CRAIG&RHODES

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19 March 2019

Our Reference: 076-18C-DA-WMR-A

Proposed Residential Subdivision

Water Management Report

53A & 53B Warriewood Road, Warriewood

Lot 3 DP 1115877 and Part Lot 3 DP 942319

Revision A

For LEGENDWAY Pty Ltd

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1 Introduction

Craig & Rhodes has been engaged by LEGENDWAY Pty Ltd to prepare the Development Application (DA) documentation for the civil works for the proposed residential development at 53B Warriewood Road, Warriewood. The proposed civil works include internal site stormwater drainage, stormwater detention and Water Sensitive Urban Design (WSUD) treatment train for the development.

The full set of engineering drawings to accompany the DA is referred to as **Craig & Rhodes Drawings 076-18C-0001 - 0902 Revision A.**

The proposed development is located within the Warriewood Valley Land Release. This site is located within the Northern Beaches Local Government Area.

1.1 Site Description

The development site is located on the southern side of Warriewood Road to the south-east of the intersection with Alameda Way. The site is part of an area defined by Council as Buffer Area 1(i) for planning purposes (refer to Figure 1).

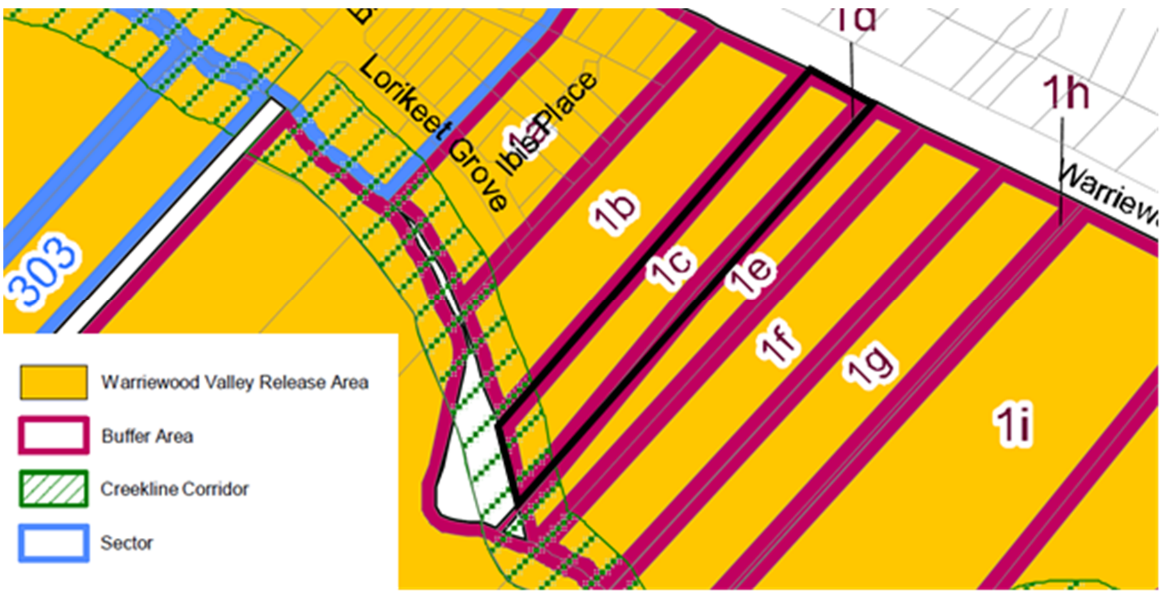


Figure 1 - Northern Beaches Planning Map

The subject site is currently zoned as medium density residential (R3) with a small portion of public recreation (RE1). The site has a total area of approximately 0.714 hectares. This site consists of a residential/farming area (north) and a densely vegetated area (south) (refer to Figure 2).

Figure 2 - Site Location

The existing site has a moderate slope and generally grades in a south-west direction from Warriewood Road towards Narrabeen Creek. The levels of the site range from approximately RL 13.0 AHD down (top north-east corner) to RL 1.0 AHD at the creek. A detailed site survey of the site has been included in Appendix A of this report.

1.2 Proposed Works

The proposed subdivision creates 17 lots (including one residue lot), together with demolition works, drainage, earthworks, the extension of existing Lorikeet Grove and widening of existing Pheasant Place.

The development also provides a public reserve adjacent to Narrabeen Creek.

The proposed site layout can be seen in Figure 3.

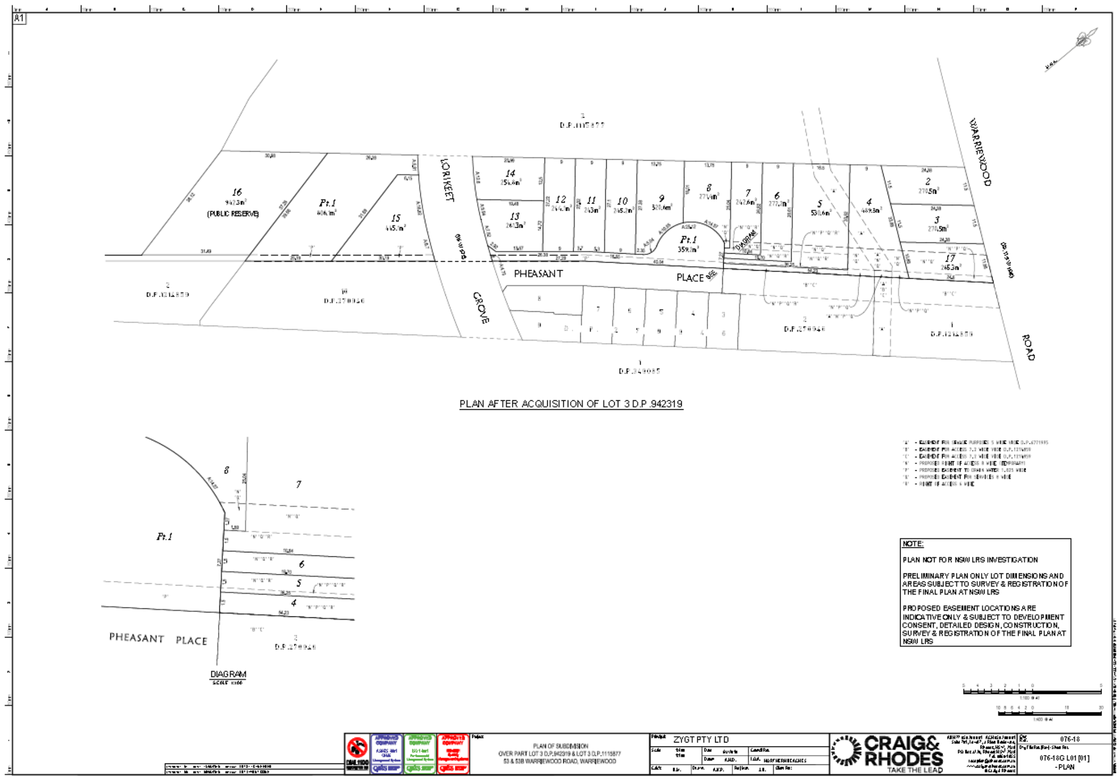


Figure 3 – Proposed Lot Layout

It is proposed to provide stormwater detention and Water Sensitive Urban Design within the residue lot to the south-west of Lorikeet Grove.

There is an existing DN600 stormwater drainage pipe that enters the site at the north-eastern corner of the development. It is proposed to reconstruct this within a proposed easement and discharge directly to Narrabeen Creek.

1.3 Reference Policies and Guidelines

The following documents have been referenced in developing the stormwater drainage and water sensitive urban design strategy for the proposed development:

1. Pittwater Council, 2015, *Pittwater 21 Development Control Plan*
2. Pittwater Council, 2001, *Warriewood Valley Urban Land Release - Water Management Specification*
3. Engineers Australia, 1987, *Australian Rainfall & Runoff: A Guide to Flood Estimation*
4. Commonwealth of Australia, 2016, *Australian Rainfall & Runoff: A Guide to Flood Estimation*
5. NSW Government, 2010, *Draft NSW MUSIC Modelling Guidelines*

2 Water Cycle Assessment

The Warriewood Valley Water Management Specification requires a water cycle assessment be carried out for the development. This is to ensure that development does not have detrimental impacts on the Warriewood Valley catchment with regards to peak surface water flow rates, and peak flow volumes of surface runoff.

Craig & Rhodes has carried out an assessment for both peak flow rates and volumes of runoff for the development under three conditions, a low rainfall year, and average rainfall year, and the high rainfall year. The average rainfall for the Warriewood Valley was determined from the Bureau of Meteorology Automatic Weather Station (AWS) at Ingleside (Station 066183). This was considered to provide an appropriate representation of rainfall within the Warriewood Valley.

The average rainfall at Ingleside AWS is 1440 mm per annum. The 10^{th} percentile rainfall is approximately 1071 mm per annum and the 90^{th} percentile is approximately 2094 mm per annum. The rainfall at Ingleside covers a period from 1984 to 2012. During this period rainfall covered annual rainfall from 945 mm to 2161 mm. The rainfall adopted for the Water Cycle Assessment of the proposed development utilised daily rainfall for the following years:

Percentile	Year	Rainfall (mm)
10^{th}	2002	1118
50^{th}	1984	1477
90^{th}	1998	2002

Table 1 - Adopted Rainfall

An additional model was also prepared to look at water balance over longer period than the individual rainfall years as above. The period covered a 28 year period from 1984 to 2012.

2.1 Treatment Measures

The aim of the water cycle assessment is to determine the changes in surface runoff from the development as result of changing the site conditions. An increase in imperviousness of the catchment increases the peak flow rates and volume of runoff from the catchment. The Warriewood Valley Management Specification requires that the volume of runoff maintain existing conditions where possible.

The primary method for maintaining peak volume of runoff is detaining runoff volumes exceeding the existing volumes. This is primarily through the use of rainwater tanks and infiltration to ground water.

2.1.1 Rainwater Tanks

At this stage, as the final dwelling sizes are unknown, and existing dwellings in the Warriewood Valley are generally three- or four-bedroom dwellings, it is appropriate to adopt values that reflect a three-bedroom dwelling as a minimum.

It is assumed that the proposed dwellings will require rainwater tanks for on-lot reuse of stormwater collected from roofs for both internal and external use as per the requirements of

BASIX. At this stage we have assumed that rainwater tanks for 2500L will be provided for each dwelling.

Rainwater tanks will collect runoff from approximately 50% of the roofs of the proposed dwellings. This water will be used to supply the daily demands for the dwellings, which will include laundry, toilet flushing and watering of landscaping.

There are a number of sources which can be considered when determining water use patterns within residential developments. There are two local government areas within the Sydney Basin that are generally accepted for water reuse values for residential development, these councils are Blacktown City and Ki-ring-gai Council. Alternate policies based on literature is that from the Sydney Catchment Authority (CMA). The CMA adopts the recommendations from Coombes et al (2003). The following table summarised these accepted sources.

Source	Daily Internal Use	Yearly External Use
Blacktown Council Ku-ring-gai Council	0.08kL/day (<320m^2 block) 0.10kL/day (320-520m^2 block)	25kL/yr (<320m^2 block) 50kL/yr (320-520m^2 block)
Coombes et al (2003) (Toilet & Laundry)	0.36kL/day (3 bedroom) 0.47kL/day (4 bedroom)	West Sydney – 55kL/yr Adelaide – 146kL/yr Brisbane – 126kL/yr Melbourne – 81kL/yr (all dwellings)

Table 2 - Rainwater Tank Reuse

AS the Warriewood Valley Water Management Specification does not provide reuse values to be assumed for use within the water balance, an assumed value needs to be determined.

As the majority of the lots are less than 320m^2 in area, the values adopted by Ku-ring-gai Council appear to be appropriate for the site. However, the values provided by Coombes appears to be more closed based on dwelling occupants than lot area.

For water reuse drawn from the proposed rainwater tanks, a daily use of 0.36kL per dwelling per day and an annual use of 25kL per dwelling per year has been adopted for the water balance and MUSIC modelling.

