposed to provide any OSD for the community park.

2.1.2 Shrimpton's Creek

As detailed in the Ivanhoe Estate Masterplan submission, Shrimpton's Creek is a second order watercourse which flows from west to east along the southern boundary of the proposed development site.

Shrimpton's Creek and its catchment has been analysed in the "Macquarie Park Floodplain Risk Management Study and Plan". This flood study, completed in 2011 considers the entire Shrimpton's Creek catchment on a regional scale and provides indicative flood extents within the Creek.

A study was undertaken as a part of the Ivanhoe Estate masterplan submission, detailing the impacts of the proposed development on Shrimpton's Creek and the surrounding areas. A further study is to be undertaken to accompany this application to address the impacts of the works associated with the C4 building.

A copy of the Masterplan flood report can be seen within the Masterplan Stormwater Report within **Appendix A,** with the new study being prepared by BMT and being submitted with this application.

2.2 WATER SENSITIVE URBAN DESIGN

Through the management of potable water, wastewater and stormwater, water sensitive urban design (WSUD) aims to manage the effects of urban development on the water cycle. Ryde Council's "Water Sensitive Urban Design Guidelines" outline the requirements for WSUD within the Ryde LGA. This development aims to not only comply with the requirements set out by Council but exceed them.

2.2.1 Stormwater Quality

In order to comply with the WSUD requirements, the stormwater drainage system must effectively remove nutrients and gross pollutants from the site prior to runoff entering the downstream drainage infrastructure. The stormwater treatment objectives have been taken from the Ryde Council "Water Sensitive Urban Design Guidelines" document and can be seen overleaf in **Table 1**.

Table 1: Stormwater Treatment Objectives

Pollutant	Treatment Objective
Gross Pollutants	**90%** retention of the average annual load for particles and suspended solids
Suspended Solids	**85%** retention of the average annual load for particles and suspended solids
Total Phosphorus	**65%** retention of average annual pollutant load
Total Nitrogen	**45%** retention of average annual pollutant load

As outlined in the Stormwater and Drainage Assessment for the Ivanhoe Estate Masterplan development application submission, a meeting was held with Council to discuss the WSUD requirements for the proposed development. Council advised that the WSUD requirements outlined within Ryde Council's Stormwater Technical Manual are only required to apply to the areas within the development that are to remain in private ownership. Similar to OSD, it is not proposed to provide any water quality devices within the community park.

2.2.2 Potable Water Conservation

The reduction of potable water usage can be achieved for a development through a number of methods, including the reuse of captured stormwater. This report details the requirements for stormwater reuse only, however it is noted that other methods may be used within the development.

Ryde Council requires that a water balance model be prepared to demonstrate how stormwater runoff from the site is reused. It should be noted that for a high-density development, as is proposed, it is extremely difficult to capture enough water to effectively reduce the extremely high potable water demand for internal uses. It has been decided at this stage for captured stormwater to be used for irrigation and car washing purposes only. It should be noted that other methods may be used within the development and these will be explored on a stage by stage basis as required.

This report will provide a water balance model to indicate how the captured stormwater is reused within the development.

3.0 Stormwater Quantity

As mentioned in Section 1.2.2, works included under the Stage 1 approval will provide stormwater connection points to each of the future buildings. These connections points will be utilised as the outlet location for both buildings C2 and C3. Given its proximity to the creek, it is proposed that the C4 building will discharge directly to Shrimpton's Creek (post passing through OSD and water quality treatment devices).

3.1 RAINGARDEN

As discussed in the Masterplan report, in order to achieve a six (6) star green star communities rating for the development, it is proposed to provide an end of line raingarden to cater for runoff generated by the public road reserves. Whilst the raingarden will not be provided under this application, the infrastructure required to connect the public stormwater network to the raingarden will need to be constructed.

The connecting infrastructure is required to be constructed under the C4 lot and, to avoid future disturbance of the C4 landscaping, the pipework is to be constructed during the C4 building works and capped for future connection.

It is noted that, as there is no detailed design available for the raingarden at this stage, the connecting infrastructure location is indicative only and is subject to change at the detailed design stage.

The indicative location of the connecting infrastructure can be seen in **Exhibit 2**.

3.2 INDICATIVE DRAINAGE LAYOUTS

The on lot drainage system has been designed to capture and convey runoff from the lots and private access roads within the site, to the underground OSD tanks and stormwater treatment devices before discharging to the stormwater connection points. The private system consists of the following elements:

- Rainwater Tanks – Rainwater tanks will be used to capture and store runoff from roof areas for external reuse within the lots;
- OSD Tanks – OSD tanks will be used to attenuate peak flows before discharging into the public drainage system;
- Surface Drainage – Surface drainage pits will be provided to capture and convey runoff from both hardstand and pervious areas to the OSD tanks.

A plan showing a concept drainage plan for each of the lots can be seen in **Exhibit 2** with typical details being found in **Exhibit 3**.

It is noted that, as the buildings will undergo a design development phase, the concept drainage plan is subject to change during the detailed design phase.

3.3 ONSITE DETENTION

In accordance with Ryde Council's Stormwater Technical Manual, OSD systems are to be designed to ensure that the peak discharge in the **post developed 100 year ARI** storm event does not exceed the peak discharge in the **post developed five (5) year ARI** storm event.

In accordance with the masterplan submission, it is proposed to use a series of rainwater tanks and dedicated OSD tanks located within the lots to adequately attenuate the peak discharges generated by each lot. Runoff generated from the site is conveyed to the proposed tanks via the following systems:

- Roof Areas – Runoff generated from the building roofs is directed via the building hydraulics to rainwater tanks located within the basement of each building. Overflow from these rainwater tanks is then directed to an OSD tank. (Building C2 is not proposed to have a rainwater tank).

  The most efficient rainwater tank sizes for each lot was provided by the building hydraulics engineer. A water balance model was performed on the rainwater tanks to determine the average volume available within the tanks at any given time. The average volume available within the tanks was adopted as available storage in the detention modelling. The water balance model is discussed further in Section 4.2.

- Remaining Lot Areas – Runoff generated from the remaining lot areas is captured in a series of surface drainage pits and conveyed to the detention tanks.

An XP-RAFTS model was created using the parameters outlined in the following sections in order to accurately model the proposed system.

3.3.1 Catchment Parameters

To ensure the runoff generated by each lot is accurately calculated the lots were split into subcatchments to reflect the conveyance systems discussed in Section 3.1 above.

The subcatchments areas were measured directly from the latest design plans for all lots and can be seen in **Exhibit 4** and **Table 2** below**.**

Table 2: Catchment Areas

CATCHMENT AREA (ha)			
Catchment*	**Roof**	**Remaining Lot (Captured)**	**Remaining Lot (Not Captured)**
C1	0.165	0.233	0.000
C1 Bypass	0.134	0.000	0.137
C2	0.095	0.065	0.000
C3	0.221	0.019	0.000
C4	0.301	0.338	0.111

** C1 / C2 to be treated as a single lot. Parameters have been split out due to different discharge locations.*

In order to produce runoff hydrographs for each catchment, a number of hydrological parameters are required to be input into the XP-RAFTS model. These parameters include:

- Percentage of Impervious Area;
- Manning's 'n' – the Manning's 'n' coefficient is a measure of the surface roughness of a catchment;
- Average Catchment Slope.

The percentage of impervious area, Manning's 'n' and average catchment slopes were all estimated based upon the latest design plans for each of the buildings.

A summary of the parameters for each of the lots can be seen below in **Table 3.**

Table 3: Hydrological Parameters

Hydrological Parameter			
Catchment	**Impervious %**	**Manning's 'n'***	**Slope (%)**
C1 – Lot Captured	60%	0.04/0.015	3%
C1 – Roof	60%	0.05/0.01	1%
C1 – Lot Bypass	40%	0.04/0.015	3%
C1 – Roof Bypass	60%	0.05/0.01	1%
C2 – Lot Captured	75%	0.04/0.015	3%
C2 – Roof	50%	0.05/0.01	1%
C3 – Lot Captured	100%	0.04/0.015	3%
C3 – Roof	70%	0.05/0.01	1%
C4 – Lot Captured	60%	0.04/0.015	3%
C4 – Lot Bypass	10%	0.04/0.015	3%
C4 – Roof	80%	0.05/0.01	1%

* Manning's 'n' values are for Pervious/Impervious

3.3.2 Detention Modelling

As per both the approved masterplan and approved Stage 1 reports, detention modelling was undertaken using an XP-RAFTS model in order to determine the size of the proposed detention tanks within the lots to achieve the requirements set out by Council.

Rainwater tanks were used in the model to supplement the storage volume provided by the proposed detention tanks. The rainwater tanks have been modelled to have an orifice 300mm from the top of the tank and as such, only provide a small amount of detention storage. The storage below the orifice does however, buffer the peak discharge generated by the roof catchments to assist in reducing the overall lot peak discharge.

The results of the detention modelling can be seen below in **Table 4.**

Table 4: RAFTS Results

Catchment	5 Year ARI Flow (m3/s)	100 Year ARI Flow - Without Detention (m3/s)	100 Year ARI Flow - With Detention (m3/s)	Rain Water Tank Size (kL)#	Detention Tank Size (m^3)
C1*	0.12	0.21	0.09	30	105
C2*	0.13	0.23	0.18	-	38.2^
C1/C2	-	-	0.25!	-	-
C3	0.08	0.13	0.08	20	42
C4	0.25	0.42	0.25	20	135

 # Only a percentage of the actual tank volume was used in the modelling
** C1/C2 flows to be considered as one lot. Flows split up due to different outlet locations to street*
^ C2 storage provided within above ground swale
! C1/C2 combined does not equal sum of C1 and C2 due to hydrograph timing.

It can be seen from **Table 5** above that, through the use of rainwater tanks and dedicated detention tanks, the post developed 1 in 100 year ARI peak discharges can be adequately attenuated back to the post developed 1 in 5 year ARI peak discharges.

Indicative rainwater and detention tanks for C4 can be seen in **Exhibit 2,** with the remainder seen on the architectural drawings. A screenshot of the XP RAFTS model can be seen in **Appendix B**.

3.1.3 Detention Tank Parameters

To ensure the 1 in 100 year ARI peak discharge is attenuated back to the 1 in 5 year ARI peak discharge, discharge control structures have been designed for each tank. Each tank has been designed with a low flow outlet and a high flow weir.

The high flow weir has been designed to cater for the 1 in 100 year ARI peak discharge, however it is an emergency overflow weir only and as such, has been placed above the 1 in 100 year level in the detention tank.

The tank configuration and outlet controls for each tank are summarised below in **Table 5.**

Table 5: Detention Tank Parameters

Detention Tank	Volume (m^3)	Tank Depth (Excluding Emergency Weir*) (m)	Low Flow Outlet	Weir Length x Height (m)
C1	105	1.0	210mm diameter	0.75m L x 0.3m H
C3	42	1.5	170mm diameter	0.5m L x 0.3m H
C4	135	1.2	0.15m H x 0.44m W	1.5m L x 0.3m H

** Tank volume is based on depth indicated. 0.3m high emergency weir to be placed above this level.*

It should be noted that as the detention tanks are to be incorporated into the basements of the proposed buildings, the final configuration of the tanks will be subject to confirmation by the building hydraulics engineers.

Rather than utilising an underground tank, the C2 OSD strategy adopts an aboveground basin/swale to achieve both water quality and OSD targets. The basin/swale parameters can be seen in **Table 6** below, whilst a graphical representation of the system can be seen in **Exhibit 3**.

Table 6: Basin / Swale Parameters

Volume (m^3)	Surface Area (m^2)	Low Flow Outlet	High Flow Outlet
38.2	191	120mm diameter	900 x 900mm GSIP

The configuration of the rainwater tanks is discussed in Section 4.1.4. An indicative sketch showing two (2) potential tank configurations can be seen in **Appendix C.** It should be noted that these are indicative only and are subject to final design and coordination with the building hydraulics engineers.

4.0 Water Sensitive Urban Design

Through the management of potable water, wastewater and stormwater, water sensitive urban design (WSUD) aims to manage the effects of urban development on the water cycle. Ryde Council's "Water Sensitive Urban Design Guidelines" outline the requirements for WSUD within the LGA.

4.1 STORMWATER QUALITY

The proposed stormwater drainage system, as discussed in Section 3 above, will incorporate a number of water quality treatment devices to effectively treat runoff generated by Stage 1 of the development prior to it being discharged to the receiving waters in Shrimpton's Creek.

As discussed in Section 2.2.1, water quality devices are only required to treat runoff generated by the proposed lots. As such, all water quality devices will be provided within the lots to treat runoff prior to it discharging to the public drainage network.

It is noted that an end of line rain garden will be provided at a future stage in order to meet the requirements of the Green Star communities' guidelines.

4.1.1 Treatment Devices

It is proposed to use a combination of at source and conveyance controls to treat the runoff prior to it entering the public drainage system. The proposed treatment train has been modelled in the water quality software "Model for Urban Stormwater Improvement Conceptualisation" (MUSIC) to demonstrate compliance with Council's treatment targets.

The following devices are proposed within the development to achieve the required targets:

Rainwater Tanks

Rainwater tanks are proposed within each building to capture and store runoff generated from the roof area for reuse. Each rainwater tank will be fitted with a first flush system to provide pretreatment prior to runoff entering the tanks.

Gross Pollutant Traps

It is proposed to provide Ocean Protect "Enviropods" or Council approved equivalent litter traps in all grated surface inlet pits within the private stormwater system to capture gross pollutants and coarse sediments. Further details of the "Enviropod" can be seen in **Appendix D.**

Media Filtration

It is proposed to provide Ocean Protect 'Stormfilter" or council approved equivalent system. The "Stormfilter" is a proprietary media filtration device consisting of multiple cartridges that will be housed within the proposed OSD tanks. Further details of the "Stormfilter" cartridges can be seen in **Appendix D.**

Bioretention Swale

As mentioned in Section 1.3, it is proposed to utilise an above ground bioretention swale to achieve water quality targets for the C2 building.

As all of the proposed treatment devices are to be provided within the private lots, maintenance of all devices will be the lot owners and as such, no maintenance burden is placed on Council. Details of the required maintenance of the system will be provided at the CC stage of the development.

A graphical, indicative, representation of the treatment train can be seen in **Figure 4** below.