Based on the above demands, the daily demand for the development of 15 lots is proposed to be 5.4 kL per day, with an annual yearly demand for the development of 375kL per year.

2.1.2 Ground Infiltration

With dwelling footprints and lot layouts limited due to size, it is proposed to assist with water retention through the use of infiltration of treated stormwater to groundwater and reduce the volume of surface runoff as required by the Warriewood Valley Water Management Specification.

It is proposed to construct the combined WSUD and Detention basin without an impervious liner. Without an impervious liner, the infiltration of treated stormwater, particularly for frequent rainfall events, will ensure that the ground water can be contributed to due to the reduced infiltration within the catchment as a result of increased imperviousness of the development site.

Soils within the Warriewood Valley are generally deep sandy soils that are highly permeable. The bore logs from the geotechnical report for the project indicate that the soils are generally sandy to a depth of 9 metres below the surface.

The Water Balance model assumes that an infiltration rate of 2.5 mm/hour has been adopted across the area of the bioretention filtration media. This is lower than the generally accepted infiltration range for sandy soils (3.6 – 180 mm/hour).

2.2 Water Balance Results

Annual flows from the development have been assessed for a dry, average and wet rainfall years utilising daily rainfall data from 2002, 1984 and 1998 respectively.

The results of the water balance have been summarised in the following table:

Percentile	Pre-Development Annual Surface Runoff (ML/year)	Post-Development Annual Surface Runoff (ML/year)	Reduction (%)
10th	1.92	2.13	-10.9
50th	2.97	2.94	1.0
90th	6.53	6.11	6.4
Long Term Average			
1984 – 2012	2.58	2.57	0.4

Table 3 - Water Balance Summary

It can be seen that during a dry year, there is an increase in the volume of runoff from the catchment by up to 11%. This increase in volume of runoff is primarily due to the increase in imperviousness of the catchment that cannot be contained on site with the water balance measures. The average year indicates that the volume of runoff under post-development conditions is approximately equal to pre-development conditions.

Wet years indicate that the volume of runoff under post-development conditions with in the introduction of rainwater tanks on each lot and the infiltration of treated stormwater under the bio-retention basin is typically reduced.

Looking at rainfall over a 28-year period, there is a reduction in the volume of stormwater runoff from the post-development is reduced by approximately 0.4% from the pre-development scenario. This indicates that the volume of runoff under development conditions is generally equal to existing runoff volumes under pre-development conditions for frequent rainfall events.

Overall, it is expected that the volume of runoff in the long-term will be similar to that which is currently generated by the site, however individual years may vary and this is to be expected due to seasonal climatic changes.

3 Water Quality Assessment

3.1 Water Quality Monitoring

Water quality monitoring requirements for the project was established in consultation with Council. Discussions with Council indicated that water quality monitoring data for Narrabeen Creek is available from various sources and previous DAs undertaken within the nearby vicinity of the site, particularly by Marine Pollution Research. It is expected that this data would provide sufficient information to form baseline data for the site.

For the purposes of this project, we have allowed to undertake water quality monitoring at Narrabeen Creek at the following 3 locations (Figure 4):

- Just upstream of the proposed development site;
- An intermediate location (likely mid-point of the creek alignment through the subject site); and
- Just downstream of the proposed development site.

Monitoring will be undertaken at the following stages of the proposed works:

- Prior to commencement of construction;
- During construction; and
- After construction of the works, up to the occupation certificate.

It is proposed that the frequency of monitoring be as follows:

- At regular three-monthly intervals under dry weather conditions; and
- Supplemented by 3 wet weather events each year, where rainfall is predicted to exceed 20mm over a 24-hour period, if possible.

We propose to sample the following physico-chemical-biological parameters at each of the above locations, as part of the water quality monitoring plan:

- Temperature
- pH
- Electrical conductivity
- DO
- Turbidity
- Nutrients (oxidized nitrogen, ammonia nitrogen, total nitrogen, total phosphorus)
- Total suspended solids, and
- Faecal coliforms

Field observations will be recorded, including weather conditions, air temperature, cloud cover, wind direction, sample depth, sample appearance, water surface conditions, and noting any nuisance organisms.

Laboratory samples will be taken and transported to an analytical laboratory (NATA registered), as per standard sampling procedures.

The results of the sampling will be assessed against baseline water quality data available for the area and ANZECC Guidelines (2000). In the unlikely event that elevated physical, chemical or biological contaminant levels are observed during either the construction or operation phase of the project, mitigation options will be implemented to ensure that any potential adverse impacts on the downstream environment are minimized or rectified.

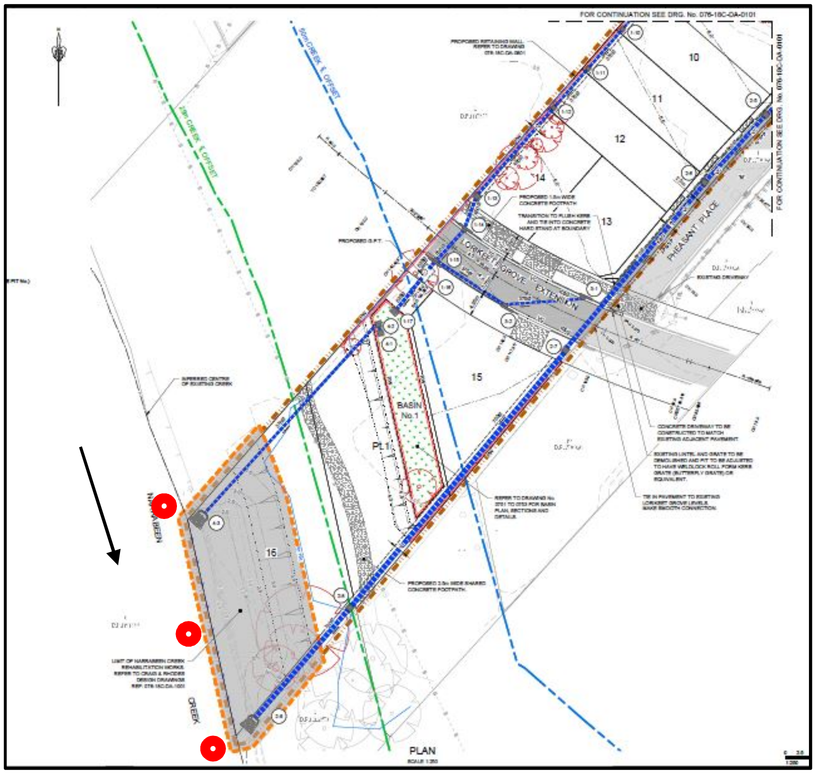


Figure 4 – Indicative Water Quality Sampling Locations

4 Stormwater Quality Management

Stormwater runoff from the development site undergoes two stages, the construction stage and the post-development stages. These two phases are handled with two different methodologies due to the unique loads each of them generates. These will be handled as required to meet a number of guidelines from various sources and requirements.

4.1 Construction Stage

During the bulk earthworks and construction phase of the development, sediment and erosion control facilities will be designed and constructed/installed in accordance with Council's specifications and requirements of the NSW DECC publication titled "Managing Urban Stormwater – Soils & Construction" January 2008.

A detailed sediment and erosion control plan will be prepared prior to construction, outlining the strategies proposed to prevent excessive pollutant loads being exported from the site in runoff during and immediately following construction. Refer Appendix 3 for sediment control and erosion plan and details prepared for the project Development Application.

A summary of the principle elements applied to the sediment and erosion control plan for the site is summarised below:

- Minimising the extent of disturbed surfaces as any one time through staging of works;
- Stabilising disturbed surfaces immediately following completion of works;
- Diverting clean runoff around disturbed areas via diversion mounds and channels;
- Protecting stockpiles via silt fencing or diversion bunds;
- Sediment control basin;
- Application of silt fencing on the downslopes of disturbed areas;
- Application of silt socks around drainage structures;
- Protection of exposed slopes;
- Restriction of construction vehicles to particular points of entry/exit locations; and
- Application of stabilised site access point sand vehicle wash down bays.

Details for the construction stages of the development have been documented indicatively as part of the DA plans and will be detailed further as part of the Construction Certificate documentation and managed ongoing through the construction process by the selected contractor.

4.2 Post-Development Stage

The proposed water quality treatment for the site consists of the following elements:

- On-lot rainwater tanks (3.0kL per lot) and associated internal & external reuse;
- Underground Gross Pollutant Trap (GPT); and
- Bio-retention Basin (estimated total surface area 185m^2)

An assessment of the post-development stage of proposed development has been carried out using MUSIC and is detailed in the following section of the report.

4.3 MUSIC Modelling (Post-Development)

The software package developed by the CRC for Catchment Hydrology termed "MUSIC" (Model for Urban Stormwater Improvement Conceptualisation) was used to assess the effectiveness of the proposed treatment under the following scenarios:

- Existing pre-development conditions
- Proposed post-development conditions (with treatment measures)

4.3.1 Catchments

For the purposes of water quality assessment, the total developable catchment of the site is approximately 0.5 hectares for both the existing pre-development and post-development scenarios. Each scenario has been separated into land-use catchments representative of the overall site. The summary of the catchment properties is outlined in the following table.

Catchment	Area (ha)	Impervious Fraction (%)
Pre-Development	0.504	5
Post-Development		
Roofed Catchment	0.147	100
Non-roofed Catchment	0.218	20
Roads	0.139	80
Overall Post-Development	0.504	60

Table 4 - MUSIC Catchment Summary

4.3.2 Rainfall & Evaporation

MUSIC models were prepared using Daily Rainfall data sourced from the Bureau of Meteorology station 066183 (Ingleside). This station has a mean annual rainfall of 1440 mm per year. The rainfall adopted for the models are outlined in Table 1 of this report.

Evaporation data for Sydney was sourced from the Bureau of Meteorology. This was combined with the rainfall data in the MUSIC models.

4.3.3 Soil Properties

The soil properties parameters for the MUSIC Source nodes adopted the default MUSIC/Duncan values.

4.3.4 Pollutant Loads

The Event Mean Concentrations adopted for the total suspended solids (TSS), total phosphorus (TP) and total nitrogen (TN) are based on the requirements of Council's WMS (Table 4.1). The EMC values applied to the MUSIC models are provided in the following table.

Land Use	Fraction Impervious	TSS EMC (mg/L)	TP EMC (mg/L)	TN EMC (mg/L)
Existing Site (Rural Residential)	5	35	0.10	1.00
Roof (Urban)	100	100	0.30	1.50
Ground (Urban)	20	100	0.30	1.50
Road (Urban)	80	100	0.30	1.50

Table 5 - Event Mean Concentrations

4.3.5 Treatment Objectives

A common and practical guideline that often applies throughout NSW is setting of the treatment objectives that are achievable using best practice. These best practice treatment objectives are provided in the following table.

Pollutant Elements	Treatment Reduction Targets
Gross Pollutants (GP)	90
Total Suspended Solids (TSS)	80
Total Phosphorus (TP)	65
Total Nitrogen (TN)	45

Table 6 - Best Practice Treatment Targets

However, it should be noted that the Northern Beaches Council (formerly Pittwater Council) Water Management Specification (WMS) clearly sets the requirement that all post-development loads must be equal to or less than the existing site conditions. Therefore, the outcomes of the MUSIC modelling shall comply with these requirements, but also compared against the treatment objectives outlined in Table 6.

4.3.6 Treatment Controls

<u>On-Lot Based Rainwater Tanks</u>

It is proposed to provide 3.0kL Rainwater Tanks for all future dwelling within the new subdivision. These tanks will reduce runoff volumes, maximise non-potable supply/reuse and reduce peak flows for more frequent storm events by capturing the majority of roof water runoff and re-using within each proposed lot. Roof runoff will be reused for toilet flushing, garden irrigation, car washing and cold water laundry.

Gross Pollutant Trap

The proposed GPT will be used to capture litter and coarse sediment from the majority of the site. This has been modelled in MUYSIC in accordance with capture rates determined in the report, *Removal of Suspended Solids & Associated Pollutants by a GPT* (Cooperative Research Centre for Catchment Hydrology, 1999). These capture rates are:

- Gross Pollutants – 95%
- Total Suspended Solids – 70%
- Total Phosphorus – 30%
- Total Nitrogen – 0%

The proposed GPT will be designed to treat all peak flows up to and include the 1 in 3-month ARI events. Preliminary calculation by Rocla have shown that a CDS Rocla 1018 or equivalent would be required for the subject site.

Bio-retention Basin

The proposed bio-retention basin will provide a number of functions for the development. These include stormwater quality improvement, ground infiltration, and stormwater detention. The bio-retention basin will consist of an above ground depression containing landscaping of native grasses and shrubs. This is constructed on top of an infiltration area with associated drainage. This infiltration zone typically features topsoil layers, filtration media, transition and gravel layers. Within the drainage gravel layer is subsoil drainage lines to collected filtered water which cannot enter ground water due to infiltration.

The basin levels have been primarily driven by the existing road levels of the adjoining development. The constraints of the neighbouring site have determined the subject site road levels and subsequent stormwater drainage design within the Lorikeet Grove extension. In compliance with Council's design guidelines for stormwater (i.e. min 1% grade of pipelines, suitable cover, etc.), the stormwater network design has been continued from the sag in Lorikeet Grove, to the proposed GPT unit and then to the inlet of proposed bio-retention basin.

For this development a basin with an estimated total surface and filter media area of 185m^2 will be constructed. The filtration media layer should have the following properties to meet the requirements the water quality management section of the Warriewood Valley Water Management Specification.

Extended Detention Depth (m)	Estimated Basin Surface Area Provided (m^2)	Filter Media Layer Depth (m)	Filter Media Infiltration Rate (mm/hr)
0.2	185	0.3	125

Table 7 - Bio-retention Media Properties

The invert of the basin filter media and drainage layer (R.L. 2.17m AHD) has been set above the estimated ground water conditions (R.L. 1.80 AHD) as per Council's requirements in Section 4.3.2 of the Warriewood Valley Water Management Specification. This ground water level was obtained from the borehole logs within the geotechnical report undertaken by Geotechnique Pty Ltd (Ref: 13234/1-AA) dated 15 Aug 2014.

4.4 <u>MUSIC Model</u>

The following figure is a screen capture from the MUSIC model showing the model configuration adopted for both the Water Balance and Water Quality modelling.

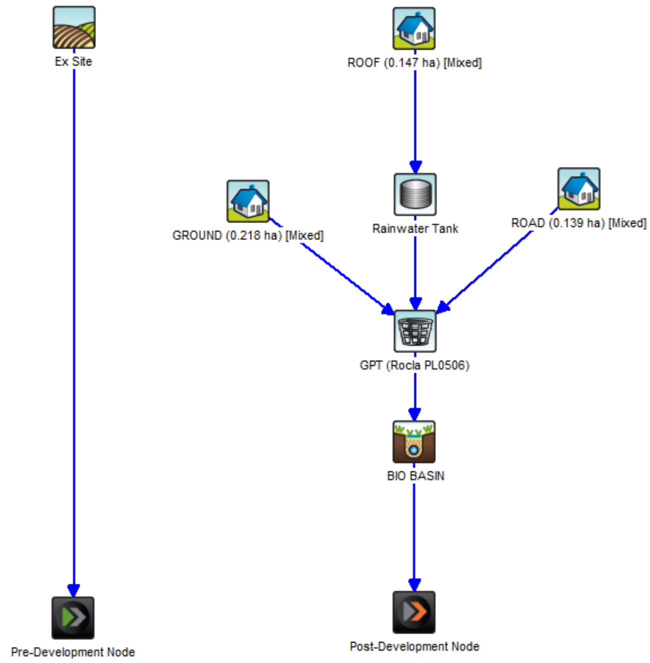


Figure 5 - MUSIC Model Layout

4.5 *MUSIC Modelling Results (Post-Development)*

The results form the MUSCI model comparing the post-development conditions with the pre-development conditions have been outlined in the following tables. It is evident that the stormwater quality complies with both the best practice treatment performance targets and the requirements outlined in the Warriewood Valley Water Management Specification for the three cases for rainfall, dry, average and wet.

Pollutant	**Pre-Development (kg / yr)**	**Post-Development (without treatment) (kg / yr)**	**Post-Development (with treatment) (kg / yr)**	**Warriewood WMS Reduction (%)**	**Best Practice Reduction (%)**
TSS	66	374	4.37	93.4	98.8
TP	0.189	1.13	0.117	38.1	89.6
TN	1.91	5.69	1.28	33.0	77.5
GP	10	86.2	0	100	100
Compliant with Best Practice Objectives				-	Yes
Compliant with Warriewood WMS Objectives				Yes	-

Table 8 - Low Rainfall Year (2002)

Pollutant	**Pre-Development (kg / yr)**	**Post-Development (without treatment) (kg / yr)**	**Post-Development (with treatment) (kg / yr)**	**Warriewood WMS Reduction (%)**	**Best Practice Reduction (%)**
TSS	99.2	510	5.95	94.0	98.8
TP	0.285	1.55	0.16	43.9	89.7
TN	2.92	7.84	1.76	39.7	77.6
GP	16.1	116	0	100	100
Compliant with Best Practice Objectives				-	Yes
Compliant with Warriewood WMS Objectives				Yes	-

Table 9 - Average Rainfall Year (1984)

Pollutant	Pre-Development (kg / yr)	Post-Development (without treatment) (kg / yr)	Post-Development (with treatment) (kg / yr)	Warriewood WMS Reduction (%)	Best Practice Reduction (%)
TSS	221	829	17.1	92.3	97.9
TP	0.634	2.52	0.353	44.3	86.0
TN	6.45	12.8	3.89	39.7	69.6
GP	22.1	125	0	100	100
Compliant with Best Practice Objectives				-	Yes
Compliant with Warriewood WMS Objectives				Yes	-

Table 10 - High Rainfall Year (1998)

4.6 Ongoing Requirements

Upon completion of the proposed development, the WMS requires ongoing monitoring and maintenance for the Stormwater Quality Improvement Devices constructed and installed as part of the subdivision.

Monitoring and maintenance of the stormwater treatment train shall include, but not limited to:

- Measurement of volume/mass of material removed from the GPT and an assessment of relative composition;
- Discrete sampling of stormwater at the inlet & outlet of the proposed bio-retention basin; and
- Qualitative assessment of effectiveness of other proposed water quality control measures.

All reporting shall conform to the requirements outlined in the WMS and forwarded to Council as required.

4.7 Mosquito Risk Assessment

The development does not propose to provide permanent waterbodies. As there are no proposed permanent waterbodies, the risk of mosquito activity is considered to be low.

There are two areas of potential concern in regards to mosquito activity. The stormwater drainage network for the development, and the creek corridor.

The stormwater drainage network consists of a pit and pipe network, with a bio-retention basin and gross pollutant trap. The stormwater network has been designed to drain and not provide areas for stagnant water to collect and allow mosquito and insects to breed. The combined bio-retention and on-site detention basin is not expected to detain stormwater for an extended period of time greater than a few hours. Provided the basin is designed, constructed and maintained in line with the industry best practices, there is minimal risk that the basin will act as a mosquito habitat.

The gross pollutant trap is a wet sump type device. This device will contain a small quantity of standing water, however the volume of the water which is contained underground is relatively small. Additionally, rainfall events will flush out the standing water and minimise the risk that the device will act as a mosquito habitat.

The lot-based rainwater tanks pose a minimal risk for mosquito breeding and habitat. Rainwater tanks must be adequately maintained with an emphasis on screening the inlets to the rainwater tank to prevents insects and pests from entering the tank.

The proposed creek corridor is being re-graded as part of the development. The proposed typical section for the creek corridor is shown on drawing **076-18C-DA-1003 Rev A** of the Narrabeen Creek Rehabilitation Works drawings.

The typical section proposed for the development side is to continually fall towards the creek centreline. As the section does not propose permanent pools of water along the creek line, the risk for mosquito forming habitats will be reduced. Natural depressions will form over time which may allow for mosquito habitats to form, however this is not unlike the existing natural site conditions. As a result of the proposed creek rehabilitation works, there will be no increase in mosquito activity from existing site conditions, however as the proposed channel will be formalised, it is expected that mosquito habitats will be reduced.

At this stage it is expected that there is a low risk of forming additional mosquito and insect habitats from what currently exists. It is expected that mosquito habitats will remain static or be reduced due to the proposed works.

A further mosquito risk assessment shall be undertaken as required during the Construction Certificate and Construction stages of the development to ensure that mosquito habitats are not encouraged or formed during the construction process.

5 Watercourse and Creekline Corridor Preservation/Restoration

The subject development has a frontage to Narrabeen Creek to the south-west where it is proposed to dedicate a portion of the site to Council as Public Reserve.

The Warriewood Valley Water Management Specification calls for a creek corridor of up to 100m wide. This is comprised of a 50m publicly owned corridor, with a 25m wide buffer held in private ownership outside of the 50m corridor.

The proposed works within the Narrabeen Creek are generally minimal and limited to reshaping of the creek bank as outlined in Section 4.4.4 of the Warriewood Valley Urban Land Release Water Management Specification (Refer to the Narrabeen Creek Rehabilitation Works drawings prepared by C&R, ref: **076-18C-DA-1001 – 1901 Revision A**).

6 Flood Storage

An assessment on flood storage for the development has been undertaken as the proposed works fill the existing floodplain. As per the requirements of the Warriewood Valley Water Management Specification, the filling of land will only be permitted if it can be demonstrated that there will be *'no net decrease in floodplain volume and no additional adverse impacts upon the surrounding sites'*.

A volume calculation was undertaken to determine the existing flood volume within the limits of the subject site under existing conditions during a 1% AEP storm event. A 1% AEP flood level of R.L. 4.308 AHD was adopted for this calculation based on the simulated existing case peak flood levels provided in the attached flood study (refer Appendix E). A total of 1,335m^3 of flood storage is present for the 1% AEP event under existing conditions.

The same assessment was carried out under proposed conditions, adopting the proposed subdivision design surface and the Narrabeen Creek rehabilitation works, and a 1% AEP flood level of R.L. 4.241 AHD as per the TUFLOW modelling referenced in the attached flood study (refer Appendix E). Under proposed conditions, a total flood storage volume of 1,345m^3 is available within the site extents, satisfying Councils requirements for no net decrease in floodplain volume.

7 Flood Protection

The subject site is primarily impacted by floodwater generated by Narrabeen Creek. Storm Consulting has undertaken a flood impact and risk assessment for the proposed development to accompany the DA documentation for the site. This report has been included as Appendix E of this report.

TUFLOW modelling has been carried out to assess the impact of the proposed development on flood levels within the catchment.

The following table is a summary of the peak flood levels for the post-development conditions. It should be noted that due to the relatively short frontage of the site to Narrabeen Creek, the flood levels reported are at the centre of the sites frontage with Narrabeen Creek.

Design Event (ARI)	Peak Water Surface Level (m AHD)
1 in 5-year	3.755
1 in 10-year	3.864
1 in 20-year	4.015
1 in 100-year	4.241
1 in 100-year + Climate Change	4.361
Probable Maximum Flood	5.359

Table 11 - Peak Water Surface Levels

The results of the modelling and assessment have confirmed the following:

- There are minimal off-site flood impacts at the 1% AEP event (limited to approximately ± 0.01m) and negligible impact on surrounding properties for the 1% AEP with Climate Change and PMF events;
- No additional flood prone lots are created within the proposed subdivision; and
- The vast majority of the development (including all of the allocated lots) are flood free during the PMF event.

The proposed subdivision development encroaches on the 1% AEP flood storage area within the site boundaries, however the proposed Narrabeen Creek rehabilitation works provides an offset in volume storage resulting in a small net increase in the overall 1% AEP flood storage volume on the site.