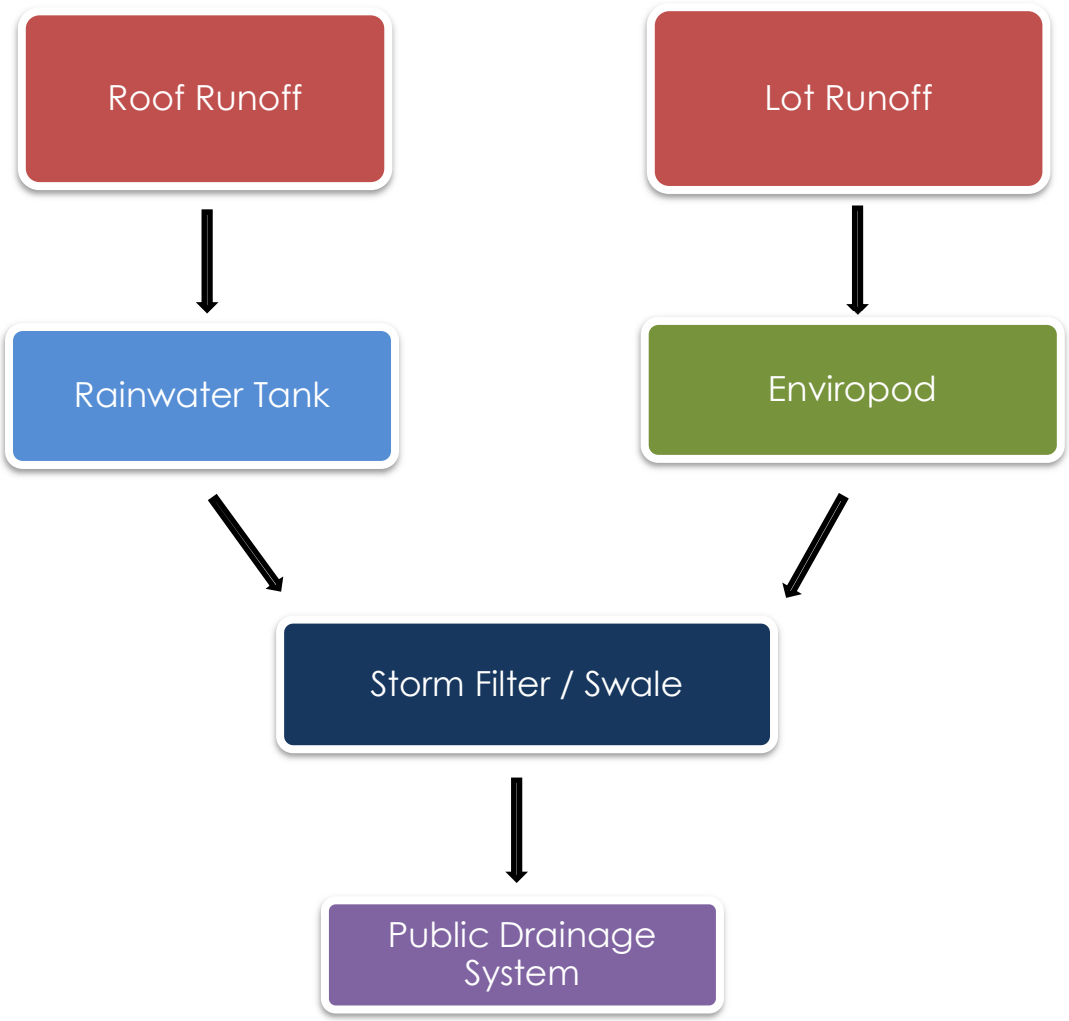

Figure 4: Proposed Treatment Train

4.1.2 MUSIC Parameters

The MUSIC model was set up in accordance with the "Using MUSIC in Sydney's Drinking Water Catchment" guidelines and Ryde Council's "Water Sensitive Urban Design Guidelines".

Catchment areas for the MUSIC modelling were adopted to correspond with those used within the detention model. Similar to the detention model, the overall catchments were broken down into smaller subcatchments in order to accurately determine the pollutant loads.

A summary of the catchment areas and parameters can be seen in Tables 2 and 3 in Section 3.1.1 above.

4.1.3 Water Quality Modelling

The MUSIC model was created using the parameters outlined above to determine compliance with council's water quality targets. The results of the water quality modelling can be seen in **Table 7** below.

Table 7: MUSIC Modelling Results

	Pollutant Load Reduction			
Catchment	**Gross Pollutants**	**Total Suspended Solids**	**Total Phosphorus**	**Total Nitrogen**
C1/C2	99.4	88.2	65	48.1
C3	100	86.1	76.8	60.3
C4	96.9	85.1	74.8	57.8

From **Table 7** above, it can be seen that the proposed treatment train of rainwater tanks, gross pollutant traps and media filtration devices not only meets, but exceeds the targets set by Council.

A screenshot of the MUSIC model can be seen in **Appendix E** whilst further details of the proposed treatment devices can be seen in Section 4.1.4 below.

4.1.4 Treatment Device Parameters

The C2, C3 and C4 catchments, as described in Section 3.1.1 above, have different characteristics and as such, require different configurations of the proposed treatment devices.

The treatment devices modelled for each catchment were chosen to achieve the required targets whilst also providing the most efficient solution for each catchment. The treatment device parameters for the rain water tanks and stormfilters can be seen below in **Tables 8 and 9**, whilst each catchment is to have Enviropods in all surface drainage pits.

Table 8: Rain Water Tank Parameters

	Tank Parameter			
Catchment	**Volume (kL)**	**Surface Area (m^2)**	**Depth Above Overflow (m)**	**Overflow Pipe Diameter (mm)***
C1	30	10	0.3	800
C3	20	10	0.3	750
C4	20	10	0.3	1000

***** *Overflow pipe diameter is an equivalent diameter.*

Table 9: Stormfilter Parameters

	Tank Parameter				
Catchment	**Chamber Surface Area (m^2)**	**Extended Detention Depth (m)**	**Overflow Weir Width (m)**	**Overflow Pipe Diameter (mm)***	**Number of Cartridges**
C1	11.5	1	2	37	4
C3	6.25	1	2	37	3
C4	42.25	1	2	37	10

***** *Overflow pipe diameter is an equivalent diameter.*

As mention in Section 3.13, a bioretention swale is proposed within the C2 lot to provide treatment. The bioretention swale parameters can be seen in **Table 10** below.

Table 10. Bioretention Swale Parameters

Surface Area (m^2)	Filter Area (m^2)	Filter Depth (m)
76	76	0.5

In addition to the abovementioned treatment devices, it is proposed to drain the C1 bypass catchment through a CDS 1009 GPT unit prior to flows discharging to the street drainage.

A sketch showing two (2) potential tank configurations can be seen in **Appendix C.**

4.2 POTABLE WATER CONSERVATION

The reduction of potable water usage can be achieved for a development through a number of methods, including the reuse of captured stormwater. This report considers stormwater reuse only; however, it is noted that other methods may be used throughout the development.

A water balance model was prepared for Stage 2 to determine the reduction in potable water consumption achieved through the reuse of stormwater captured within the rainwater tanks for irrigation purposes. Whilst the development will ultimately use captured stormwater for both irrigation and car washing purposes, the water balance model will only consider irrigation as the demand for car washing is unknown at this stage.

4.2.1 Water Balance Model Parameters

To accurately determine the potable water reduction for the development, a daily water balance model was set up for each individual building. In order to create the water balance model, the following parameters were required for each building:

- Catchment Area – As with the detention and water quality models, it was assumed that 50% of the roof catchment is a rooftop garden. Due to the expected low runoff from the rooftop garden (in the order of 4-5 l/s in the 1-year ARI event), it has been assumed for the water balance model that only 50% of the roof catchment reaches the tank.

- Water Demand – To determine the amount of water used each day within the lots a water demand is required. An irrigation rate for each catchment was provided by the landscape architects.

A demand of 27,000 l/day was adopted for catchment C3 and 60,000 l/day was adopted for catchment C1.

- Daily Rainfall – To ensure consistency between models, the same rainfall data adopted within the MUSIC model was adopted for the water balance model.

The most efficient rainwater tank size for each lot was provided by the building hydraulics engineers and combined with the above parameters were used to perform a water balance model. The results of the water balance model can be seen in **Table 11** below.

Table 11: Water Balance Model Results

Block	Tank Size (kL)	Reduction in Potable Water *	Average Volume Available in tank (kL)#
C1	30	21.6%	24
C3	20	49.31%	12.2
C4	20	35.35%	14

***** *Reduction in potable water used for irrigation purposes only.*
#The average volume available in the tank was adopted in the OSD modelling as available storage.

It should be noted that reduction in potable water demand in **Table 11** above is for irrigation purposes only and does not consider car washing or internal building uses.

Table 11 also indicates that the average volume (empty space) available within the tanks. These volumes have been adopted within the OSD model as described in Section 3.1.2

5.0 Erosion and Sedimentation Control

Erosion and sedimentation control are an important part of any development to ensure downstream receiving waters are not adversely affected during construction.

As each of the buildings will encompass basement excavations, it is considered likely that there will be very little runoff from each site (rainfall will be captured within the basement excavation). Detailed erosion and sediment control plans, including details of pump outs within the excavation will be provided by the building contractor prior to construction works commencing.

An indicative erosion and sediment control plan covering external infrastructure can be seen in **Exhibit 5**.

It should be noted that the erosion and sediment control plans contained within this report are provided as an indicative plan only and all erosion and sediment controls should be constantly updated during construction to ensure adequate protection is provided at all times.

6.0 Groundwater Assessment

A groundwater assessment of the subject site has been undertaken by Douglas Partners and is detailed within their report.

7.0 Water Licensing Requirements and Other Approvals

Potable water for use within the site will be provided via the Sydney Water Corporation's existing carrier water mains, with this being supplemented by captured stormwater for reuse within buildings. No other permanent water sources are proposed to be utilised by the development and accordingly an ongoing water license for the site is not required.

Based upon the results of the geotechnical testing, it is likely that groundwater will be encountered in basement excavations and therefore dewatering will be required. The appropriate dewatering licenses will be obtained prior to construction commencing.

8.0 Conclusion

This report supports a Development Application for Stage 2 of the Ivanhoe Estate redevelopment, a State Significant Development (SSD) submitted to the Department of Planning and Environment (DPE) pursuant to Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). It has been prepared for Frasers Property Australia on behalf of NSW Land and Housing Corporation.

This report considered the stormwater drainage aspects of the proposed development, with specific focus on onsite detention and Water Sensitive Urban Design. Flood modelling within the adjacent Shrimpton's Creek was considered in a separate report.

In accordance with the Stormwater and Drainage Assessment for the Ivanhoe Estate Masterplan, OSD and WSUD requirements outlined within Ryde Council's Stormwater Technical Manual would only apply to the areas within the development that are to remain in private ownership. A concept drainage plan was developed on this basis and consisted of an on lot private system and a public drainage system located within the proposed public road reserves.

Through the use of rainwater tanks and dedicated detention tanks, it was shown that the private stormwater system could adequately attenuate peak flows generated by the proposed development and comply with the OSD requirements set out by Ryde Council. Similarly, through the use of rainwater tanks, gross pollutant traps and filtration devices, it was shown that the proposed development complies with the WSUD requirements set by Council.

In accordance with Council's requirements, a water balance model was developed to demonstrate how captured stormwater was reused within the site to reduce the demand on potable water. Whilst the development proposes to reuse captured stormwater for both irrigation and car washing purposes, only irrigation has been considered in the water balance model due to the car washing demand being unknown at this stage.

An indicative erosion and sedimentation control plan was developed for the infrastructure external to each of the development lots, with detailed plans for the building construction to be prepared by the building contractor prior to the commencement of works.

This report shows that from a stormwater management perspective, the proposed development can adequately meet the requirements set out by both Ryde City Council and the SEAR's and as such, should be approved.

Appendix A

BMT WBM FLOODING REPORT

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Our Ref: L.A11141.001.MidtownStg2_FIA.docx

23 June 2021

Liz Yao
Frasers Property Australia
Level 2, 1C Homebush Bay Drive
Rhodes NSW 2138

Dear Liz

RE: MIDTOWN STAGE 2 DEVELOPMENT FLOOD IMPACT ASSESSMENT

Introduction

This letter presents a Flood Impact Assessment (FIA) of the proposed Midtown Stage 2 development within the Ivanhoe Estate at Macquarie Park, Sydney undertaken to support the Development Application (DA) submission for this State Significant Development (SSD). This FIA addresses the flooding-related conditions outlined in the Secretary's Environmental Assessment Requirements (SEARs).

SEARs Conditions

The flooding-related SEARs conditions relevant to the proposed development are outlined below:

- *The EIS must:*
  - *Identify any flood risk on-site having regard to adopted studies for the development site, consideration of any relevant provisions of the NSW Floodplain Development Manual and the potential effects of climate change, sea level rise and an increase in rainfall intensity.*
  - *Assess the impacts of the development, including any changes to flood risk on-site or off-site, and detail design solutions to mitigate flood risk where required.*
  - *Identifies required management measures and design solutions, including water sensitive urban design and detention, to minimise the impacts of flooding on the proposed development.*
- *The EIS must also address the following flood related issues:*
  - *Finished Floor Levels (FFLs) shall be set at levels that comply with Council's freeboard requirements defined in DCP-2014-8.2 Stormwater Management Technical Manual.*
  - *Basement ramps shall raise up to PMF levels, at each location, before descending to the basements, to fully flood proof every basement.*
  - *No gaps/openings connected to any basement are allowed below the PMF level at each location.*
  - *Fences located in overland flow paths shall allow flows to pass through.*

Previous Master Plan Assessment and Findings

In 2017, BMT completed a flood impact assessment for Frasers Property Australia to support the proposed Ivanhoe Estate Master Plan (Reference: *L.S20319.03.Flood Impact Assessment for Ivanhoe Estate Masterplan.pdf*). This assessment considered the following Master Plan development components of the Ivanhoe Estate:

- buildings (residential flat buildings comprising private, social and affordable housing, seniors house comprising residential care facilities and self-contained dwellings, a new school, child care centres and minor retail development);
- public open space and roads; and
- community uses.

The above components were incorporated into a 2D hydraulic flood model (refer hereafter as the "Ivanhoe Flood Model") and assessed against existing catchment conditions to establish the change in flood regime due to the Master Plan development.

In all modelled design events, flood conditions outside of Shrimptons Creek and within the Ivanhoe Estate were typified by shallow inundation (low depths) and low velocities (<0.2m/s). These areas are referred to as "Local Drainage" under the NSW Government's 'Floodplain Development Manual' (2005).

Outside of the local drainage areas, the flood impact assessment found negligible differences in design flood conditions in the areas adjacent to Shrimptons Creek. Hence impacts on: emergency planning and evacuation, social and economic cost to the community and erosion, siltation, riparian vegetation and bank stability were not predicted to be altered due to the proposed Ivanhoe Estate Master Plan development.

Midtown Stage 2 Development Updates

The assessment herein focuses on the Midtown Stage 2 development within the Ivanhoe Estate. Subsequent to the Master Plan flood impact assessment referenced previously, the Midtown Stage 2 development including Blocks C2, C3 and C4 has undergone revision. The latest architectural drawings have been provided and are listed below:

- Midtown Stage 2 – Block C2 Village Green and Community Centre by CHROFI, issued 22/6/2021.
- Midtown Stage 2 – Block C3 Residential and Retail by Fox Johnston, issued 11/6/2021.
- Midtown Stage 2 – Block C4 Residential and Social by Cox Architecture, issued 10/6/2021.

Updates to the Ivanhoe Flood Model for Stage 2

BMT have reviewed the architectural drawings for each block illustrating the proposed building footprint and public domain, as shown in Figure 1, Figure 2 and Figure 3 for Block C2, C3 and C4, respectively. The revised building footprints along with the surface roughness for post-development conditions were incorporated into the Ivanhoe Flood Model for this subsequent flood impact assessment.

BMT were also provided with an updated Digital Elevation Model (DEM) for the site for pre-development (ADWJohnson, issued 5/5/2021) and post-development (ADWJohnson, issued 10/6/2021) conditions. Both datasets have been used to update the Ivanhoe Flood Model, with the post-development DEM providing definition of the proposed internal roads within the Ivanhoe Estate and the earthworks along the western bank of Shrimptons Creek (introduced as part of the Ivanhoe Estate development).

This updated version of the Ivanhoe Flood Model is hereafter referred to as the "Ivanhoe Stage 2 Flood Model".