7.1 *NSW Office of Water*

A Controlled Activity Approval (CAA) is required from the NSW Office of Water as part of the detailed design phase prior to the issue of the Construction Certificate.

7.2 *Flood Planning Levels*

The proposed development shall set the habitable floor levels for lots within the development at 500mm (min.) above the 100yr + CC ARI creek flood levels (i.e. Flood Planning Level). The minimum proposed finished floor level height is to be set at RL 4.861m AHD, which is 0.5m above the 100yr + CC creek flood level. The current design earthworks levels within the developable lots allow for the finished building floor levels to be set at least 0.5m above the 100yr + CC flood level.

Note that no basement entries are proposed.

No interim flood protection measures were determined to be required for the site.

7.3 Flood Emergency Response

No flood warning or response plan will be required for the site given the small size of the upstream catchment. Additionally, all proposed lots in question shall have a 'shelter in place' strategy available during the PMF event, in most cases, the second storey level of the building notably for Lots 11-16. The period of inundation would be relatively short, being likely less than one hour and assistance for residents would therefore not be required.

A floodway sign shall be installed at regular intervals along the shared pathway which is subject to overtopping during larger flood events.

A handrail will also be installed along the edge of the shared path in accordance with the BCA and Council requirements.

For further details refer to Appendix E for the Storm Consulting Flood Assessment Report.

8 Stormwater Quantity Management

The proposed strategy for stormwater quantity management comprises of a series of pits and pipes collecting runoff generated by the development to convey flows to the proposed Water Quality and Detention basin located within the Residue lot to the south-west of Lorikeet Grove.

8.1 Hydrology

A DRAINS model was prepared to represent both the existing and proposed site conditions as illustrated in the following figure.

Figure 6 - DRAIN Layout

Event rainfall data was based on Australian Rainfall & Runoff 1987 methodology and Intensity-Frequency-Duration data obtained from the Bureau of Meteorology. This data is summarised in the following table:

Duration	2-year ARI	50-year ARI
1 hour	39.6	80.5
12 hours	8.9	17.5
72 hours	2.6	5.5
G = 0.0 F_2 = 4.30 F_{50} = 15.88		

Table 12 - Warriewood IFD Data

8.2 External Catchment

There is an external catchment to the north-east of the development site which discharges into an existing DN600 pipe running along the eastern boundary of the development. It appears, through visual inspection of the site, that this pipe ends at a surcharge pit approximately 40m into the site off Warriewood Road. It is understood that flows surcharging from this pit are conveyed overland within the existing drainage easement, and discharge into Narrabeen Creek.

A DRAINS model was prepared for this external catchment to determine the hydraulic impact on the development site, as well as ensuring that the proposed development does not impact on the existing site flows from this upstream catchment. The catchment plan for this external catchment is shown in drawing **076-18C-DA-0701-A** of the Civil Engineer drawings.

The DRAINS model indicates that the stormwater pipe network conveys flows from the upstream catchment, however overland flows from the catchment are contained within the carriageway of Warriewood Road and are conveyed to the sag adjacent to 45 Warriewood Road. The overland flow does not impact on the development site.

8.2.1 Proposed Works

It is proposed to replace the existing DN600 with a new pipeline along the eastern boundary to convey the upstream catchment through the development site to Narrabeen Creek. It is not proposed to connect this stormwater line to the internal site drainage network. This pipe will subsequently act as a bypass line, conveying upstream external flows through the subject site without impacting on the internal stormwater network or OSD system. The proposed alignment of the new pipe will follow the existing 1.825m wide drainage easement through proposed Lots 4 and 17, and then within the proposed road carriageway of Pheasant Place. Due to the hydraulic grade line of the proposed upgrade, it is proposed to provide “GATIC” type covers to ensure that flows within the pipe do not surcharge within the subdivision works before discharging into Narrabeen Creek.

8.3 Internal Catchments

The following table summarises the general parameters adopted for each of the catchments within the DRAINS model for both pre- and post-development conditions.

Parameter	Pre-Development Catchments	Post-Development Catchments
Total Catchment Area (ha)	0.58	0.60
Fraction Impervious (%)	5	Varies (50 – 80) Overall: 65 Refer DRAINS Model
Time of Concentration (min)	Impervious: 6 min Pervious: 10 min	Impervious: 6 min Pervious: 10 min

Table 13 - DRAINS Catchment Conditions

8.4 Post-Development (On-Site Detention)

To accommodate the change in imperviousness of the catchment as a result of the proposed development, it is proposed to provide a detention basin to assist with reducing peak flow rates to pre-development peak flow rates. The on-site detention basin has been combined with the proposed bio-retention basin to provide both a detention and temporary retention of stormwater runoff from the development.

In DRAINS, this has been modelled by introducing a basin node with outlet control. This configuration was determined through several iterations to optimise the design and ensure compliance with Council's stormwater management objective outlined in the Warriewood Valley Water Management Specification.

The following table provides a summary for the drainage modelling results for both the pre- and post-development scenarios of the development.

ARI Storm Event (years)	Pre-Development Flow – PSD (m^3/s)	Post-Development Basin Outflow (m^3/s)	Detention Volume Utilised (m^3)
2	0.129	0.129	
5	0.177	0.128	224.7
10	0.204	0.142	262.5
20	0.249	0.151	303.2
100	0.305	0.299	328.3

Table 14 - Site Discharge Summary

It can be seen that with the increase in imperviousness of the catchment, there is a significant increase in the post-development flow rates towards the detention basin. However, with the inclusion of the combined detention and water quality basin, the peak flow rates discharging from the site into Narrabeen Creek are equal to or lower than the pre-development flow rates.

9 Stormwater Drainage Concept Plan

The elements of the proposed stormwater drainage concept plan for the subject site are illustrated by the **Craig & Rhodes Drawings 076-18C-0001 - 0902 Revision A** and are summarised as follows:

- All roof water is firstly captured by rainwater tanks on each lot and then reused for toilet flushing, garden irrigation, car washing and laundry cold water;
- Impervious surface is restricted to maximize infiltration (limited to 65% impervious for the site area);
- Runoff leaving each lot then connects directly to Interallotment stormwater pits;
- A 20yr ARI plus 30% Climate Change (minor) capacity drainage system will convey all local site flows to the bio–retention/detention basin. Flows in excess of the 20yr ARI + CC and up to the 100yr ARI + CC (major) shall be conveyed by the road carriageway into the basin. All flows will then discharge to Narrabeen Creek;
- Local runoff will be treated in a single GPT near the basin outlet into the basin. The GPT will be located adjacent to the road reserve and have clear access for maintenance; and
- Outflows form the GPT will receive tertiary treatment in the bio-retention basin.

Stormwater detention measures are proposed, primarily in the form of free storage. These measures ensure flows generated by the site do not exceed those under existing conditions

Runoff water quality is proposed to be managed through a combination of treatment measures. These measures ensure post development stormwater loads generated by the site do not exceed those under existing conditions

No development structures are proposed within the site that do not comply with Council flood planning levels.

The proposed development generally complies with Council guidelines and achieves best practice standards in sustainability and stormwater management.

10 Maintenance Operations and Checklist

10.1 Maintenance Objectives

The stormwater quality devices constructed and occurring naturally within an urban environment suffer from a number of constraints placed upon them by disturbance within the upstream contributing catchment. Consequently, these structures will not be able to perform efficiently and continuously without regular maintenance.

Maintenance is required to increase the functionality of each design element and increases the aesthetic amenity and reduces public health and safety risks.

The purpose for this maintenance manual is as follows:

- To set out the procedures of maintenance operations and checklists whereby it can be maintained to a standard that ensure it remains operation in accordance with its original design objectives and intent;
- To provide a systematic monitoring and review procedures for the water quality devices, so that they will remain functionally effective as its original design throughout the design life of the structure.

An overall summary of the maintenance operations related to the stormwater quality improvement devices associated with the development are summarised in the following sections.

10.2 Signage

Signage outlining the nature of hazards and descriptions for the stormwater detention and water quality devices shall be inspected twice yearly for vandalism. Signs should be repaired or replaced as required.

10.3 On-Site Detention Basin

The On-Site Stormwater Detention (OSD) system is designed to temporarily store water during significant rainfall events so that stormwater runoff from the development does not have an impact on flooding downstream of the development. The ponding of water will occur but should not last for more than a few hours in most storms. If ponding persists, it is likely that maintenance is required.

The following schedule (Table 15) provides a guide to the timing of typical maintenance actions for an On-Site Stormwater Detention (OSD) System as well as defining the person responsible and describing the actions required.

Most components of the system should be checked for blockages after each significant storm to ensure that they continue to function effectively. The build-up of sludge and debris depends on the individual site and more frequent maintenance may be required where there are many trees, especially after windy conditions.

Item	Period	Responsibility	Maintenance Procedure
Inspection – Minor Maintenance	Six months and after major storms	Council / Maintenance Contractor	• Inspect pit and grate conditions
Inspection – Minor Maintenance	Six months and after major storms	Council / Maintenance Contractor	• Remove debris & accumulated sediment for disposal
Inspection – Minor Maintenance	Six months and after major storms	Council / Maintenance Contractor	• Inspect Berm for erosion
Inspection – Minor Maintenance	Six months and after major storms	Council / Maintenance Contractor	• Check signage for vandalism and repair as required
Inspection – Major Maintenance	1-2 years (except in case of oil spill)	Council / Maintenance Contractor	• Inspect pit and grate conditions. Evidence of cracking or spalling of concrete structures.
Inspection – Major Maintenance	1-2 years (except in case of oil spill)	Council / Maintenance Contractor	• Repair erosion downstream of basin outlet

Table 15 - On-Site Detention Basin Maintenance

Refer to Appendix B for a Maintenance Schedule.

10.4 Stormwater Pits & Pipes

Stormwater pits and pipes are designed to convey stormwater runoff during significant rainfall events so that surface flows are reduced to reduce inconvenience to users. Pits and pipes should minimise ponding of surface water but if ponding persists after rainfall events, it is likely that maintenance is required.

Pits and pipes should be checked for blockages after each storm event to ensure they continue to function effectively. The build-up of sludge and sediment depends on the upstream catchment and stormwater flows. More frequent maintenance may be required in areas where there is significant bare earth or heavy leaf litter material is conveyed in surface runoff.

In general, land managers could maintain pit and pipe systems where the depth is less than 1.2 metres. For pits deeper than 1.2m, experienced personnel with appropriate experience and qualifications (i.e. confined space training) should maintain the system.

Refer to Appendix B for a Maintenance Schedule.

10.5 Water Sensitive Urban Design

There is a number of WSUD devices proposed for this development that operate in a treatment train approach. The development runoff passes through a gross pollutant trap prior to discharging through a bio-retention basin planted with grasses and native plants. The recommended maintenance procedures by the manufacturers of these products are summarised in this section. The detailed maintenance procedure is included in the appendices.

10.5.1 Rocla CDS Gross Pollutant Trap (GPT)

Rocla CDS units have been proposed on low-flow pipe inlets to the bio-retention basin cells as per the C&R Engineering Drawings. These are offline to reduce the resuspension of pollutants that have been removed in previous storm events.

These units are to be cleaned and maintained on a quarterly basis and when it reaves 100% of its holding capacity (level reaches the top of the sump). Additionally, Rocla recommends that non-scheduled inspection shall be carried out after heavy weather and prolonged periods of rainfall within the catchment.

As per the Rocla Operational Manual provided in Appendix C, it is to be mechanically cleaned using a vacuum truck. During the inspection, any damage identified to the device shall need to be rectified to ensure that system maintains treatment performance as per the design intent.

Item	Period	Responsibility	Maintenance Procedure
Inspection – Minor Maintenance	Three months and after major storms	Council / Maintenance Contractor	Follow recommended procedure set out in the Manufacturer “Operation and Maintenance Guidelines”
Inspection – Major Maintenance	2-3 years (except in case of oil spill)	Council / Maintenance Contractor	Follow recommended procedure set out in the Manufacturer “Operation and Maintenance Guidelines”

Table 16 - Gross Pollutant Trap Maintenance

10.5.2 Bio-retention Basin

Following its construction, the bio-retention pond should be inspected every 1 to 3 months (and after each major rainfall event) during the initial vegetation establishment period to determine whether or not the bio-retention zone requires maintenance, or the media requires replacement. The following critical items should be monitored:

- Ponding, clogging and blockage of the filter media;
- Establishment of desired vegetation/plants and density; and
- Blockage of the outlet from the bio-retention system.

After the initial establishment period (typically 1 to 2 years), inspections may be extended to the frequencies shown in the maintenance frequency table below.

If the bio-retention system is not maintained frequently, the entire filter media may need to be replaced due to clogging of the media material with fine particles. This can result in frequent maintenance being more cost effective in the long-term.

The following maintenance activities will be required with inspection frequencies shown in Table 17 below.

- Maintenance of flow to and through the system;

- Maintaining the surface vegetation;
- Preventing undesired overgrowth vegetation/weeds from taking over the area;
- Removal of accumulated sediments; and
- Debris removal

The recommended maintenance frequency for the bio-retention pond is included in Table 17 below.

Item	Period	Responsibility	Maintenance Procedure
Inspection – Minor Maintenance	Three months and after major storms	Council / Maintenance Contractor	• Check for sediment deposition, oily or clayey sediment on filtration media • Remove depositions or sediment
Inspection – Minor Maintenance	Three months and after major storms	Council / Maintenance Contractor	• Check for erosion and scour of filtration media • Infill holes and repair erosion and scour
Inspection – Minor Maintenance	Three months and after major storms	Council / Maintenance Contractor	• Check for litter • Remove both organic and anthropogenic litter
Inspection – Minor Maintenance	Three months	Council / Maintenance Contractor	• Assess plants for disease and pest infestation • Check plants for signs of stunted growth or die off • Check original plant densities are maintained • Treat and replace plans as necessary
Inspection – Minor Maintenance	Three months	Council / Maintenance Contractor	• Check for presence of weeds • Manually remove weeds where possible or use spot treatment with herbicide appropriate for use near waterways
Inspection – Minor Maintenance	Six months and after major storms	Council / Maintenance Contractor	• Check underdrains are not blocked with sediment or roots • Clear underdrains as required
Inspection – Minor Maintenance	Three months and after major storms	Council / Maintenance Contractor	• Pit and grate conditions. Evidence of cracking or spalling of concrete structures.

Item	Period	Responsibility	Maintenance Procedure
Major Maintenance	Two years	Council / Maintenance Contractor	• In situ hydraulic conductivity testing • Replace transition layer and filtration media when hydraulic conductivity falls below Council acceptable limits

Table 17 - Bio-retention Basin Maintenance

10.6 Annual Review

An annual review of all stormwater drainage and water quality infrastructure should be carried out to record changes for the infrastructure over time. This should be in the form of photographs and documentation

10.6.1 Photographs

Monitoring should incorporate photography of the infrastructure to record changes. Annual photos should generally be taken at the same time of year from the same location.

10.6.2 Procedures

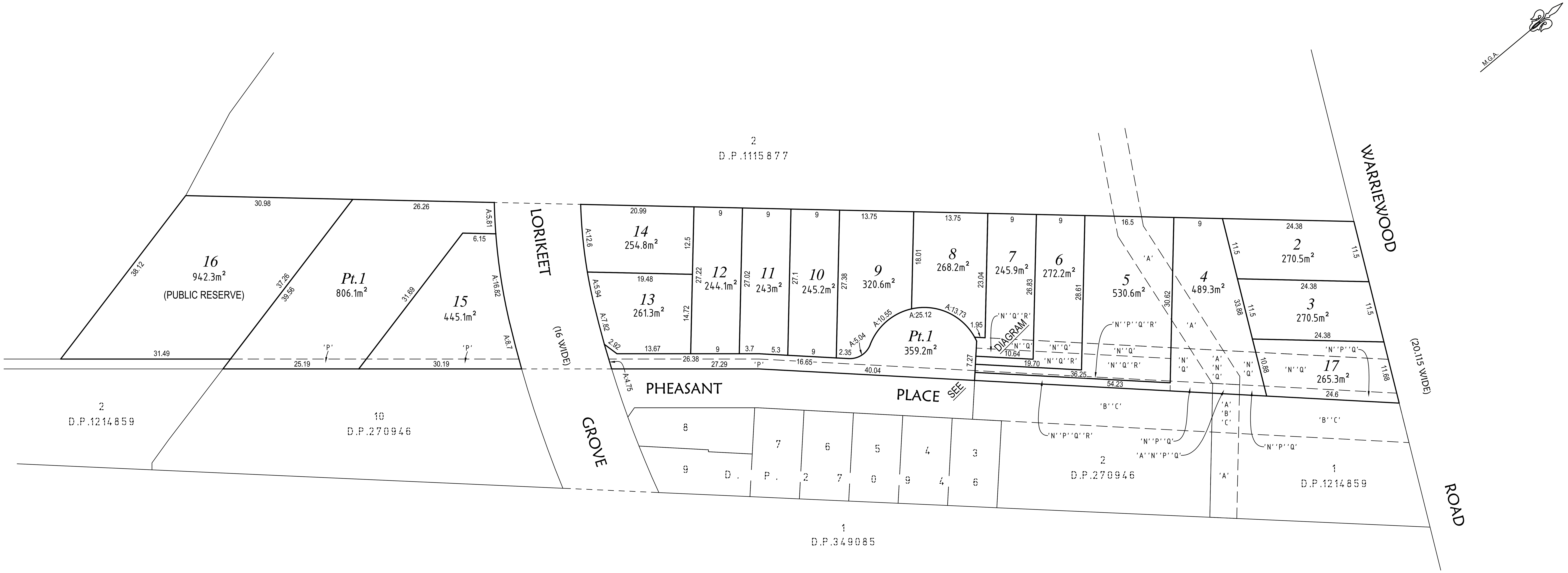
The monitoring and maintenance program should be reviewed each year to determine if the maintenance objectives are being fulfilled and to ensure that maintenance staff are finding that the maintenance program is adequate for performing maintenance tasks.

The yearly review should include and assessment of the maintenance database to determine the effectiveness of inspections, reporting mechanisms and scheduled maintenance tasks that are effective.

Information in the database should be assessed to determine whether any noticeable changes are evident in vegetation, bird usage of the basin, and operational efficiency of any structure. This will further provide indications as to whether sufficient information is being recorded for management purposes.

Appendix A – Lot Layout & Detailed Site Survey

A1



PLAN AFTER ACQUISITION OF LOT 3 D.P.942319

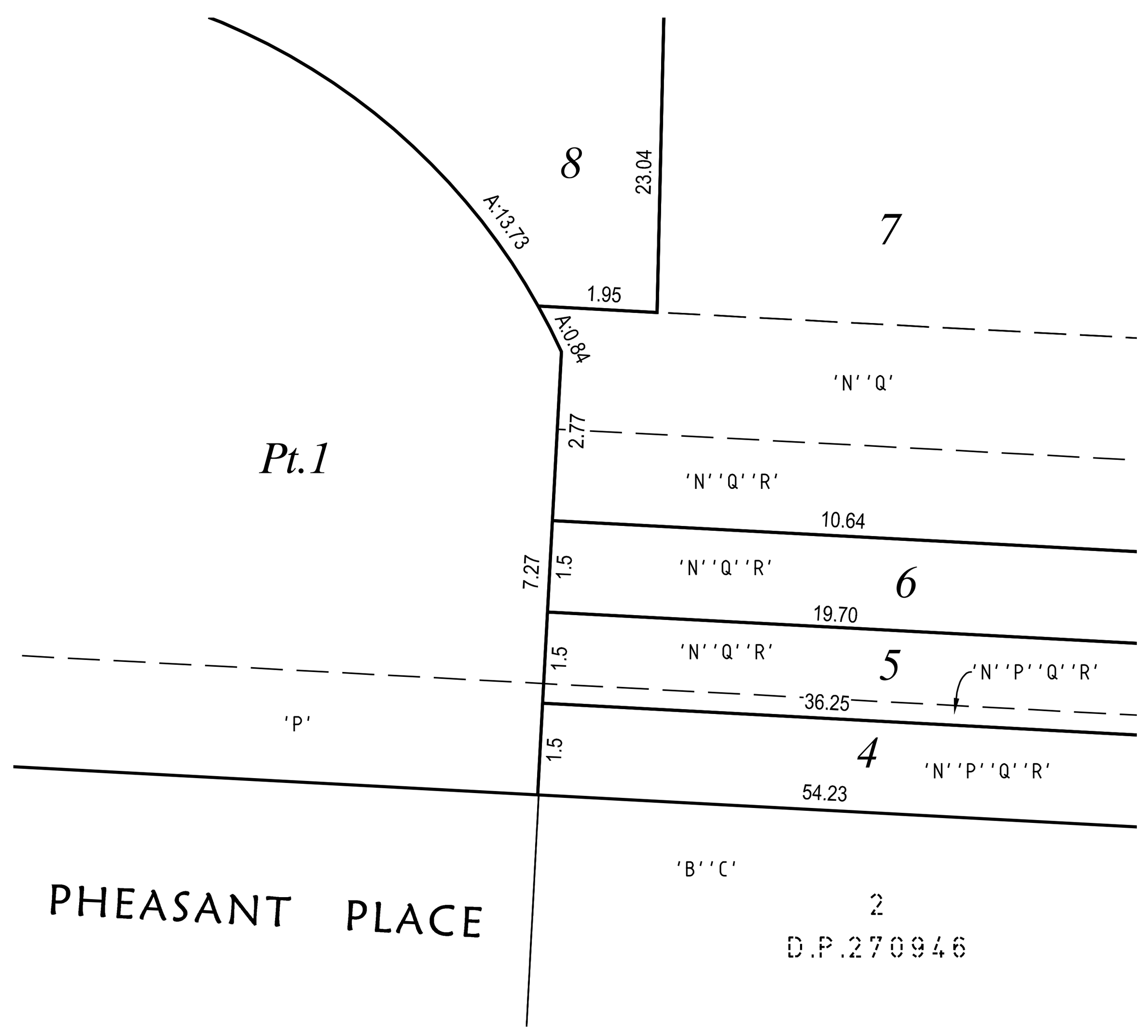


DIAGRAM
SCALE 1:100

'A' - EASEMENT FOR SEWAGE PURPOSES 5 WIDE VIDE D.P.6771995
'B' - EASEMENT FOR ACCESS 7.2 WIDE VIDE D.P.1214859
'C' - EASEMENT FOR ACCESS 7.2 WIDE VIDE D.P.1214859
'N' - PROPOSED RIGHT OF ACCESS 8 WIDE (TEMPORARY)
'P' - PROPOSED EASEMENT TO DRAIN WATER 1.825 WIDE
'Q' - PROPOSED EASEMENT FOR SERVICES 8 WIDE
'R' - RIGHT OF ACCESS 6 WIDE

NOTE:

PLAN **NOT** FOR NSW LRS INVESTIGATION

PRELIMINARY PLAN ONLY LOT DIMENSIONS AND AREAS SUBJECT TO SURVEY & REGISTRATION OF THE FINAL PLAN AT NSW LRS

PROPOSED EASEMENT LOCATIONS ARE **INDICATIVE ONLY** & SUBJECT TO DEVELOPMENT CONSENT, DETAILED DESIGN, CONSTRUCTION, SURVEY & REGISTRATION OF THE FINAL PLAN AT NSW LRS

1:100 @ A1

1:400 @ A1

AMEND. No.	DATE	DETAILS
03	15/03/2019	LOT 7 & 8 BOUNDARY ADJUSTMENTS
02	14/03/2019	PRINCIPAL AMENDED
01	13/03/2019	LOTS 4 - 8 AMENDED
00	06/03/2019	LOT LAYOUT ISSUE

DIAL 1100 BEFORE YOU DIG

APPROVED COMPANY AS/NZS 4801 OH&S Management System QMS Certification Services

APPROVED COMPANY ISO 14001 Environmental Management System QMS Certification Services

APPROVED COMPANY ISO 9001 Quality Management Systems QMS Certification Services

Project:
PLAN OF SUBDIVISION
OVER PART LOT 3 D.P.942319 & LOT 3 D.P.1115877
53A & 53B WARRIEWOOD ROAD, WARRIEWOOD

Principal: LEGENDWAY PTY LTD			
Scale 1:400 1:100	Date 6/3/2019	Council Ref.	
	Datum A.H.D.	L.G.A. NORTHERN BEACHES	
Calc's B.M.	Drawn. A.K.P.	Proj.Man. J.B.	Client Ref:

CRAIG& RHODES
TAKE THE LEAD

ABN 77 050 209 991 ACN 050 209 991
Suite 701, Level 7, 3 Rider Boulevard,
Rhodes, NSW, 2138
PO Box 3220, Rhodes NSW 2138
Tel. 9869-1855
reception@crhodes.com.au
www.craigandrhodes.com.au

Our Ref. 076-18
Dwg File Ref. [Rev] - Sheet Ref.
076-18G L01 [03]
- PLAN

Survey Notes:-

Location of structures approximate only.