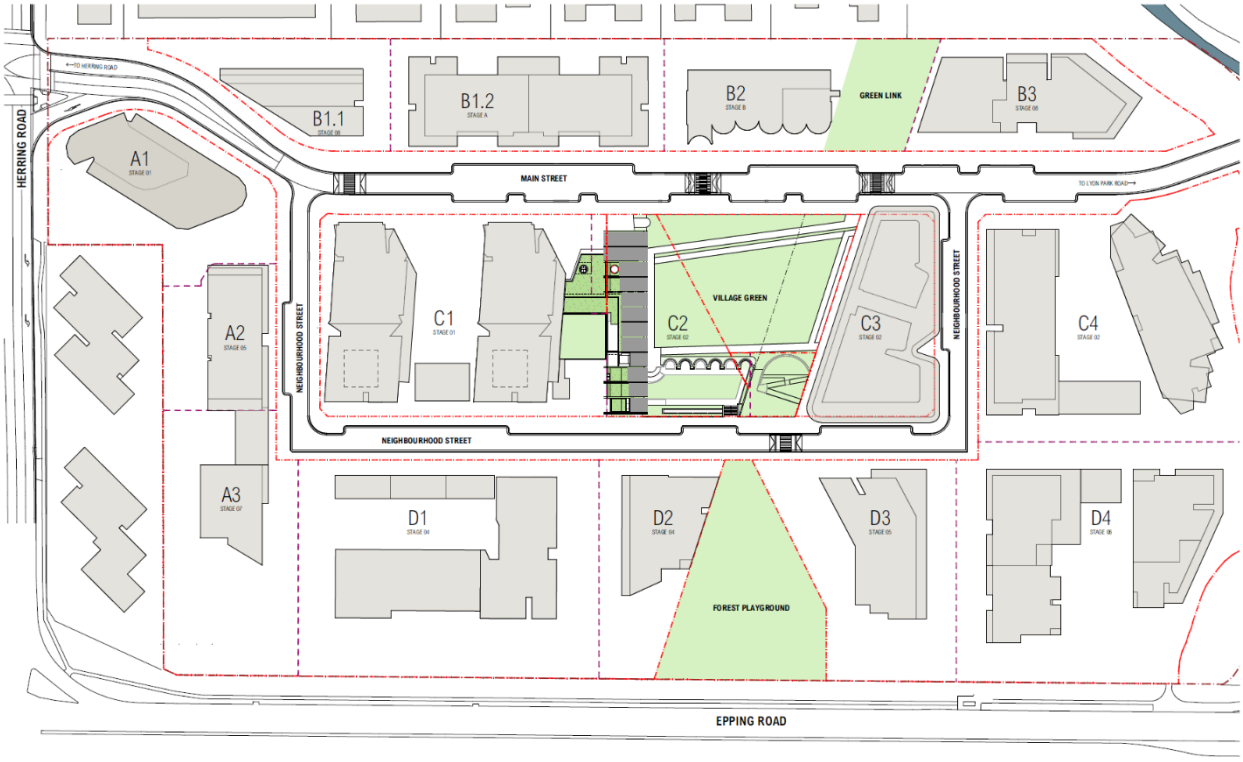


Figure 1 Midtown Stage 2 – Block C2 Village Green and Community Centre (CHROFI, Drawing Number A-A-002 Rev 02 issued 22/6/2021)

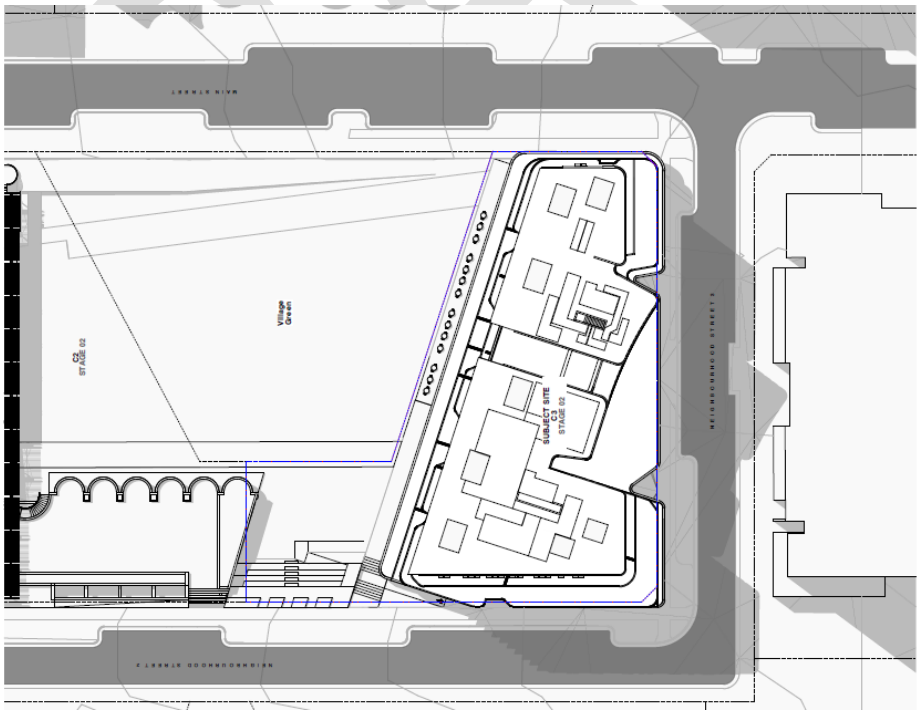


Figure 2 Midtown Stage 2 – Block C3 Residential and Retail (Fox Johnston, Drawing Number A-A-100-P3 Rev 003 issued 11/6/2021)

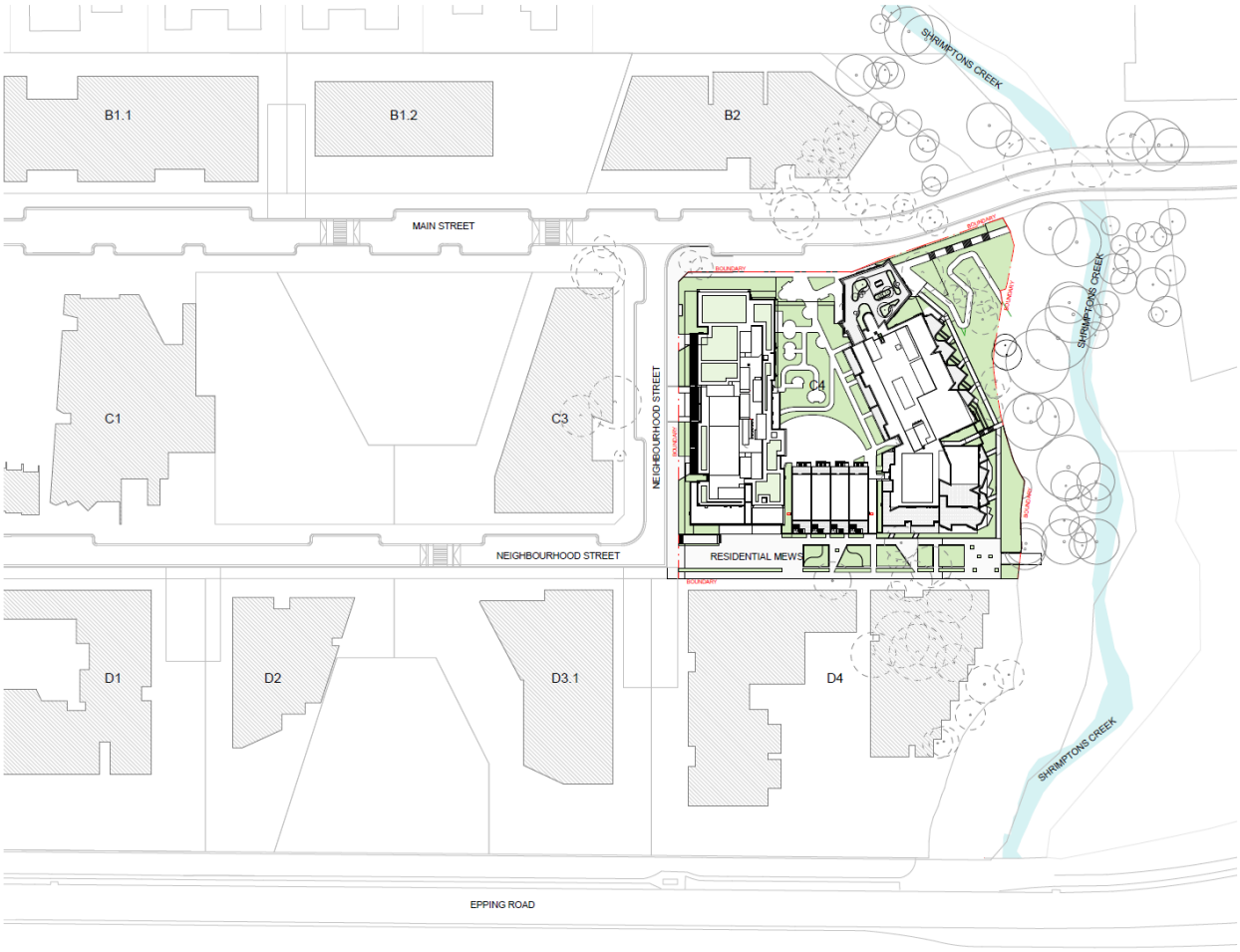


Figure 3 Midtown Stage 2 – Block C4 Residential and Social (Cox Architecture, Drawing Number A-DA-1100 Rev C issued 10/6/2021)

Flood Impact Assessment Results

The flood impact assessment was undertaken based on the Ivanhoe Stage 2 Flood Model for the following design flood events:

- 5% AEP (Annual Exceedance Probability) 2 hour critical storm for blocked[1] and unblocked scenarios;
- 1% AEP 2 hour critical storm for blocked and unblocked scenarios;
- 1% AEP plus 10% rainfall increase (climate change)[2] 2 hour critical storm for blocked and unblocked scenarios; and
- Probable Maximum Flood (PMF) 15 minute critical storm for unblocked scenario[3].

Flood impact maps showing the peak flood level comparison between the pre-development and post-development scenarios are provided in Attachment A (note: maps were prepared based on the post-

[1] Drainage blockage methodology as per Macquarie Park Floodplain Risk Management Study and Plan Flood Study Report (Bewsher, 2010).
[2] Climate change assessment consistent with Macquarie Park Floodplain Risk Management Study and Plan Final Report (Bewsher, 2011). The site and adjacent creek are not subject to impacts from sea level rise.
[3] Blockage scenario was not investigated for the PMF in the Macquarie Park Floodplain Risk Management Study and Plan Flood Study Report (Bewsher, 2010).

development peak flood levels minus the pre-development peak flood levels). The results show that under post-development conditions there is minimal change in the mainstream flood levels on Shrimptons Creek up to the 1% AEP design flood event including climate change, with adverse impacts highly localised and limited to within the Shrimptons Creek corridor. Therefore, there are no predicted flood impacts on adjacent properties as a result of the proposed development. The Midtown Stage 2 development extent generally does not encroach onto the 1% AEP Shrimptons Creek mainstream flood extent, even in the climate change scenario.

For the PMF extreme event, adverse flooding impacts are predicted to extend upstream of Epping Road and downstream of the Ivanhoe Estate development. However, it is important to note that this is an extremely rare event with an AEP of 1 in 10,000,000 according to *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method* (Bureau of Meteorology, 2003), and Shrimptons Creek and its adjacent floodplain are already subject to significant inundation depths.

As previously mentioned, runoff within the Ivanhoe Estate including the Midtown Stage 2 development is generally shallow overland flow outside of the Shrimptons Creek corridor and considered as “Local Drainage”. As the internal stormwater drainage and design terrain surrounding the Ivanhoe Estate have not been finalised (other than the grading of the internal roads and the earthworks along the western bank of Shrimptons Creek), the assessment herein is limited to assessing impacts primarily on Shrimptons Creek mainstream flooding and not local catchment flooding.

Finished Floor and Basement Entry Levels

Finished Floor Levels (FFLs) for the Midtown Stage 2 development have been assessed in reference to the City of Ryde’s freeboard requirements defined in *Part 8.2 Stormwater Management Technical Manual* of the City of Ryde Development Control Plan (DCP) 2014. The requirements are outlined in Table 1, with Figure 4 also referred to in categorising the site in accordance with the flood risk and overland flow precincts. Given that the site adjacent to the Shrimptons Creek corridor may experience medium to high risk flooding, the 0.5 m freeboard for habitable floor level and 0.3 m freeboard for non-habitable floor level would be applicable for the proposed development.

The buildings on Block C4, which are located at the lowest elevation of the site (compared to Blocks C2 and C3) and nearest to Shrimptons Creek, have proposed minimum FFLs of 47.0 mAHD. Compared to the peak flood levels listed in Table 2, a freeboard in excess of 0.5 m has been achieved for all events up to the PMF event.

The lowest threshold for a basement entry into the underground car park at Block C4 is proposed at 47.7 mAHD. This is above the Shrimptons Creek PMF level of 46.14 mAHD as per Table 2. Hence, the floodwaters from Shrimpton Creek will be prevented from ingressing the basement in all events up to and including the PMF.

Table 1 Freeboard Requirements based on City of Ryde DCP (2014)

Drainage System/ Overland Flow	Residential			Industrial/ Commercial	
	Land Level [b]	Habitable Floor Level	Non-Habitable Level [c]	Land Level [b]	Floor Level
Surface Drainage/ adjoining ground level [a]	-	.15m	-	-	.15m
Public drainage infrastructure, creeks and open channels	0.5m	0.5m	0.1m	0.3m	0.3m
Flooding and Overland Flow (Overland Flow Precincts and Low Risk)	N/A	0.3m	0.15m	N/A	0.3m
Flooding and Overland Flow (Medium Risk and greater)	N/A	0.5m	0.3m	N/A	-
Onsite Detention [d]	N/A	0.2m	0.1m	N/A	0.2m
Road Drainage Minor Systems (Gutter and pipe flow)		0.15m below top of grate			
Road Drainage		Refer to Figure 2-1.			
Detention Basins [4]		The top water level shall be designed to be 0.5m below top of embankment (100yr ARI)			

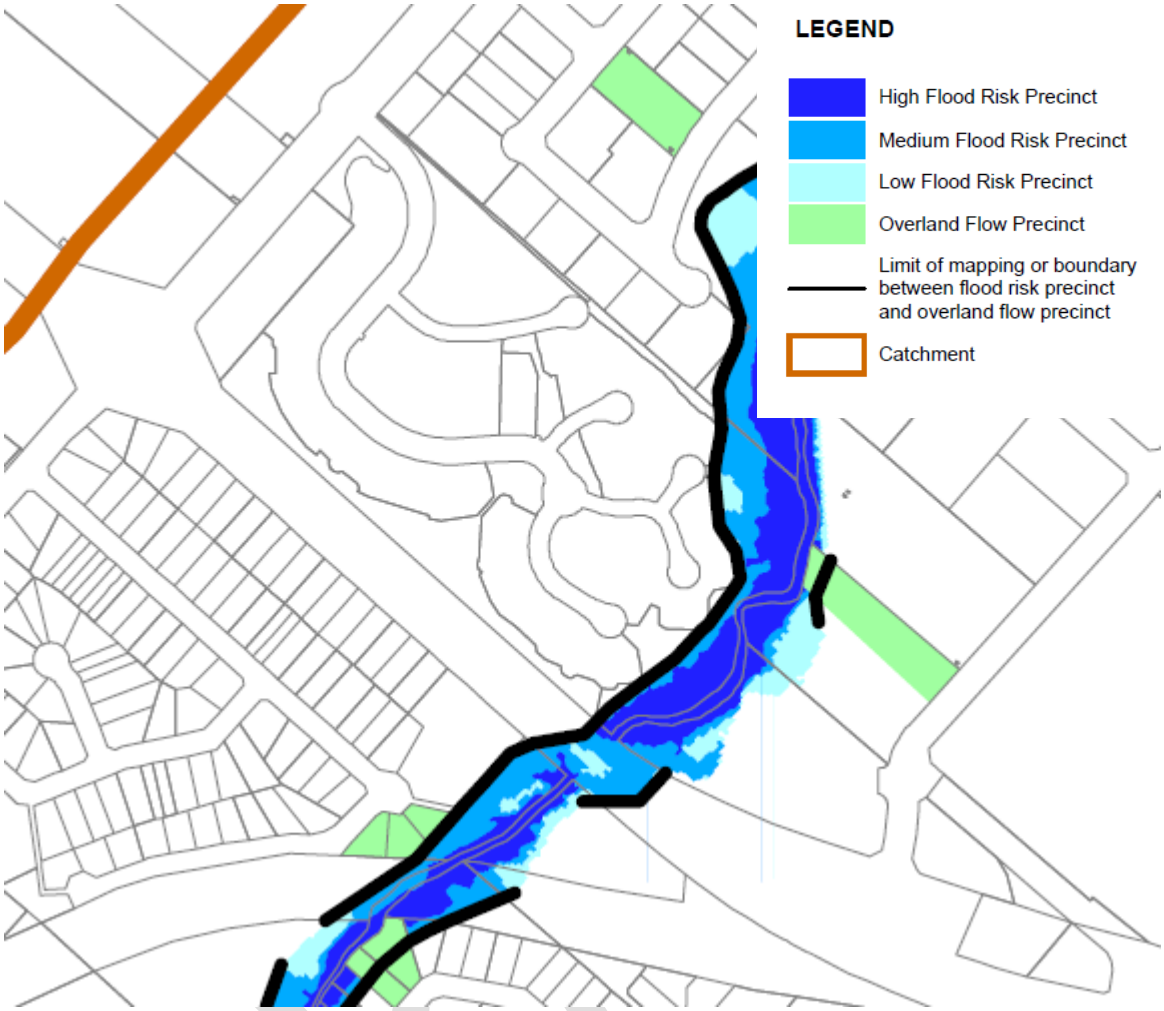


Figure 4 Flood Risk and Overland Flow Precincts based on Macquarie Park Floodplain Risk Management Study and Plan Final Report (Bewsher, 2011)

Table 2 Shrimptons Creek Peak Flood Levels adjacent to Midtown Stage 2 Development[4]

Design Storm (AEP)	Peak Flood Levels (mAHD)
5%	44.42
1%	44.48
1% with climate change	44.68
PMF	46.14

Conclusions and Recommendations

The Flood Impact Assessment undertaken herein for the Midtown Stage 2 development found that there is minimal impacts on the Shrimptons Creek mainstream flood levels predicted to result from the proposed development for events up to and including the 1% AEP design flood with climate change (10% rainfall

[4] Peak flood levels based on the critical of the blocked and unblocked scenarios.

increase). The proposed development extent generally does not encroach onto the 1% AEP Shrimptons Creek mainstream flood extent, even in the climate change scenario.