The levels and details on this plan have been determined by stadia methods and are within the general accepted accuracies for such surveys. All set out levels must be referred to the bench mark.

Bearings and Distances are by deed only and are subject to Final Survey. Except where shown by dimension, the relationship of improvements to boundaries is diagrammatic only. The true positions are subject to Final Survey.

Tree sizes are estimates and indicative only.

Services and utilities shown have been located by physical evidence and/or by reference to service plans from the relevant authorities. Subsurface utility information shown in accordance with AS5488-2013 QL-D. Pits may not have been opened to verify the type of utility. Excavation has not been carried out to confirm underground location. Service details should be confirmed with the relevant service authority during design and prior to commencement of construction.

As part of your duty of care, please contact the following where necessary :-

Ausgrid	Ph. 131535
Dial Before You Dig	Ph. 1100
Endeavour Energy	Ph. 131081
Jemena Gas Company	Ph. 131245
NBN	Ph. 1800 881 816
Optus Communications	Ph. 1800 505 777
Sydney Water	Ph. 132092
Telstra Corporation	Ph. 132203

This plan has been prepared for the exclusive use of the principal as listed in the title block.

Any construction on or near the boundaries will require further survey so that marks defining boundaries can be placed.

All set out levels must be referred to the bench mark.

AMEND. No. 00 DATE 20/09/2018 DETAILS FIRST ISSUE

DIAL BEFORE YOU DIG (DBYD) SEARCH DATED 9/08/2018

ORIGIN OF LEVELS: S.S.M.24840 R.L.13.902 A.H.D. VIDE SCIMS DATED 7/08/2018

APPROVED COMPANY AS/NZS 4801 OH&S Management System | APPROVED COMPANY ISO 14001 Environmental Management System | APPROVED COMPANY ISO 9001 Quality Management Systems

Project: DETAIL SURVEY
OVER LOT 3 D.P.1115877 AND LOT 3 D.P.942319
No.53B WARRIEWOOD ROAD,
WARRIEWOOD NSW

Principal:	ZYPT PTY LTD				
Scale	1:200	Date	20/09/2018	Council Ref.	
		Datum	A.H.D.	L.G.A.	NORTHERN BEACHES
Calc's	S.P.	Drawn.	K.S.	Proj.Man. B.M.	Client Ref:

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Dwg File Ref. [Rev] - Sheet Ref.
076-18G T01 [00]
- SHEET 01 OF 03

'A' - EASEMENT TO DRAIN WATER (VIDE AC717367)
'D' - EASEMENT FOR DRAINAGE OF WATER 1.5 & 7.2 WIDE (VIDE D.P.1214859)
'E' - EASEMENT FOR DRAINAGE OF WATER 1.5 WIDE (VIDE D.P.1214859)
'F' - RIGHT OF FOOTWAY 2.5 WIDE (VIDE D.P.270946 DOC.1)
'N' - RIGHT OF FOOTWAY 1.5 WIDE (VIDE D.P.270946 DOC.1)

1:2000 @ A1
1:200 @ A1

AMEND. No. 00 DATE: 20/09/2018 DETAILS: FIRST ISSUE

DIAL BEFORE YOU DIG (DBYD) SEARCH DATED 9/08/2018

APPROVED COMPANY AS/NZS 4801 OH&S Management System
APPROVED COMPANY ISO 14001 Environmental Management System
APPROVED COMPANY ISO 9001 Quality Management Systems

Project:
DETAIL SURVEY
OVER LOT 3 D.P.1115877 AND LOT 3 D.P.942319
No.53B WARRIEWOOD ROAD,
WARRIEWOOD NSW

ORIGIN OF LEVELS: S.S.M.24840 R.L.13.902 A.H.D. VIDE SCIMS DATED 7/08/2018

Principal: ZYPT PTY LTD			
Scale 1:200	Date 20/09/2018	Council Ref.	
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Calc's S.P.	Drawn. K.S.	Proj.Man. B.M.	Client Ref:

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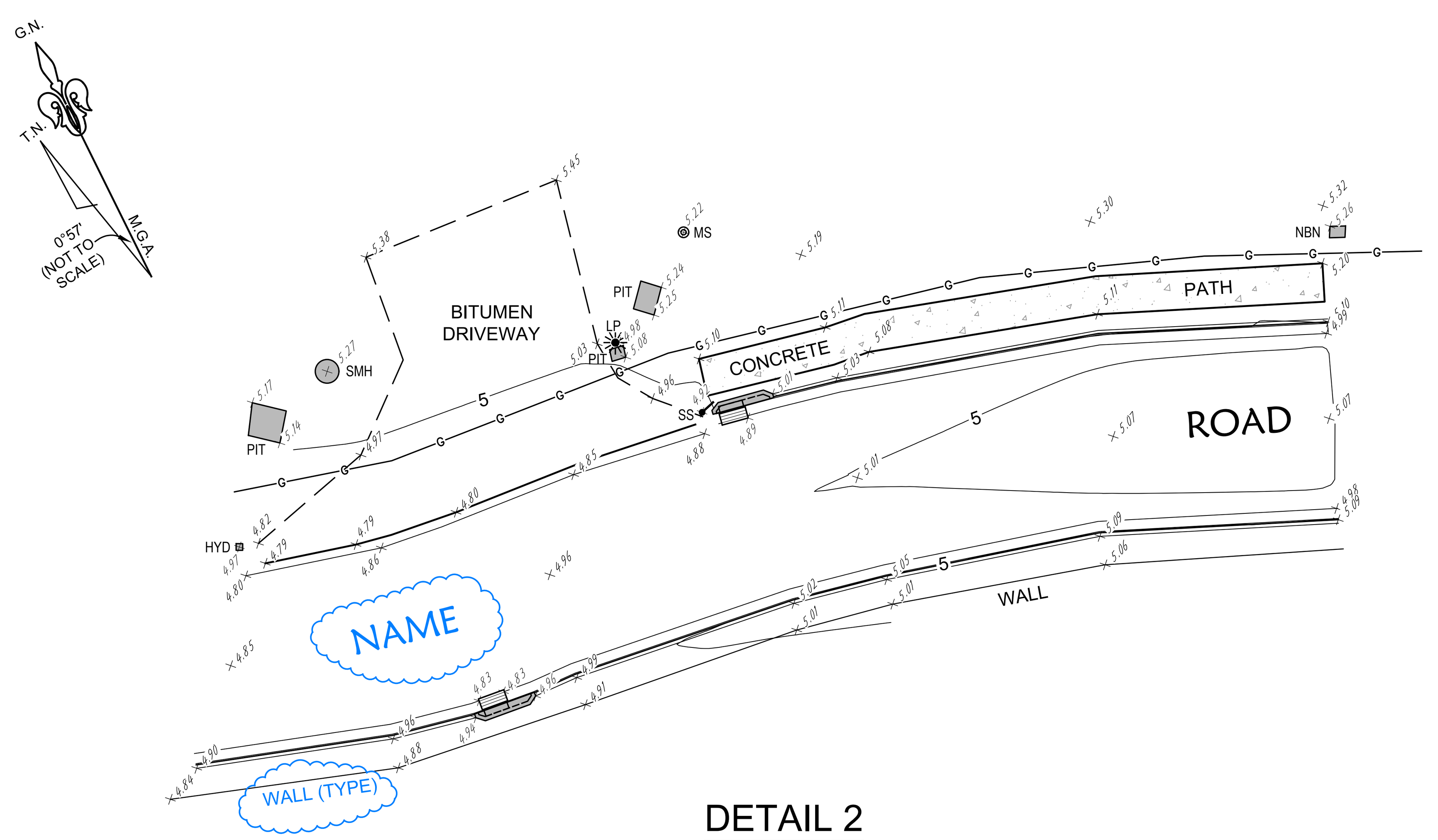
Our Ref. 076-18
Dwg File Ref. [Rev] - Sheet Ref.
076-18G T01 [00]
- SHEET 02 OF 03

A1



DETAIL 2

SCALE 1:200

REFER TO SHEET 2 FOR LEGENDS

1:200 @ A1

AMEND. No.: 00 DATE: 20/09/2018 DETAILS: FIRST ISSUE

DIAL BEFORE YOU DIG (DBYD) SEARCH DATED 9/08/2018

ORIGIN OF LEVELS: S.S.M.24840 R.L.13.902 A.H.D. VIDE SCIMS DATED 7/08/2018

DIAL 1100 BEFORE YOU DIG

APPROVED COMPANY AS/NZS 4801 OH&S Management System — QMS Certification Services

APPROVED COMPANY ISO 14001 Environmental Management System — QMS Certification Services

APPROVED COMPANY ISO 9001 Quality Management Systems — QMS Certification Services

Project:
DETAIL SURVEY
OVER LOT 3 D.P.1115877 AND LOT 3 D.P.942319
No.53B WARRIEWOOD ROAD,
WARRIEWOOD NSW

Principal: ZYPT PTY LTD			
Scale 1:200	Date 20/09/2018	Council Ref.	
	Datum A.H.D.	L.G.A. NORTHERN BEACHES	
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Our Ref. 076-18

Dwg File Ref. [Rev] - Sheet Ref.

076-18G T01 [00]
- SHEET 03 OF 03

Appendix B – Maintenance Schedule

On-Site Detention Basin

Item	Period	Responsibility	Maintenance Procedure
Inspection – Minor Maintenance	Six months and after major storms	Council / Maintenance Contractor	• Inspect pit and grate conditions
Inspection – Minor Maintenance	Six months and after major storms	Council / Maintenance Contractor	• Remove debris & accumulated sediment for disposal
Inspection – Minor Maintenance	Six months and after major storms	Council / Maintenance Contractor	• Inspect Berm for erosion
Inspection – Minor Maintenance	Six months and after major storms	Council / Maintenance Contractor	• Check signage for vandalism and repair as required
Inspection – Major Maintenance	1-2 years (except in case of oil spill)	Council / Maintenance Contractor	• Inspect pit and grate conditions. Evidence of cracking or spalling of concrete structures.
Inspection – Major Maintenance	1-2 years (except in case of oil spill)	Council / Maintenance Contractor	• Repair erosion downstream of basin outlet

Gross Pollutant Traps

Item	Period	Responsibility	Maintenance Procedure
Inspection – Minor Maintenance	Six months and after major storms	Council / Maintenance Contractor	Follow recommended procedure set out in the Manufacturer “Operation and Maintenance Guidelines”
Inspection – Major Maintenance	2-3 years (except in case of oil spill)	Council / Maintenance Contractor	Follow recommended procedure set out in the Manufacturer “Operation and Maintenance Guidelines”

Bio-retention Basin

Item	Period	Responsibility	Maintenance Procedure
Inspection – Minor Maintenance	Three months and after major storms	Council / Maintenance Contractor	• Check for sediment deposition, oily or clayey sediment on filtration media • Remove depositions or sediment
Inspection – Minor Maintenance	Three months and after major storms	Council / Maintenance Contractor	• Check for erosion and scour of filtration media • Infill holes and repair erosion and scour
Inspection – Minor Maintenance	Three months and after major storms	Council / Maintenance Contractor	• Check for litter • Remove both organic and anthropogenic litter
Inspection – Minor Maintenance	Three months	Council / Maintenance Contractor	• Assess plants for disease and pest infestation • Check plants for signs of stunted growth or die off • Check original plant densities are maintained • Treat and replace plans as necessary
Inspection – Minor Maintenance	Three months	Council / Maintenance Contractor	• Check for presence of weeds • Manually remove weeds where possible or use spot treatment with herbicide appropriate for use near waterways
Inspection – Minor Maintenance	Six months and after major storms	Council / Maintenance Contractor	• Check underdrains are not blocked with sediment or roots • Clear underdrains as required
Inspection – Minor Maintenance	Three months and after major storms	Council / Maintenance Contractor	• Pit and grate conditions. Evidence of cracking or spalling of concrete structures.
Major Maintenance	Two years	Council / Maintenance Contractor	• In situ hydraulic conductivity testing • Replace transition layer and filtration media when hydraulic conductivity falls below Council acceptable limits

Appendix C – Rocla Operational Manual

OPERATION AND MAINTENANCE MANUAL

DATE

CDS UNIT MODEL

PROJECT NUMBER

SITE ADDRESS

INSTALLER;

CDS UNIT OWNER

CDS Technologies is part of the Rocla Pipeline Company.
ABN 31000032191 www.rocla.com.au
72 Orchardleigh Street, PO Box 748 GUILDFORD NSW 216
Telephone (02) 8724 2861 Facsimile (02) 8724 2862

Contents

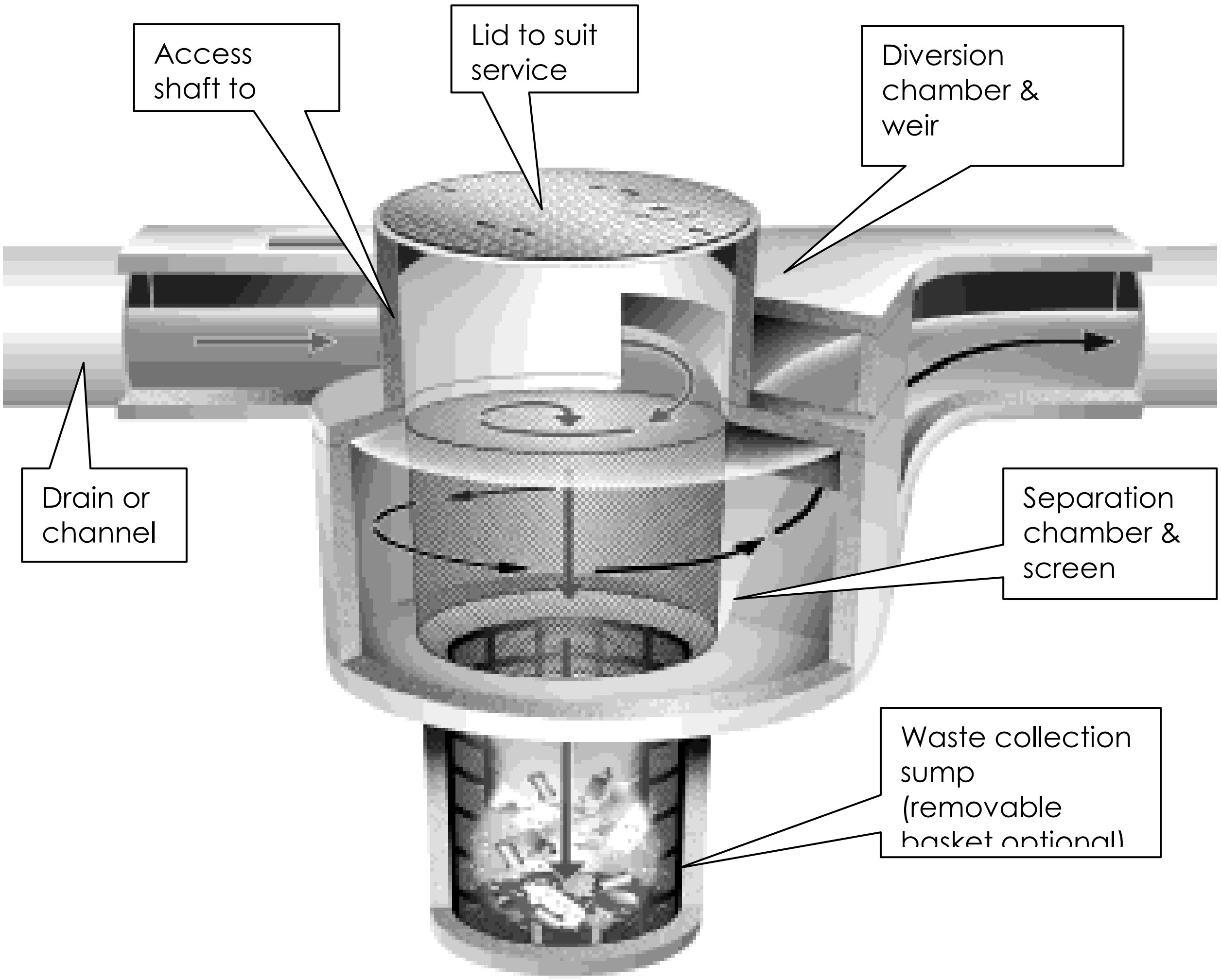
1 Preamble

1.1 CDS Technologies has been established to provide a cost-effective way to achieve environmental sustainability in water quality. The company is committed to its Clients and the environment, however its focus is on the development, manufacture, construction, installation, maintenance and repair of the CDS units.

1.2 The CDS owner may opt to perform their own cleaning or contract the cleaning to a pre-qualified contractor. Pre-qualified contractors are approved by CDS Technologies to perform inspections and cleaning in conformance with CDS Technologies Specification. They have demonstrated that they can meet all safety and environmental legislation and are adequately insured. These contractors can provide very competitive rates, provide valuable feedback on the CDS operation and will take the worry and effort out of the maintenance process.

1.3 Definitions

CDS For simplicity, the letters CDS will be taken to mean a CDS unit.



2 Inspections

2.1 Routine Inspections

2.1.1 Routine inspections are recommended to ensure the CDS is functioning correctly and indicate when cleaning is necessary. These should be carried out on a regular monthly basis. Additionally, it is recommended that a non-scheduled inspection be carried out after any heavy downpour or prolonged period of wet weather. These inspections are the responsibility of the CDS unit owner, unless other arrangements have been made with CDS Pty Ltd. Due to the efficiency of the CDS design, it is likely that they will collect large quantities of pollutants during significant rainfall events. Inspections after heavy rain are therefore even more important than scheduled inspections.

2.1.2 The routine inspection involves removing the access hatch in the CDS main lid and visually checking the visible part of the screen, the percentage of water surface occupied by floatables and measuring the level of accumulated debris in the sump.

2.1.3 This level can be calculated using a survey staff or weighted string line, by measuring the distance from the estimated top of the debris to the top of the lid. A chart is provided on the data sheet that allows the depth measurement to be converted into a percentage full. The data sheet is located in Appendix D. CDS can also provide simple Excell spreadsheet programs for constructed units on request.

2.1.4 When the accumulated material reaches the level of the top of the sump (100% full), it is recommended that it be emptied.

2.1.5 Should the trapped material be allowed to accumulate and rise into the separation chamber, i.e. above the bottom of the screen, the efficient operation of the unit will be compromised with subsequent flows possibly leading to screen blockage.

2.1.6 A standard report for a routine inspection is shown at Appendix A. This should be faxed to the CDS unit owner and CDS Technologies head office. This information helps in future CDS unit sizing and cleaning frequency estimations.

2.1.7 CDS Technologies should be informed if there is any damage or non-functionality observed with the CDS through the completion and forwarding of the 'Damage and Non-Functionality Report' included in Appendix A.

2.2 Annual Inspection

2.2.1 CDS recommends Annual Inspections involving dewatering the unit and checking the condition of the screen, area behind the screen , diversion chamber , weir, lids and any special features of the unit (Baskets can be excluded from this because they can be inspected at every cleanout).

2.2.2 The Damage or Non-Functionality Report (Appendix C) can be used to record any damage or wear and tear that will require attention.

2.2.3 This is also a good opportunity to apply grease to the frame of any cast iron lids and/or lubricate padlocks.

3 Recommended Cleaning Methods

3.1 There are several factors influencing the choice of cleaning method, the main factor being CDS unit size. Other factors include access, equipment availability, required frequency, cost any restrictions, eg units in tidal locations cannot generally be cleaned by eduction.

Unit Size (Screen Diameter mm)	Recommended Cleaning Method	Comments
500 (PL0506)	Suction	Unit not designed for basket; total volume of water and waste is well within range of standard eduction equipment
700 (P0708 series)	Suction	Unit not designed for basket; total volume of water and waste is well within range of standard eduction equipment
900 (P1000 Series)	Suction/basket	Suction is the most cost-effective method.
1500 (P1512 series)	Suction/basket	Suction is the most cost effective method.
2000 (P2000 series)	Suction/basket/ grab	Grab is the most cost effective method.
3000 (P3000 series)	Suction/grab	Grab is the most cost effective method.

3.2 The basket is available for purchase from CDS Technologies and consists of a fabricated fibreglass and steel lifting ring supporting a reinforced fabric basket and connected by SWR slings and shackles. The basket has stainless steel quick-release closures and buckles. A basket is preferred in units which are below low tide or where other methods are not feasible.

3.3 The following chapters detail procedures for each of the recommended methods with illustrations, and include safety information and related regulations.

4 Basket Cleaning

The following is a recommended procedure for emptying the CDS unit fitted with an optional collection basket (this procedure is shown in Figure 4.1). See also Hazard Analysis at Section 4.8.

For units fitted with an Oil Baffle the Oil must be removed using the methodology for Eduction Cleaning prior to the removal of the basket process. See Section 5.

4.1	Remove lid(s) from access chamber	CDS units in trafficked areas (roadways) are fitted with load-class lids (Gatic). The lids are usually multi-part and have tapered edges. Special lifting levers are required to remove them. Larger units in trafficked areas may have RSJ beams to support the lid structure. These also must be removed. If the lifting tackle for the basket is hanging from the RSJ, it must be disconnected and temporarily connected to the inside of the access shaft while the RSJ is removed. CDS units in non-trafficked areas (parks or reserves) may be constructed from fibreglass, galvanised steel or timber and may be single or of multi part construction. Fibreglass lids on models F0908/0912 can be easily removed by hand after unlocking with a T bar key. Galvanised and timber lids have adequate lifting points to assist in removal by crane. When working in a roadway, utilise appropriate traffic control measures. For safety reasons, any staff working over the open unit should wear a safety harness tied back to an immovable object.
4.2	Connect lifting tackle	Subject to access, the following crane capacities should be adequate to lift full baskets from the sumps of CDS units. The estimate of the full basket weight can be obtained from the CDS unit Data Sheet. 900mm CDS — 5 tonne capacity crane minimum 1500mm CDS — 8 tonne capacity crane minimum 2000mm CDS — 12 tonne capacity crane minimum 3000mm CDS — 15 tonne capacity crane minimum The crane needs to be able to raise the bottom of the basket, which is up to 7 metres below the lifting ring, over the side of the truck being used to transport the waste. The crane should be located on suitably firm ground and

operated by a qualified crane operator and guided by a qualified dogman. All staff on the ground in the vicinity of the unit should wear hard hats.

The lifting ring, which is temporarily attached to the side of the CDS, is to be attached to the crane hook.

4.3 Lifting the basket

If the unit is especially full or there is a great deal of floating material on the surface, it is recommended that the basket be raised slowly to reduce turbulence in the separation chamber which can wash floatable items over the rim of the basket.