Outside of the Shrimptons Creek corridor, runoff within the Ivanhoe Estate (including the Midtown Stage 2 development) is generally shallow overland flow and considered as “Local Drainage”. It should be noted that as the internal stormwater drainage and design terrain surrounding the Ivanhoe Estate have not been finalised (other than the grading of the internal roads and the earthworks along the western bank of Shrimptons Creek), the assessment herein is limited to assessing impacts primarily on Shrimptons Creek mainstream flooding and not local catchment flooding. It is assumed that the detailed design of the development (e.g. stormwater management plan, drainage design) will address and mitigate any local drainage impacts.

For Block C4 within the Midtown Stage 2 development, which has buildings located at the lowest elevation of the site (compared to Blocks C2 and C3) and is located nearest to Shrimptons Creek, the FFLs comply with the freeboard requirements outlined in the City of Ryde DCP (2014). The FFLs for the development should also be checked against the local drainage/overland flow freeboard requirements once the internal stormwater drainage and design terrain are finalised.

The basement ramp threshold leading into the underground car park at Block C4 is proposed above the PMF Shrimptons Creek flood levels. Hence, the floodwaters from Shrimpton Creek will be prevented from ingressing the basement in all events up to and including the PMF.

Other conditions outlined in the SEARs shall also be adhered to:

- No gaps/openings connected to any basement shall be below the PMF level at each location.
- Fences located in overland flow paths shall allow flows to pass through.

I trust that this letter addresses the flooding-related conditions outlined in the SEARs for the Midtown Stage 2 development. Should you have any further questions regarding this assessment, please do not hesitate to contact myself.

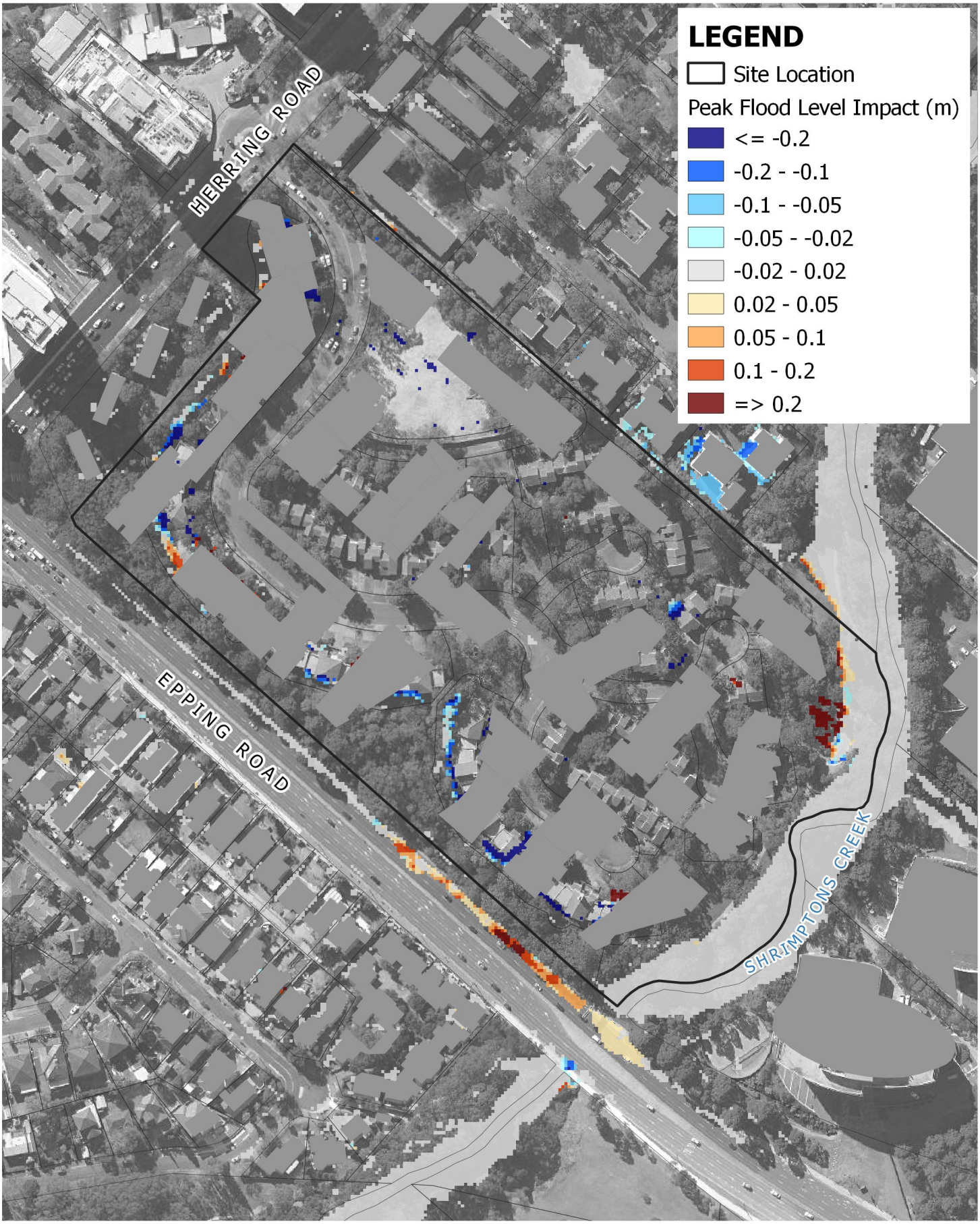
Yours Faithfully

Nathan Cheah
Associate Principal Engineer
BMT

Attachments:

- *Attachment A: Flood Impact Maps*

Attachment A - Flood Impact Maps



Title:

Peak Flood Level Impact
5% AEP Event - No Blockage Scenario

Figure: 1

Rev: A

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BMT

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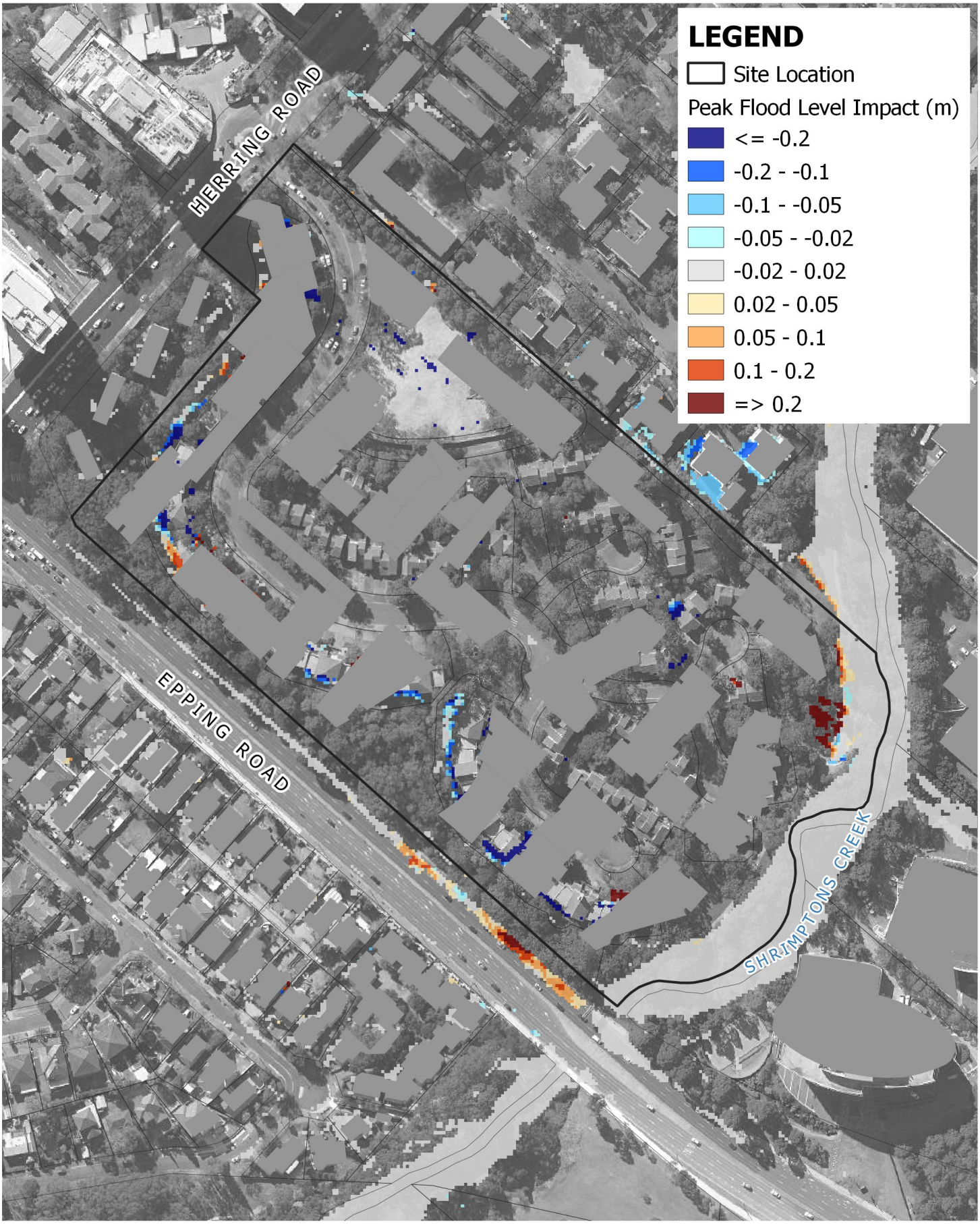

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Peak Flood Level Impact
5% AEP Event - Blockage Scenario

Figure: 2

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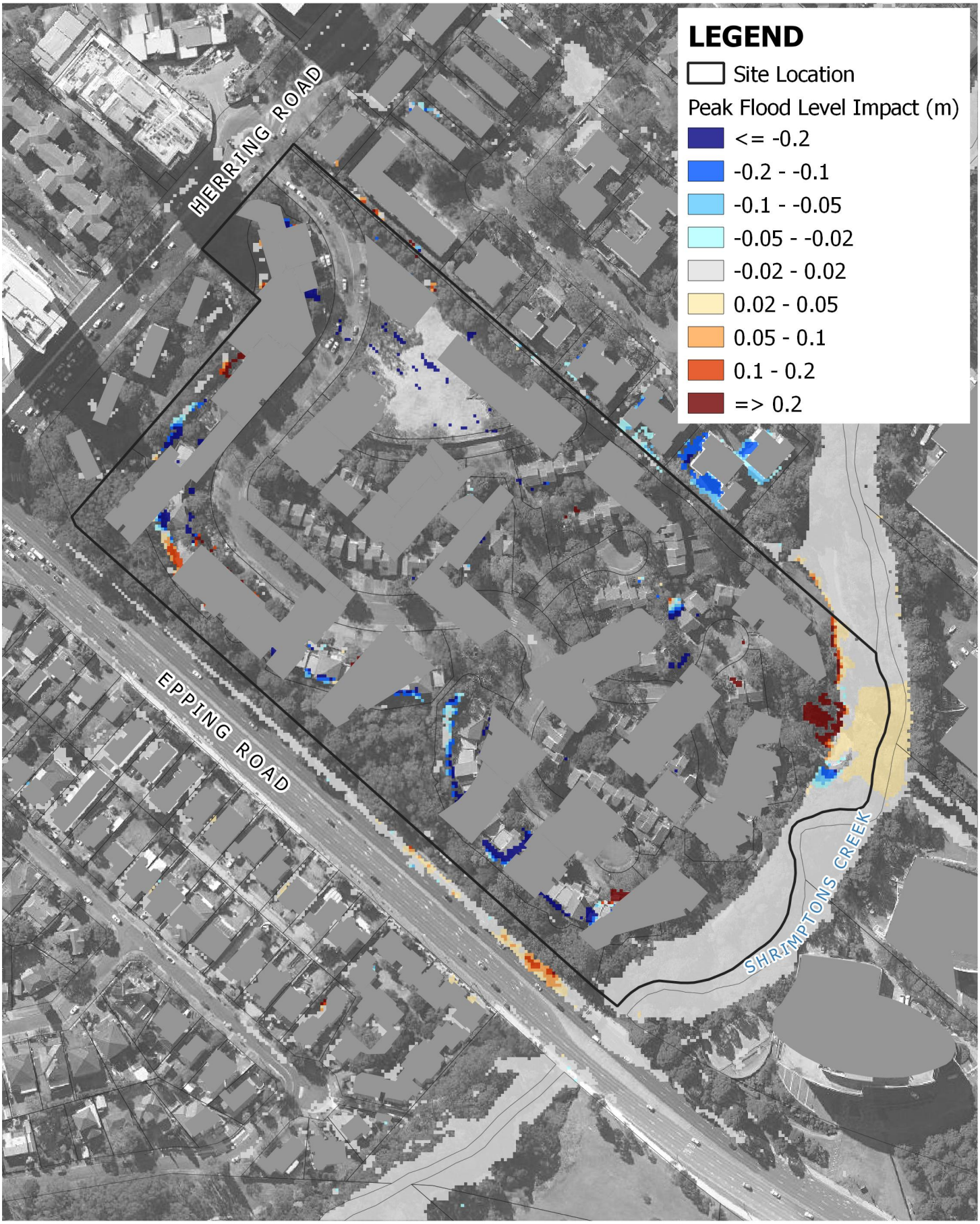

Title:

Peak Flood Level Impact
1% AEP Event - No Blockage Scenario

Figure: 3

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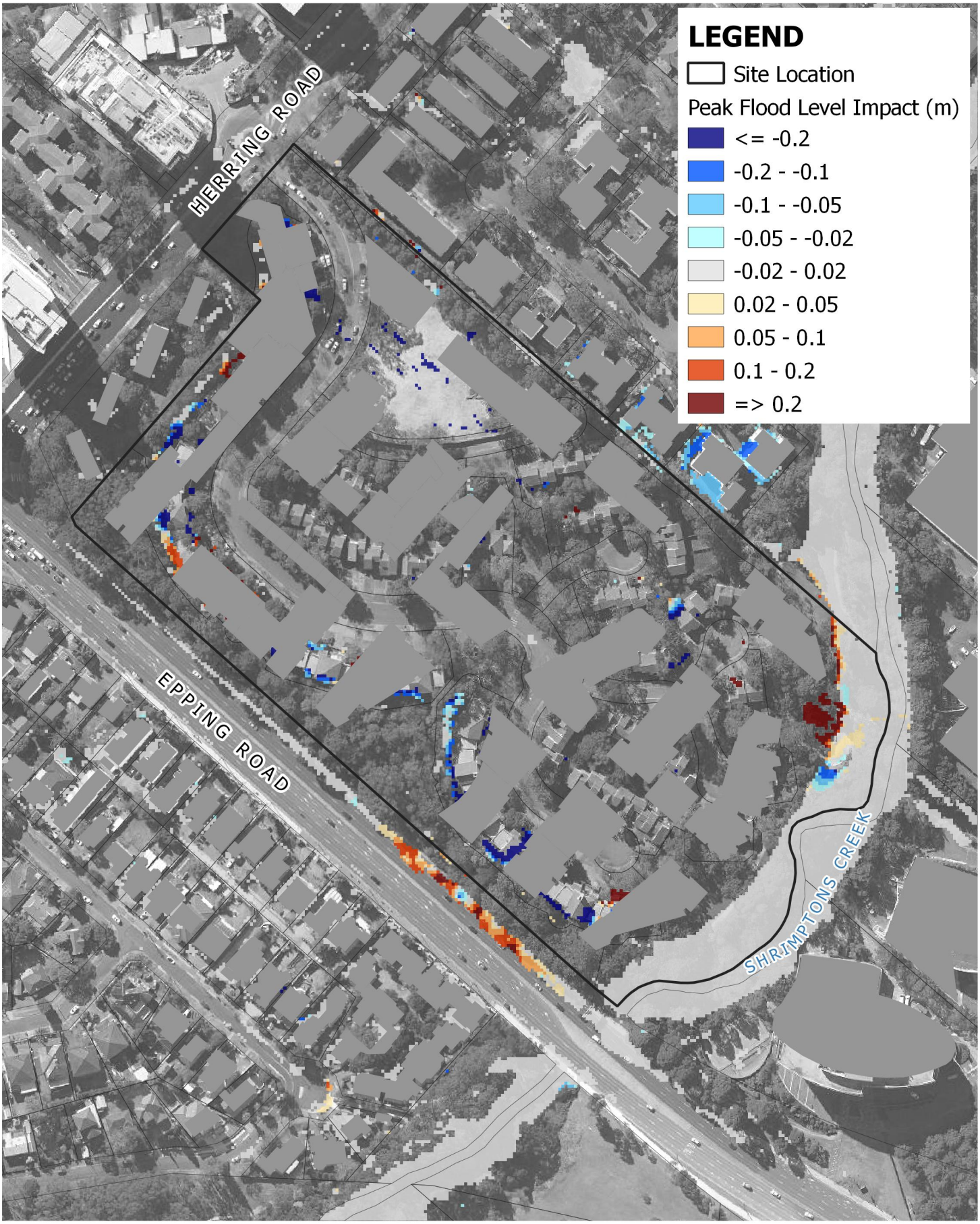

Title:

Peak Flood Level Impact
1% AEP Event - Blockage Scenario

Figure: 4

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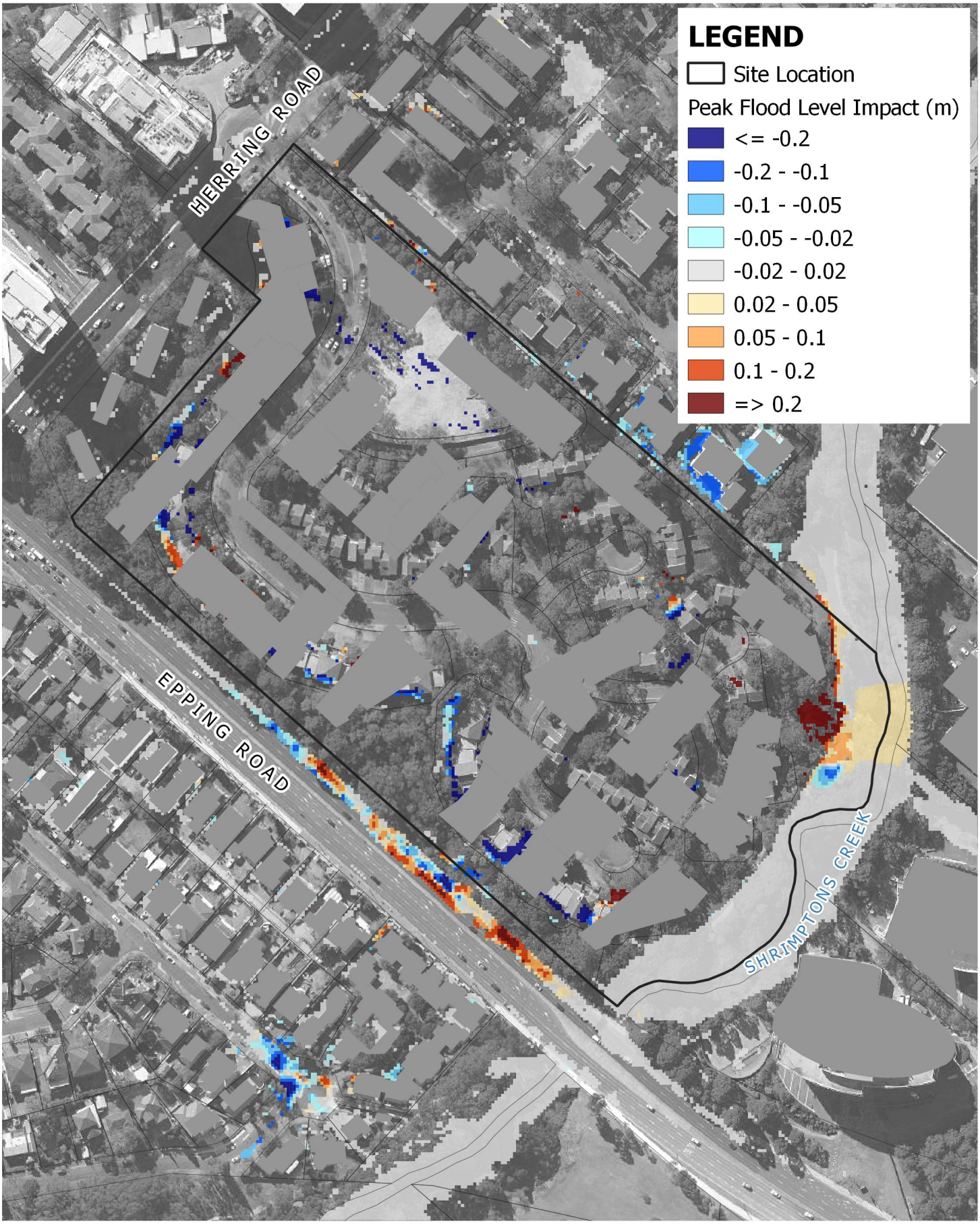

Title:

Peak Flood Level Impact
1% AEP with Climate Change - No Blockage Scenario

Figure: 5

Rev: A

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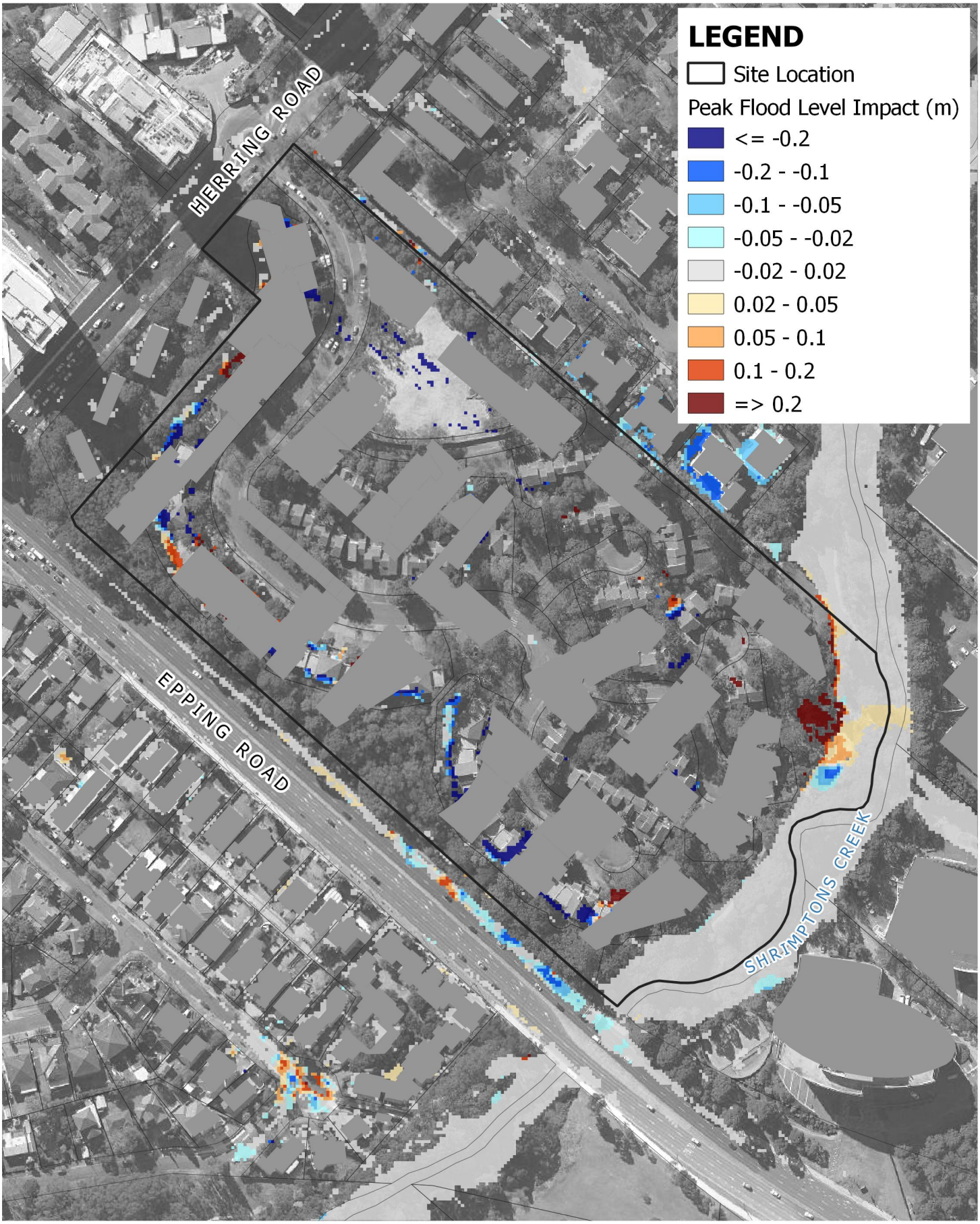

Title:

Peak Flood Level Impact
1% AEP with Climate Change - Blockage Scenario

Figure: 6

Rev: A

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BMT

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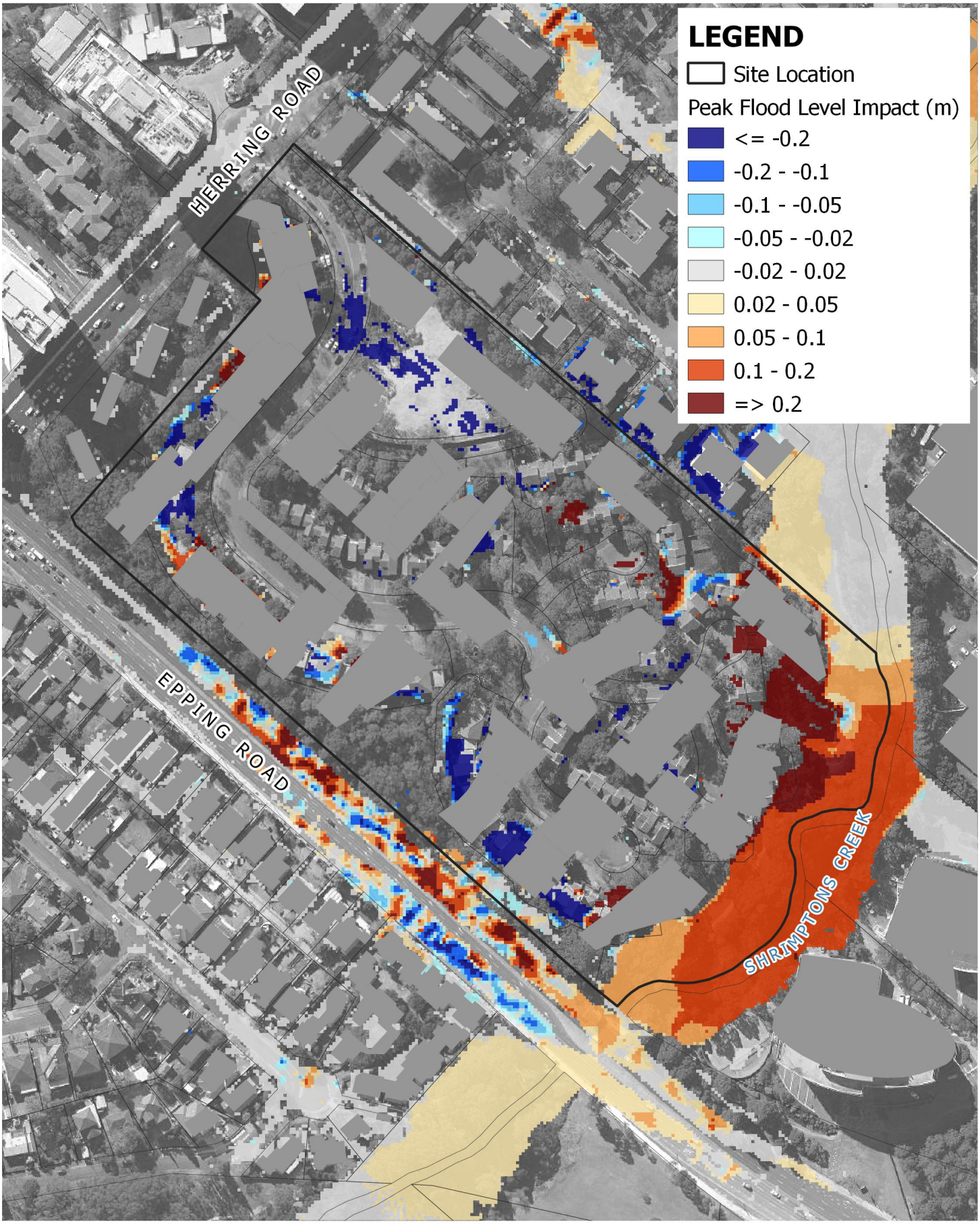

Title:

Peak Flood Level Impact
PMF Event

Figure: 7

Rev: A

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BMT

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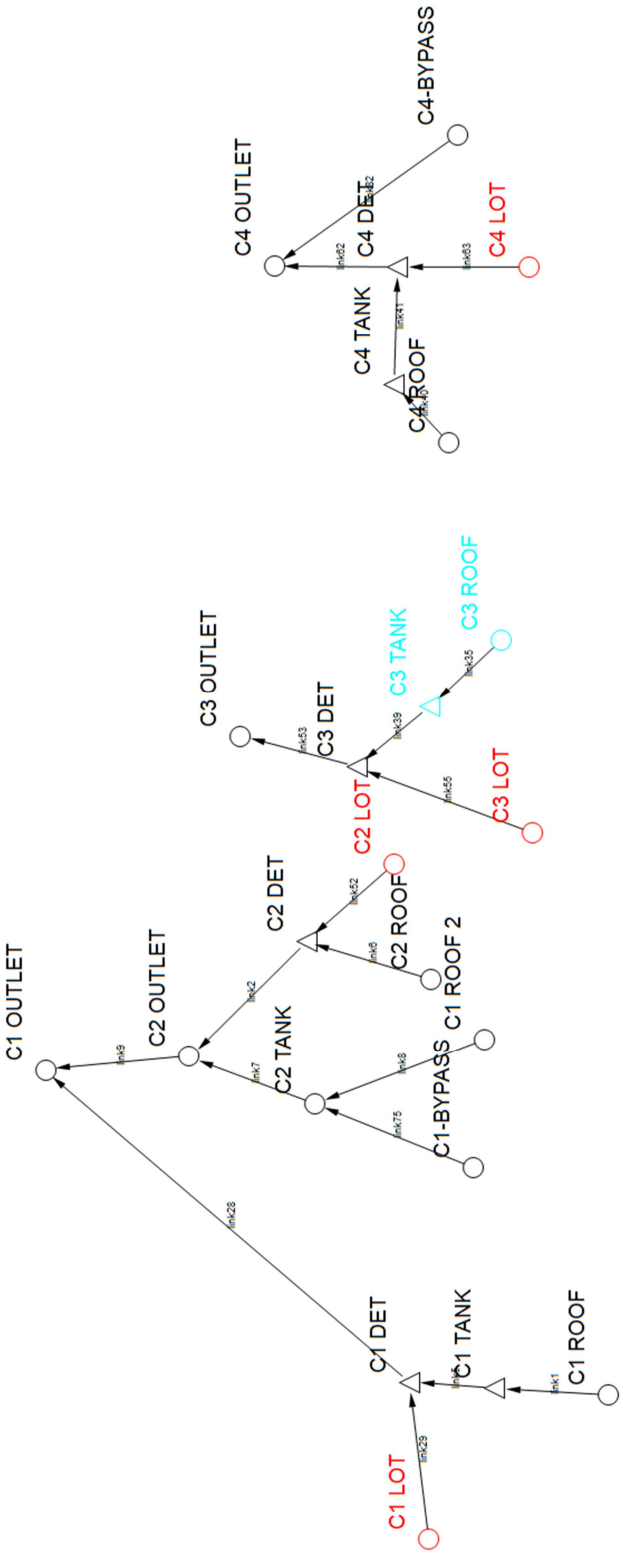
Appendix B

XP-RAFTS MODEL

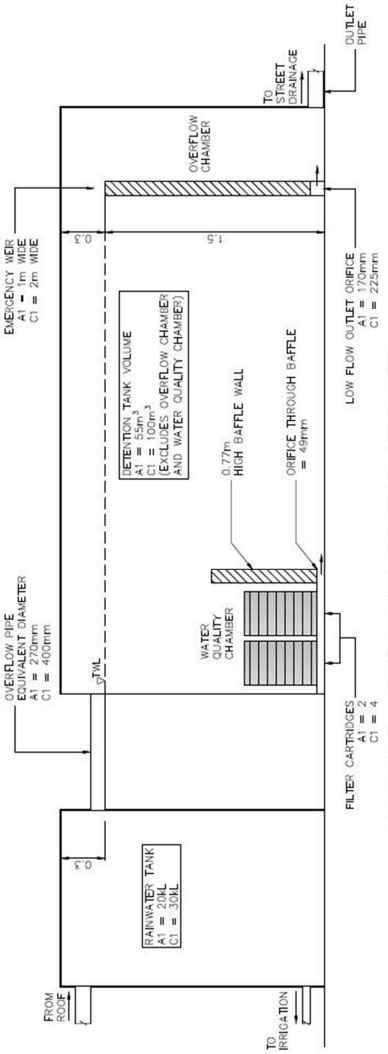


Appendix C

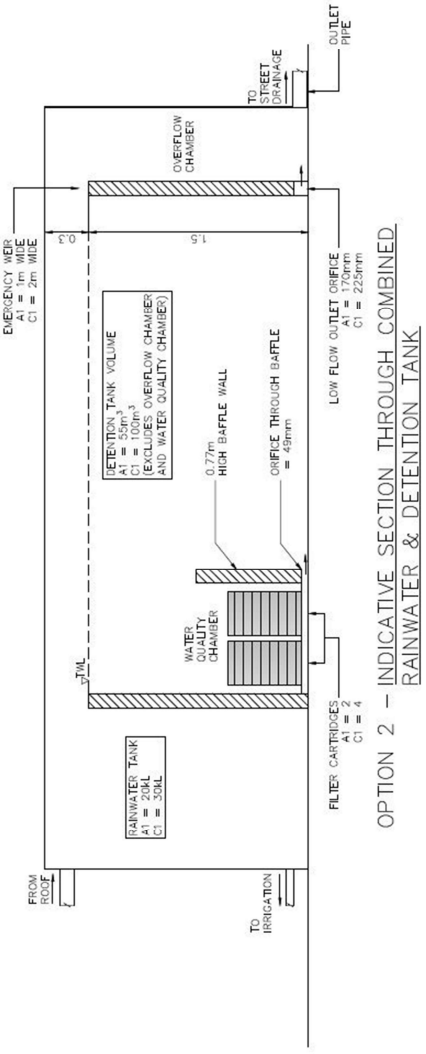
INDICATIVE TANK DETAILS

NOTES:-

1. TANK DESIGNS ARE INDICATIVE ONLY AND ARE SUBJECT TO DETAILED DESIGN.
2. FINAL TANK CONFIGURATION SUBJECT TO BUILDING HYDRAULICS AND ARCHITECTURAL DESIGN.
3. OUTLET TO STREET DRAINAGE MAY BE PUMPED OR DRAINED VIA GRAVITY.
4. REFER TO STORMWATER 360 BROCHURE FOR STORMFILTER DETAILS



OPTION 1 – INDICATIVE SECTION THROUGH RAINWATER & DETENTION TANK



OPTION 2 – INDICATIVE SECTION THROUGH COMBINED RAINWATER & DETENTION TANK

Appendix D

STORMWATER 360 INFORMATION

EnviroPod®

Cost-effective, easily maintained gullypit insert

The EnviroPod is a proven gullypit insert that's been designed for easy retrofitting into new and existing stormwater gullypits, requiring no construction or land take. It removes a significant portion of sediment, litter, debris and other pollutants from water entering the stormwater system, and can be installed in either kerb inlet, standard pre-cast gullypits or manhole gullypits. Using low-cost passive screening and optional oil-adsorbent media, the EnviroPod can be customised to meet site-specific requirements with interchangeable polyester mesh screens ranging from 200 to 1600 micron pore size. Unless specified otherwise, 1600 micron filter mesh screening bags are supplied as standard.

> "Designed for easy fit into new or existing gully pits, the EviroPod® is a simple and effective solution for preventing gross pollutants from entering the stormwater system.

The EnviroPod is also effective as a pre-treatment device for use in a treatment train with hydrodynamic separators, filtration devices, ponds and wetlands. In many cases, it is often the most practical solution for retrofits.

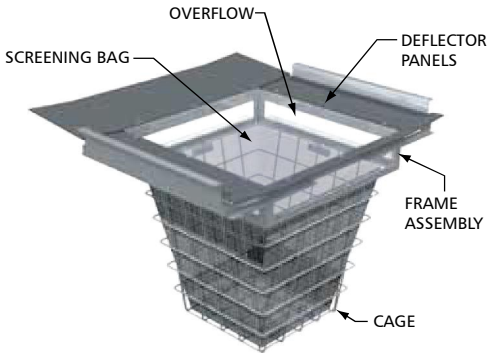
Independently trialled and tested by city councils throughout Australia and New Zealand, and with installation of over 15,000 units including North America, the EnviroPod filter is the premier gully pit insert.

How does it work?

As stormwater enters a storm grate or gullypit, it passes over the oil adsorbent pillows (optional) and into the screening bag. Litter, debris, and other pollutants larger than the screening bag aperture are captured and retained, while the oil adsorbent pillows reduce oil and grease. If the screening bag is full, or during high flows, overflow is released through the overflow apertures in the frame assembly.

Design and operation

The EnviroPod consists of a screening bag supported by a filter box and structural cage. Modular plastic deflector panels attach to the filter box and guide the flow of water to the screening bag. The screening bag captures pollutants and allows the water to pass through to the outlet pipe. Optional absorbent material inside the screening bag captures oil and grease. Openings in the filter box allow water to bypass the screening bag during high flow conditions to prevent surface flooding.



Capabilities

- Captures sediment, litter, debris and other pollutants before they enter the drainage system
- Fits a range of gullypit sizes – ideal for retrofits
- Easy access – maintenance friendly design, generally no confined space entry required
- Bypasses high flows with no moveable parts
- Adjustable panels allow fine-tuning during installation for a perfect fit

Configurations

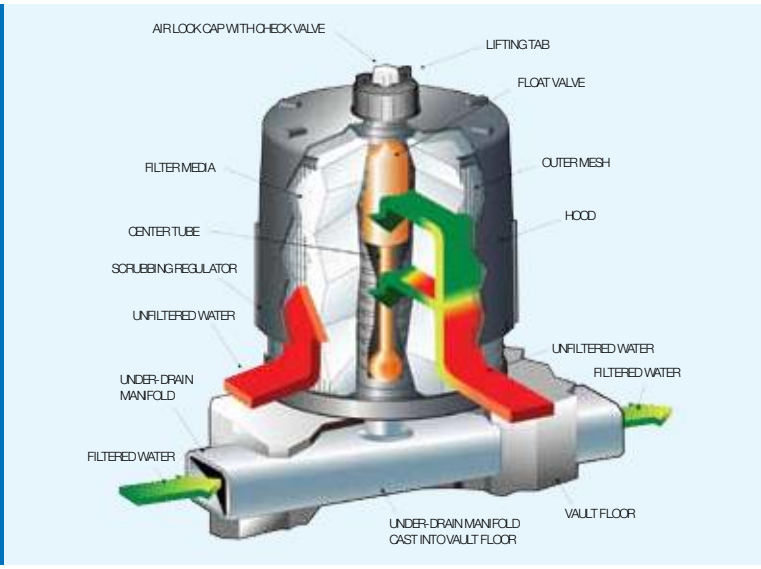
The kerb entry EnviroPod is inserted through the pit access cover and is supported by aluminium arms fixed to the kerb channel/pit wall.

The Drop-In EnviroPod is designed to simply insert into the gullypit below the grate, again supported by aluminium arms fixed to the kerb channel/wall pit. Plastic deflector panels seal against the pit walls and direct flow into the filter box and through the mesh screens. There are two standard sizes to fit most pre-cast regular and kerb entry gullypits. Custom designs can be fabricated for non-standard pits.

Installation, inspection and maintenance

Traffic control must be well planned when installing, inspecting or maintaining EnviroPod Filters. All standard rules and regulations governing traffic control and safety while working on the road must be rigidly followed at all times. All potential hazards must be identified and control methods put in place prior to installing, inspecting or maintaining filters.

The Stormwater Management StormFilter



Removing the most challenging target pollutants

The Stormwater Management StormFilter is a best management practice (BMP) designed to meet stringent regulatory requirements. It removes the most challenging target pollutants – including fine solids, soluble heavy metals, oil, and total nutrients (inc. soluble) – using a variety of media. For more than two decades, StormFilter has helped clients meet their regulatory needs and through product enhancements the design continues to be refined for ease of use.

Why StormFilter is the best filter available

Superior hydraulics

- External bypass – protects treatment chamber from high flows and ensures captured pollutants are not lost during low frequency, high intensity storm events
- Multiple cartridge heights – minimises head loss to fit within the hydraulic grade line and shrink system size, reducing installation costs
- Multiple StormFilter configurations in use across the country

Reliable longevity

- One-of-a-kind self-cleaning hood – prevents surface blinding, ensures use of all media, and prolongs cartridge life
- Customised maintenance cycles – fewer maintenance events compared to similar products, which reduces costs over the lifetime of the system
- 12 years of maintenance experience – predictable long-term performance comes standard

Proven performance

- Only filter on the Australian market tested within Australia achieving best practice guidelines, for TSS, TP and TN
- Qualifies for a minimum 2 EMI 5 Green star credits
- Achieve water quality goals with confidence – easy approval speeds development assessment process
- 8th generation product – design refined and perfected over two decades of research and experience

Maximising your land use and development profitability

StormFilter systems are utilised in below ground systems. The advantages this offers over above ground systems includes:

- Land space saving that enable an increase in development density and reduce sprawl
- The potential to add car parking, increase building size, and develop out parcels

In addition, StormFilter's compact design reduces construction and installation costs by limiting excavation.

Media options

Our filtration products can be customised using different filter media to target site-specific pollutants. A combination of media is often recommended to maximise pollutant removal effectiveness.

PhosphoSorb™ is a lightweight media built from a Perlite-base that removes total phosphorus (TP) by adsorbing dissolved-P and filtering particulate-P simultaneously.

Perlite is naturally occurring puffed volcanic ash. Effective for removing TSS, oil and grease.

Zeolite is a naturally occurring mineral used to remove soluble metals, ammonium and some organics.

GAC (Granular Activated Carbon) has a micro-porous structure with an extensive surface area to provide high levels of adsorption. It is primarily used to remove oil and grease and organics such as PAHs and phthalates.

	PhosphoSorb	Perlite	ZPG	Zeolite	GAC
Sediments	•	•	•		
Oil and Grease	•	•	•		
Soluble Metals	•		•	•	
Organics			•	•	•
Nutrients	•	•	•	•	•
Total Phosphorus	•		•		

Note: Indicated media are most effective for associated pollutant type. Other media may treat pollutants, but to a lesser degree.

ZPG™ media, a proprietary blend of zeolite, perlite, and GAC.

Cartridge options

With multiple cartridge heights available, you now have a choice when fitting a StormFilter system onto your site.

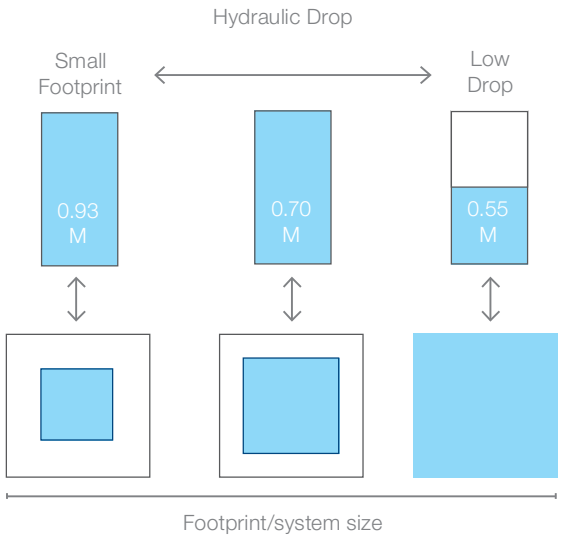
The 69cm cartridge provides 50% more treatment than the previously standard 46cm cartridge, which enables you to meet the same treatment standards with fewer cartridges, and via a smaller system.

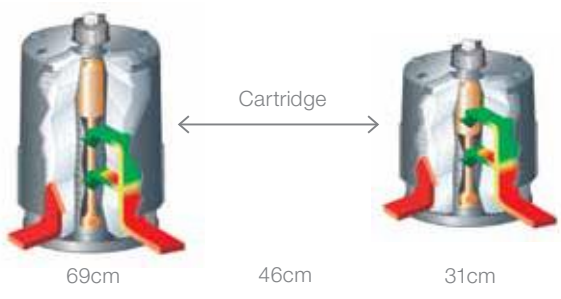
If you are limited by hydraulic constraints, the low drop cartridge provides filtration treatment with only 0.55m of headloss.

Cartridge flow rates

Cartridge Type	Hydraulic Drop	Treatment Capacity (l/sec)	
		0.7 l/s/m²	1.4 l/s/m²
StormFilter 69cm	0.93 m	0.71	1.42
StormFilter 46cm	0.70 m	0.47	0.95
StormFilter Low Drop	0.55 m	0.32	0.63

Selecting cartridge height





Configurations and applications

The StormFilter technology can be configured to meet your unique site requirements. Here are a few of the most common configurations, however many other configurations are available. A Stormwater360 engineer can assist you evaluate the best options for your site or you can find out more by downloading the StormFilter Configuration Guide from www.stormwater360.com.au

Upstream treatment configurations

The following suite of StormFilter configurations are easily incorporated on sites where WSUD is recommended. These low-cost, low-drop, point-of-entry systems also work well when you have a compact drainage area.

GullyPit StormFilter

Combines a gullypit, a high flow bypass device, and a StormFilter cartridge in one shallow structure.

- Treats sheet flow
- Uses drop from the inlet grate to the conveyance pipe to drive the passive filtration cartridge
- No confined space required for maintenance

Gully inlet

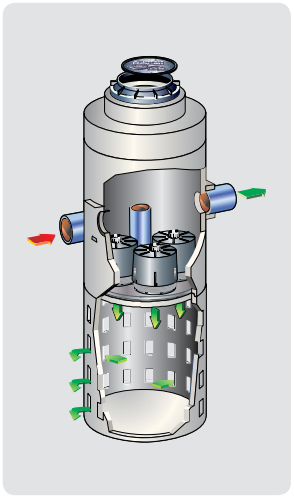
- Accommodates kerb inlet openings from 900 to 3000mm long
- Uses drop from the kerb inlet to the conveyance pipe to drive the passive filtration cartridges

Linear grate

- Can be designed to meet volume based sizing requirements
- Can be installed in place of and similar to a typical gullypit
- No confined space entry required for maintenance
- Accommodates up to 29 StormFilter cartridges

Infiltration/retrofit configuration infiltration

- Provides treatment and infiltration in one structure
- Available for new construction and retrofit applications
- Easy to install
- Re-charge groundwater and reduces run-off



Roof runoff treatment configuration

Down pipe

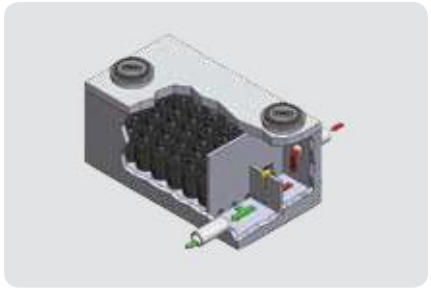
- Easily integrated into existing gutter systems to treat pollution from rooftop runoff
- Fits most downpipe configurations and sizes; single or dual-cartridge models available
- Treats up to 1300m^2 of rooftop area per dual-cartridge system

Downstream treatment configurations

Conventional stormwater treatment involves collecting, conveying and treating stormwater runoff with an end-of-pipe treatment system before discharging off-site. StormFilter configurations suitable for these applications are listed below and can be engineered to treat a wide range of flows.

Peak diversion

- Provides off-line bypass and treatment in one structure
- Eliminates material and installation cost of additional structures to bypass peak flows
- Reduces the overall footprint of the treatment system, avoiding utility and right-of-way conflicts
- Internal weir allows high peak flows with low hydraulic head losses
- Accommodates large inlet and outlet pipes (up to 900mm) for high flow applications



Vault / manhole

- Treats small to medium sized sites
- Simple installation – arrives on-site fully assembled
- May require off-line bypass structure

High flow

- Treats flows from large sites
- Consists of large, precast components designed for easy assembly on-site
- Configurations available, include, Panel Vault and Cast-In-Place

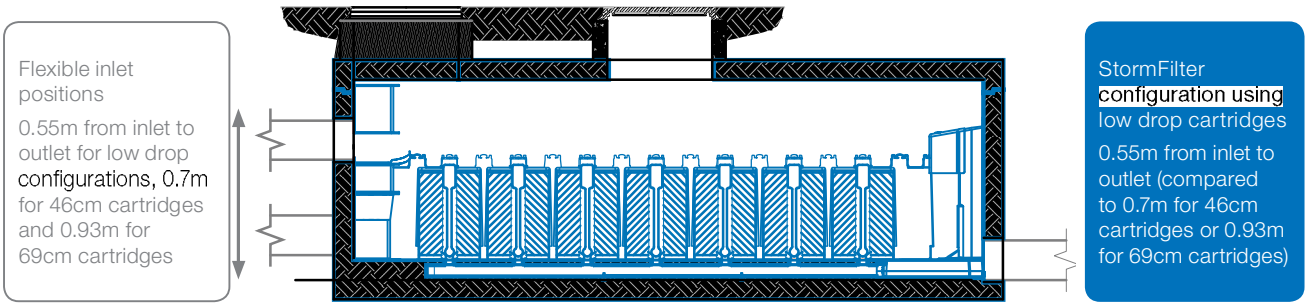
Volume

- Meets volume-based stormwater treatment regulations
- Captures and treats specific water quality volume (WQv)
- Provides treatment and controls the discharge rate
- Can be designed to capture all, or a portion, of the WQv

Filtration for low drop sites

Designing for limited drop

In some cases, site constraints limit the hydraulic drop that is available to drive the passive filtration cartridges. Following are a variety of solutions to either create the required drop or work around the limited drop without impacting the performance of the system.



Solutions for Low Drop Sites

Site modfications

Reduce pipe slope

Use an alternate pipe material with a lower Manning's n value for a portion of the site and reduce the pipe slope.

Reduce pipe cover

Use controlled density fill (CDF) at the front-end of the conveyance system to minimise pipe cover and raise the conveyance system. CDF, a method of pouring concrete with fine aggregate (sand vs. gravel) around pipe, allows the use of most pipe materials with limited cover.

Drain inlet treatment

Substitute several shallow inlet configurations for the single end-of-pipe system. Shallow options include the Catchpit/Gullypit StormFilter, CurbInlet StormFilter, Manhole StormFilter and the Linear StormFilter. These systems still require the normal drop (0.7m for 46cm cartridges) but utilise the drop into the conveyance system to drive the cartridges.

Provide pumping system

Stormwater360 offers the Integrated Pumping System (IPS), which can be designed in tandem with filtration system sizing.

Treatment system modfications

Use low drop cartridges

The StormFilter can be configured with low drop cartridges that activate at 31cm, reducing the overall head loss to only 0.55m, compared to 0.7m for the 46cm cartridge or 0.93m for the 69cm cartridge.

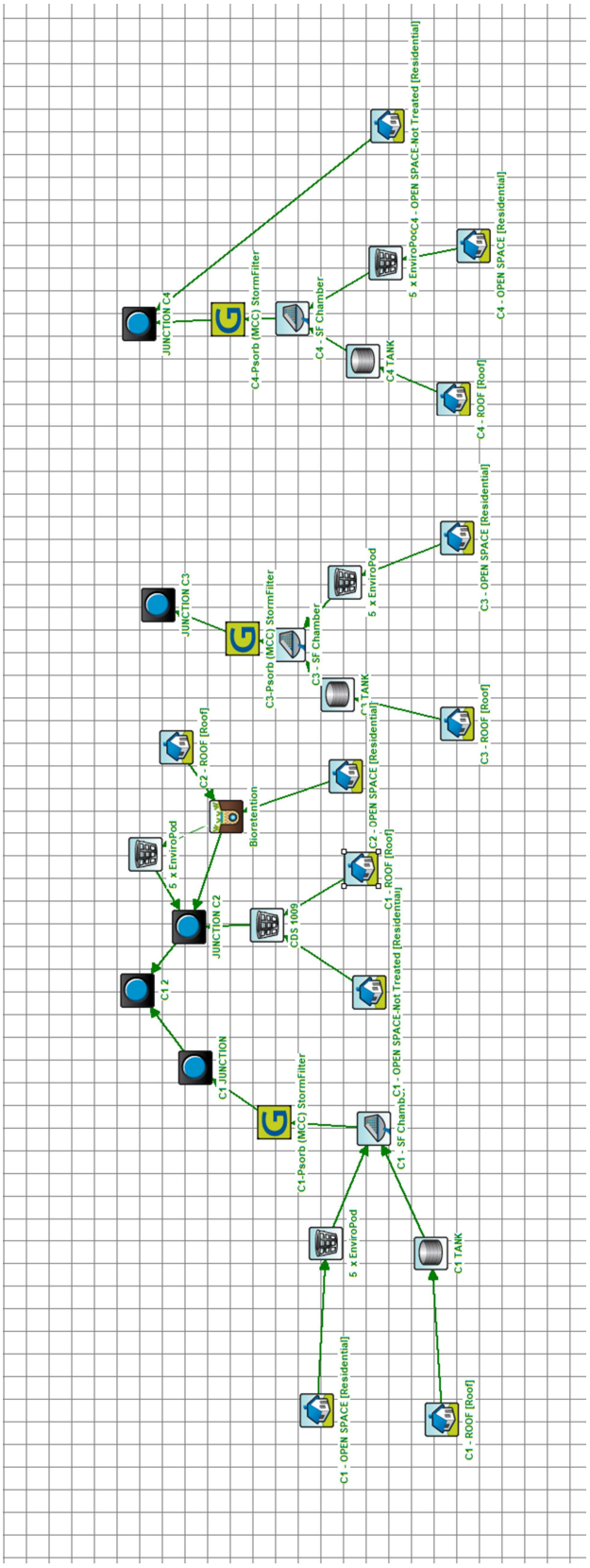
Surcharge the inlet pipe

Backing-up water into the conveyance system can create the necessary drop to drive the StormFilter cartridges. This will affect the HGL and increase the volume of water required to activate the cartridges, which could have a detrimental effect on system longevity. The following design modifications mitigate these risks:

- Confer with a Stormwater360 design engineer before surcharging the inlet pipe
- Verify this is an acceptable practice in your local jurisdiction
- Modify the overall system design to accommodate the increased HGL
- Calculate the additional treatment volume and consider using more cartridges

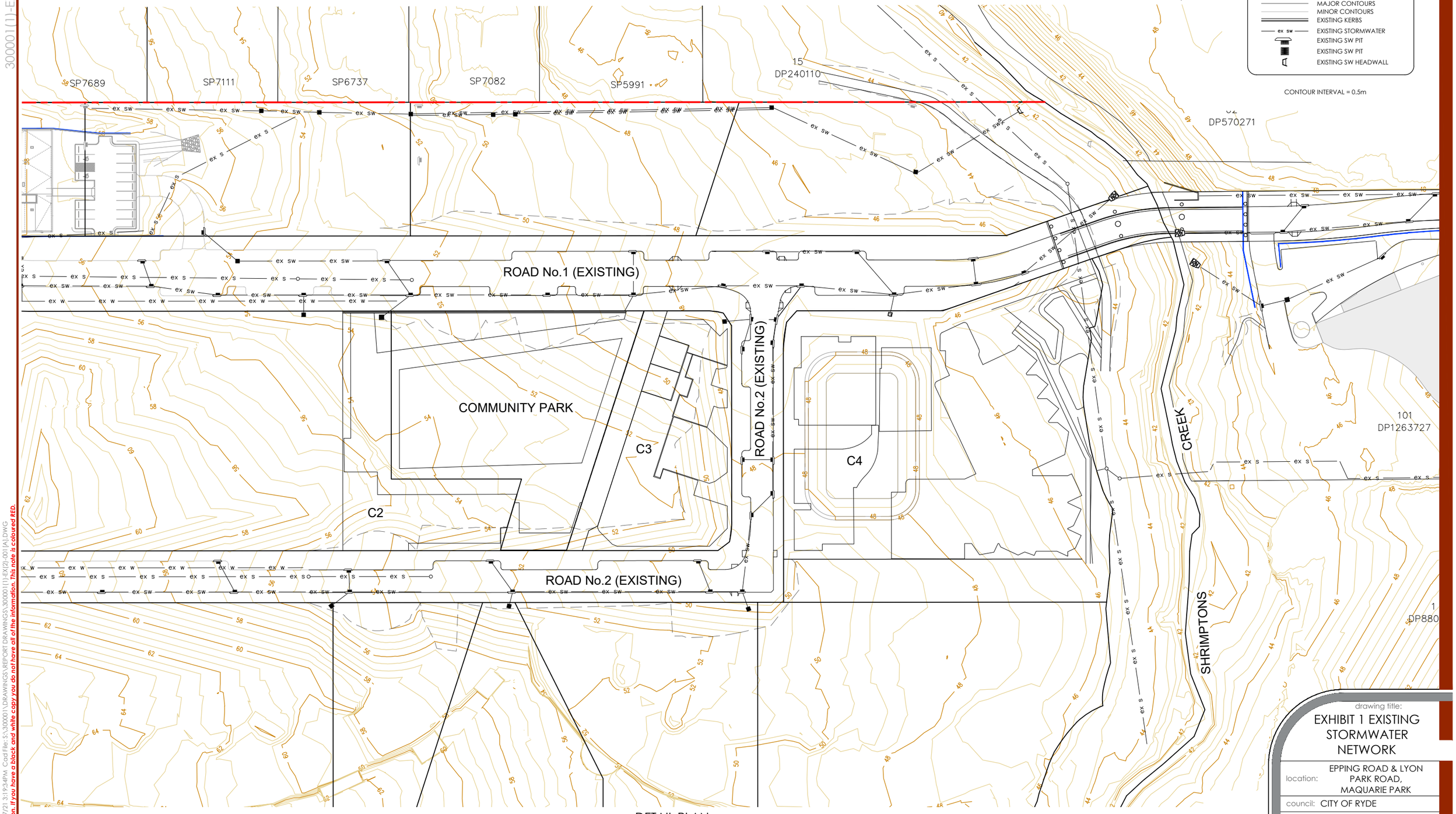
Appendix E

MUSIC MODEL



Exhibits

300001(1)-EX(2)-001[A]



DETAIL PLAN
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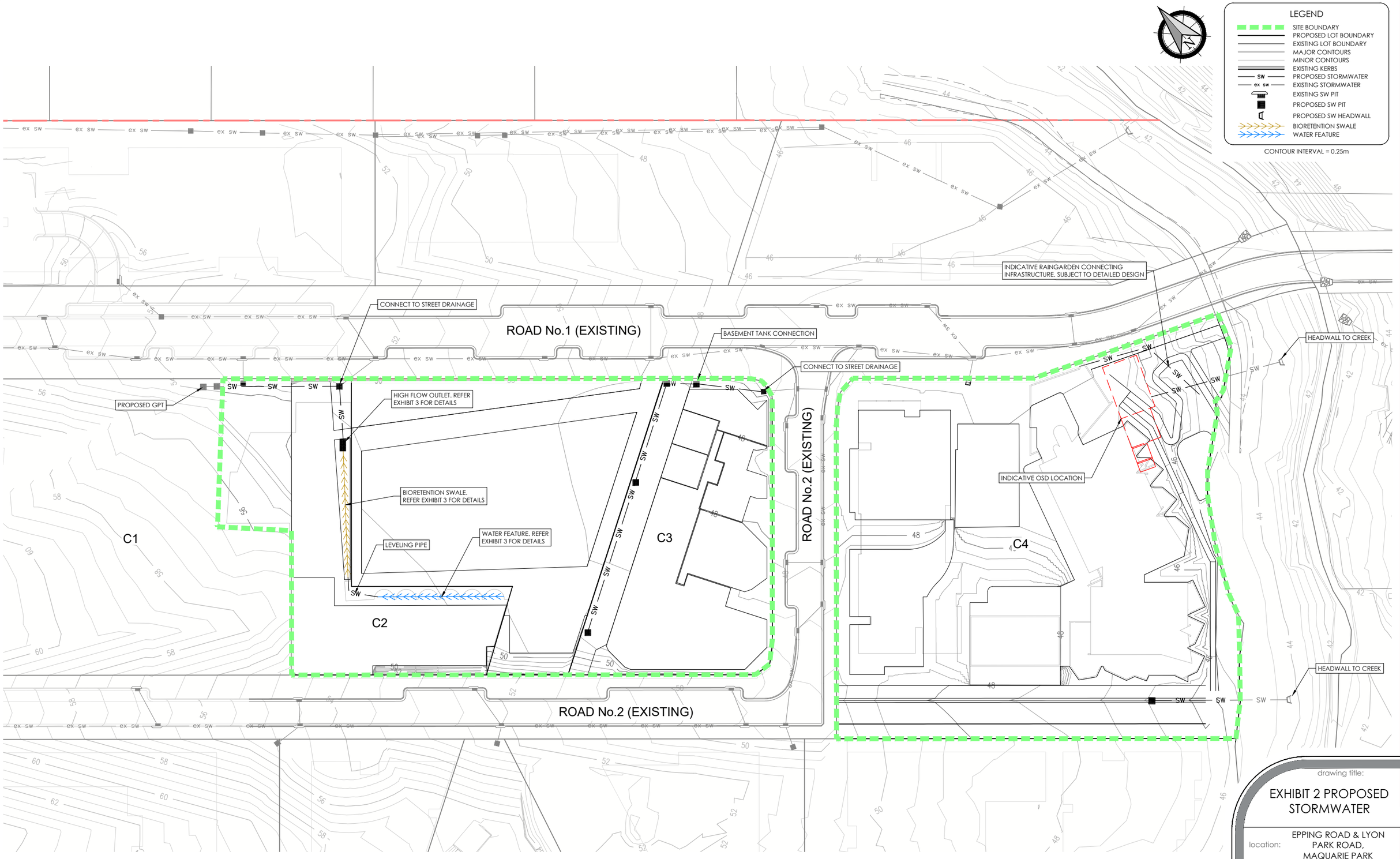
drawing title:
EXHIBIT 1 EXISTING STORMWATER NETWORK

location: EPPING ROAD & LYON PARK ROAD, MAQUARIE PARK
council: CITY OF RYDE
dwg ref: 300001-EX(2)-001[A]
client: FRASERS PROPERTY

adw johnson
central coast office ph: (02) 4305 4300
hunter office ph: (02) 4978 5100
sydney office ph: (02) 8046 7411



STORMWATER PLAN
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drawing title:

EXHIBIT 2 PROPOSED STORMWATER

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council: CITY OF RYDE

dwg ref: 300001-EX(2)-002[A]

client: FRASERS PROPERTY

adw johnson

central coast office ph: (02) 4305 4300
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ver.	date	comment	drawn	pm	level information	scale (A1 original size)	notes
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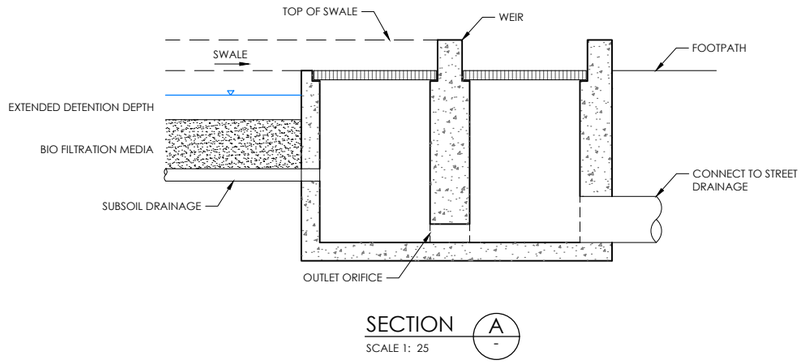

SECTION A
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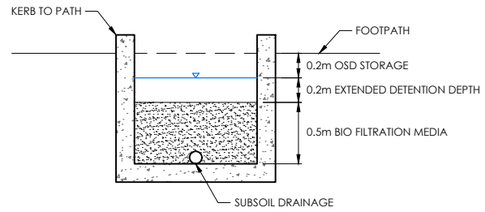

TYPICAL BIORETENTION SWALE DETAIL
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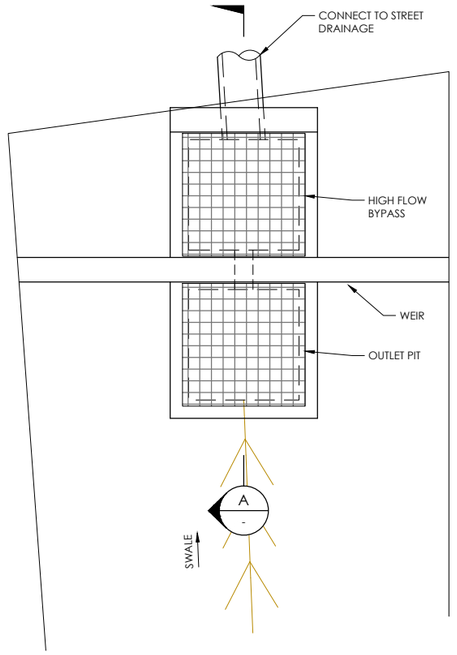

BIORETENTION SWALE OUTLET DETAIL
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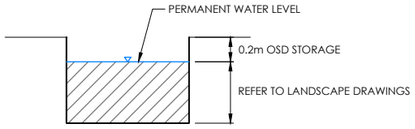

TYPICAL WATER FEATURE DETAIL
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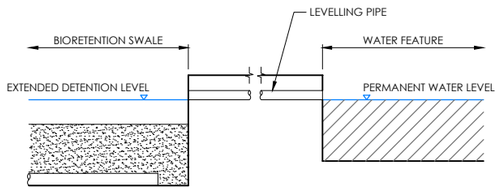

TYPICAL LEVELLING PIPE DETAIL
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drawing title:

EXHIBIT 3
TYPICAL DETAILS

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council: CITY OF RYDE

dwg ref: 300001-EX(2)-003[A]

client: FRASERS PROPERTY

adw johnson
central coast office ph: (02) 4305 4300
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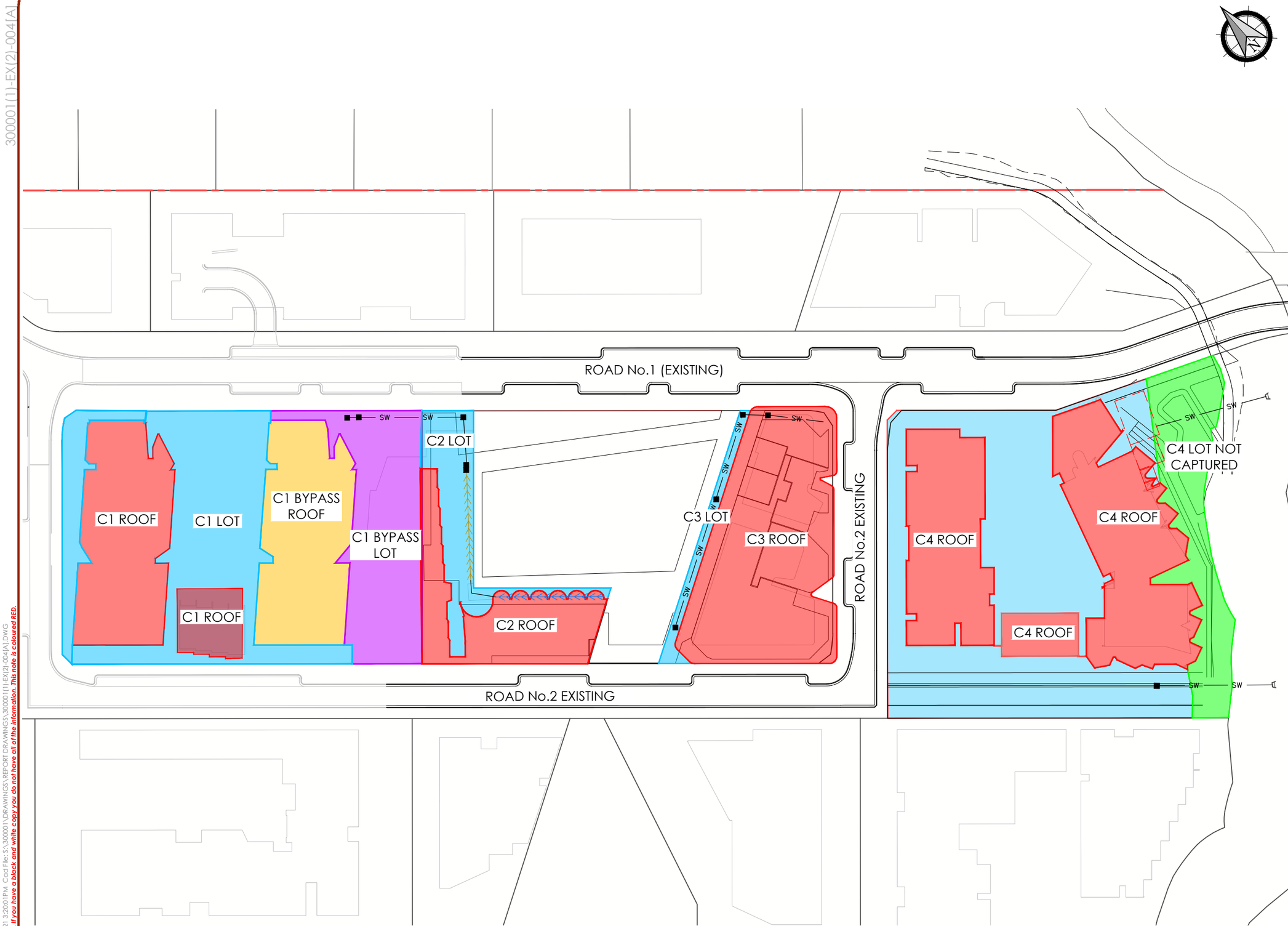
300001(1)-EX(2)-004[A]



LEGEND

- SITE BOUNDARY
- LIMIT OF WORKS BOUNDARY
- PROPOSED LOT BOUNDARY
- EXISTING LOT BOUNDARY
- MAJOR CONTOURS
- MINOR CONTOURS
- PROPOSED KERB
- EXISTING KERB
- EXTENTS OF BATTER
- PROPOSED FOOTPATH
- SW — PROPOSED STORMWATER
- EXISTING SW PIT
- PROPOSED HEADWALL
- GRASS LINED SWALE
- WATER FEATURE
- C1 ROOF
- C2 ROOF
- C3 ROOF
- C4 ROOF
- C1 LOT
- C2 LOT
- C3 LOT
- C4 LOT
- C4 LOT (NOT CAPTURED)
- C1 BYPASS LOT
- C1 BYPASS ROOF

CONTOUR INTERVAL = 0.5m

DETAIL PLAN
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drawing title:

EXHIBIT 4 PROPOSED CATCHMENTS

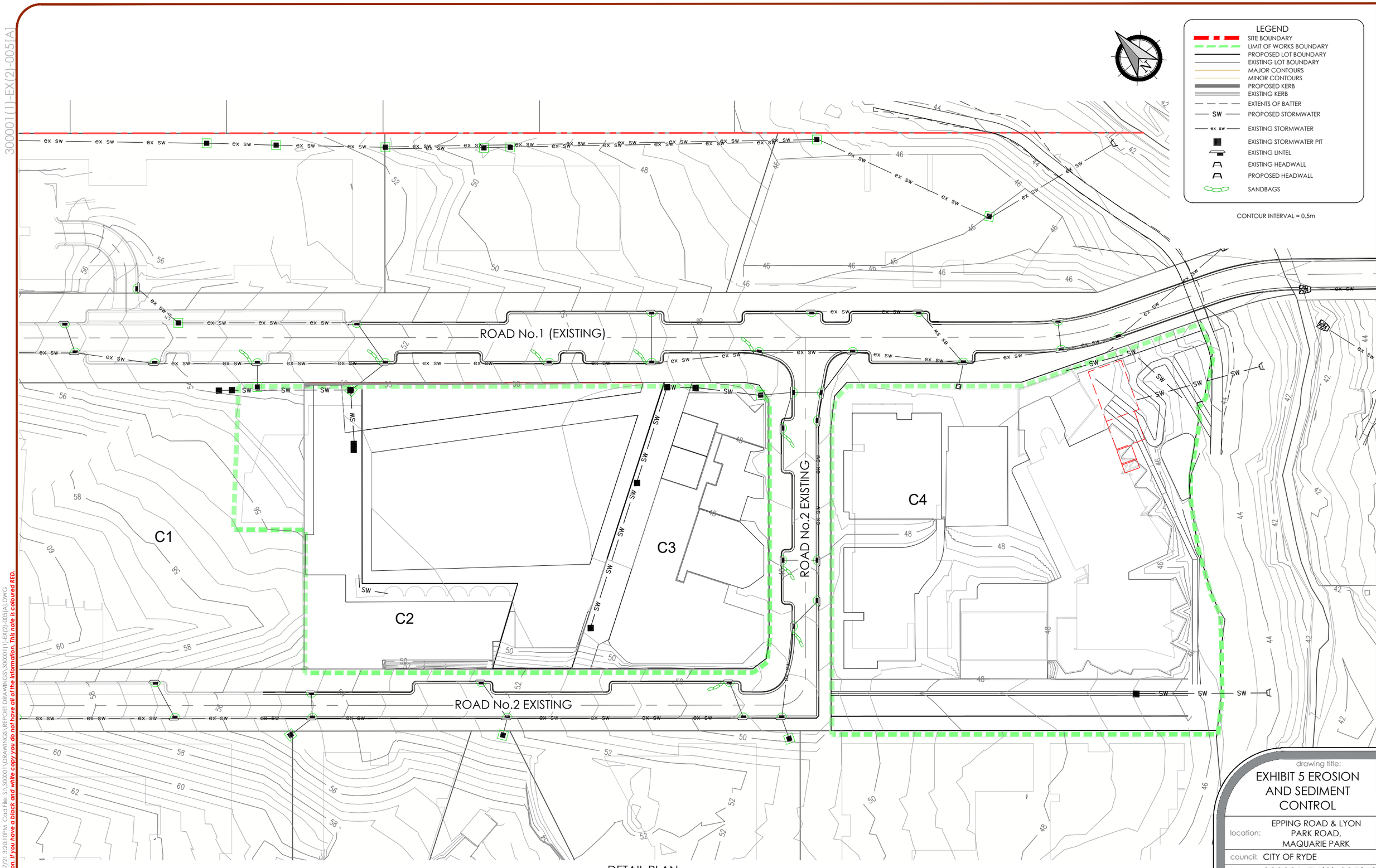
location: EPPING ROAD & LYON PARK ROAD, MAQUARIE PARK

council: CITY OF RYDE

dwg ref: 300001-EX(2)-004[A]

client: FRASERS PROPERTY

adw johnson
central coast office ph: (02) 4305 4300
hunter office ph: (02) 4978 5100
sydney office ph: (02) 8046 7411



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drawing title:
EXHIBIT 5 EROSION AND SEDIMENT CONTROL

location: EPPING ROAD & LYON PARK ROAD, MAQUARIE PARK
council: CITY OF RYDE
dwg ref: 300001-EX(2)-005[A]
client: FRASERS PROPERTY

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sydney office ph: (02) 8046 7411