Floating material should be pushed towards the centre to ensure it is caught as the basket rises. If some floating material remains in the CDS unit, it will likely be removed next time or it is possible to create a backwash by "dunking" the basket under the surface and quickly back up again. If the basket is found to have a significant amount of material "nesting" on the lifting collar, it is recommended that this material be pushed down into the basket using a broom, rake, shovel or staff before removing the basket completely from the unit.

With the bottom of the basket raised above the water level, allow water to drain back into the CDS unit for a few minutes.

Lift and place basket into truck and allow it to settle to relieve tension in securing straps. Release the Quick-release couplings that hold the basket closed.

Raise basket and allow contents to discharge into truck.

Lower basket and remove any trapped contents. If material is tangled in lifting slings, remove it.

Waste should not be handled unless appropriate protective gloves are worn.

Close basket and secure straps with Quick-release couplings. Place and position basket back in the CDS unit. It is sometimes advisable to weight the basket with two or three bricks to prevent the fabric from billowing up.

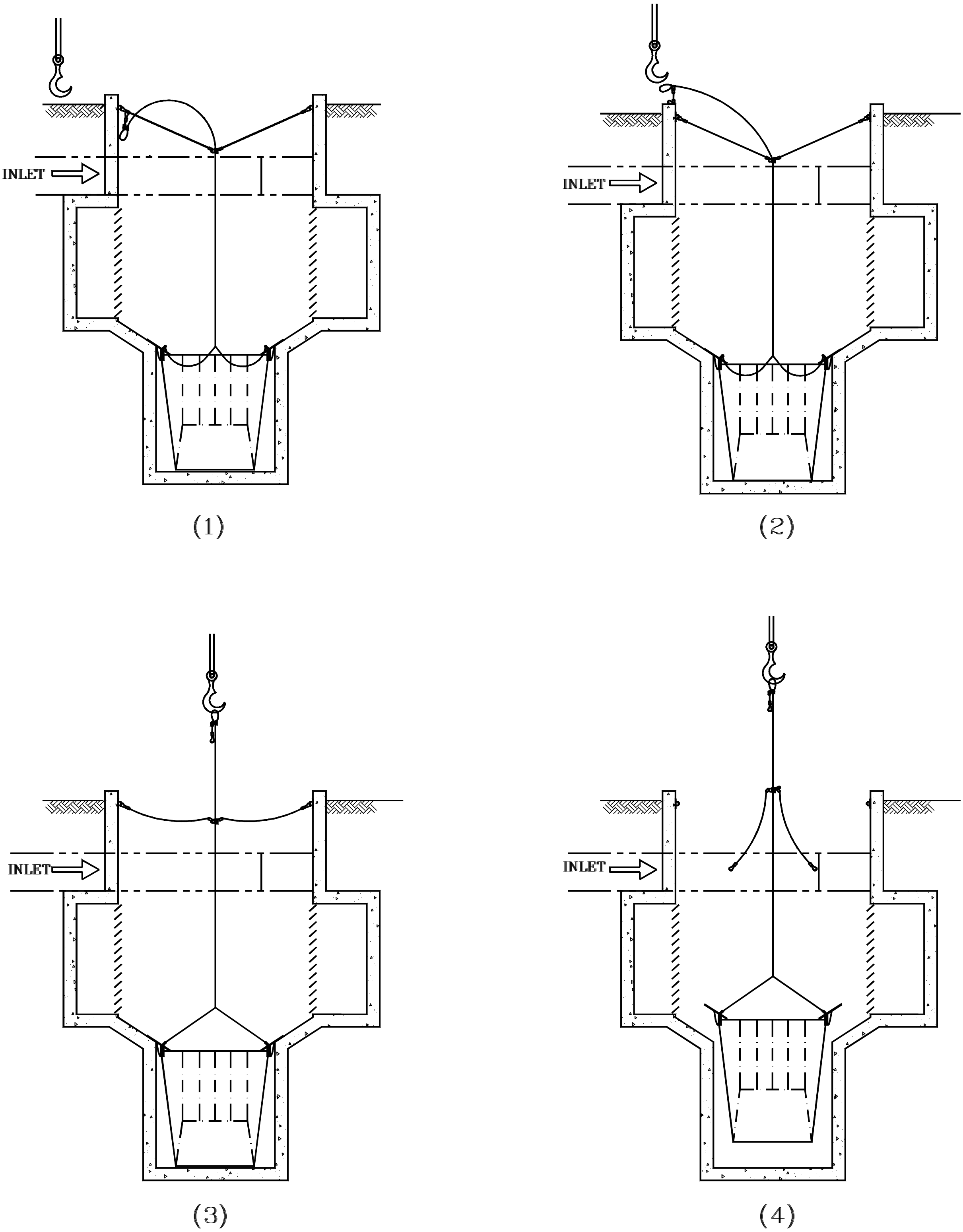
Check the separation screen for blockage or damage. Any material caught on the screen should be hosed or scrubbed off with a hard-bristle broom.

A significant quantity of material blocking the screen can be regarded as evidence of non-functionality and reported to CDS Technologies. If any damage is apparent, it should be reported to CDS as soon as practicable to enable a site inspection to be done. The phone number is listed on the CDS Data Sheet.

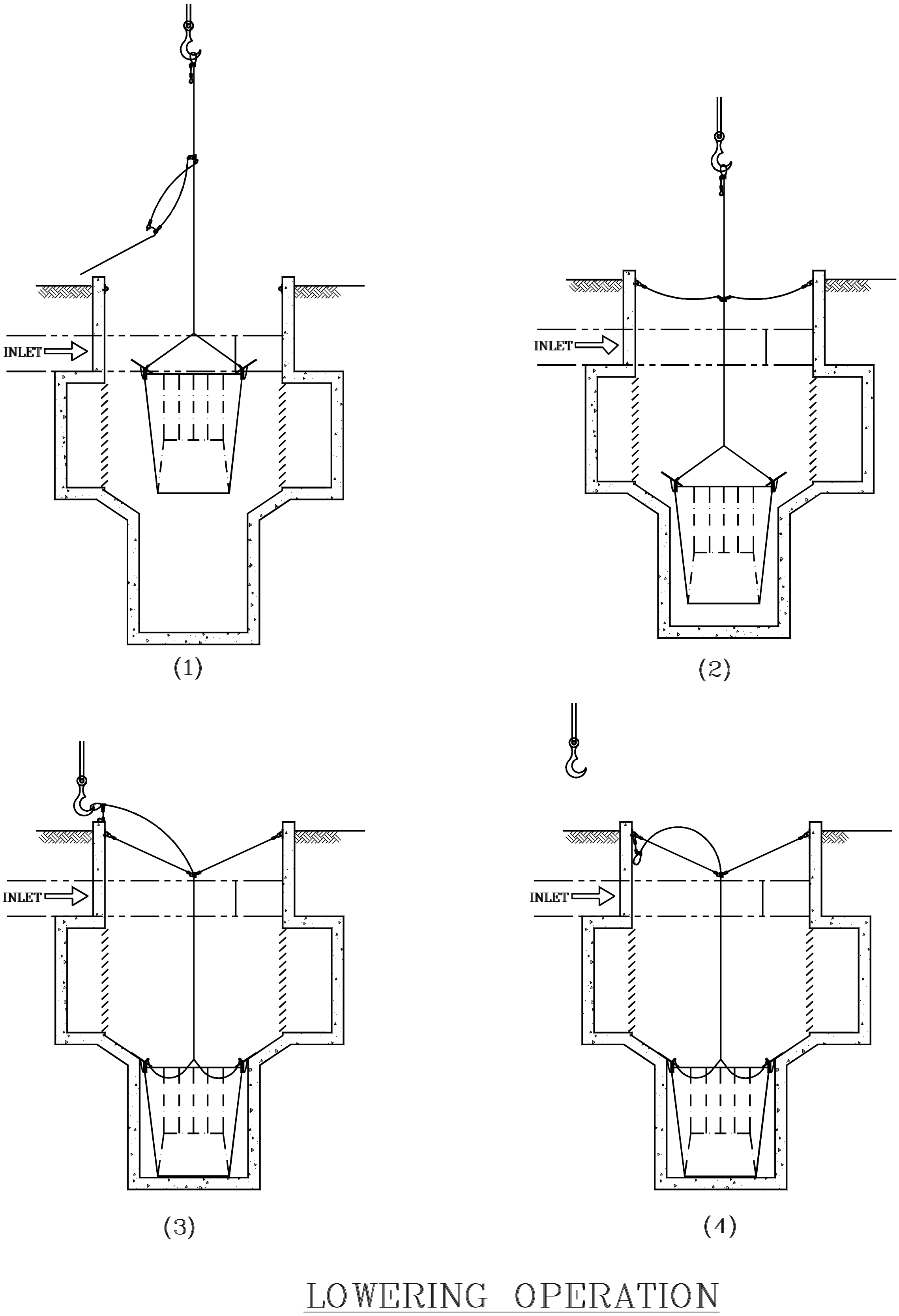
Replace lifting tackle and lids to their normal position.

NB It is important that the lifting cable hangs vertically down from the centre of the lid so as not to impede the circular flow of water in the CDS.

4.4	Disposal of Pollutants	Record the quantity of pollutants removed from the CDS with a visual assessment of the breakdown by type: • % silt and sediment • % litter • % vegetation A note should be made of any unusual or large items, eg. oil, paint, car tyres etc. Dispose of pollutant material at an approved tipping site, ie. a tip which is licensed by the Waste Authority in the relevant state. A record of the weight of the material extracted should be kept. The weight may be read by the crane, or the weigh station as the disposal truck enters the tip. The weight should be recorded on the CDS Cleanout Report (Appendix B). Care should be taken to: Cover the load en-route to the tip and to ensure that none of the litter from the load escapes from the truck. Adequately drain the material before leaving the site.
4.5	Tidy Site	Tidy the site of any debris prior to leaving.
4.6	Complete and Forward Cleaning Report	Complete Cleaning Report (Appendix B) and forward to the CDS unit owner. If there is any damage or non-functionality, complete Damage or Non-Functionality Report (Appendix C) and forward to the CDS Contact Person listed on the CDS Data Sheet.
4.7	Annual Clean and Inspection	On an annual basis the CDS should be pumped down as described in the section on Suction Cleaning, the basket removed, the sump pumped out and thoroughly cleaned of any debris that may have accumulated under the basket. The water from the sump is either disposed of appropriately to sewer or pumped upstream so that it can be released and retreated by the CDS unit. A close inspection should be carried out on the screen, basket, lifting tackle etc and any maintenance requirements should be reported. Inform CDS Technologies when this annual service is to occur if they are required to attend. Inspect the return channel behind the screen and remove any accumulated silt or other deposits, if present. Record details in the "Comments" section of the 'Clean Out Report'.



LIFTING OPERATION



Figure

4.8 HAZARD ANALYSIS

Activity: Basket Cleaning of CDS Unit

Task	Possible Hazard	Hazard Control
Site Establishment	Traffic Hazards	Implement Traffic Control Plan Obtain Road Closure Approval if necessary
	Risk to Pedestrian	Care to be taken when driving cranes, trucks etc. through public areas. Use assistant to guide reversing vehicle and ward off pedestrians In high pedestrian traffic areas, erect barricades around open CDS unit
Remove CDS Lid	Manual Handling	Correct Manual Lifting Techniques PPE : Steel cap boots, hard hat, gloves Lifting tackle in good condition. Crane in good condition, qualified operators. Crane near overhead electrical cables 3m clearance required to overhead electrical cables
Remove Basket	Lifting Cable Breaks	Check basket lifting tackle for deterioration. Check cable as it emerges from under the water for deterioration. No person to stand under basket as it is removed.
	Person fall into CDS unit	It is not possible to remove the CDS basket whilst barriers are placed around CDS unit. Therefore special care must be taken whilst working around the open CDS unit.
Empty Basket into truck	Biological contamination Basket swings hitting employee	Wear gloves and wash hands afterwards with anti-bacterial soap. PPE, hard hat
Replace Basket	See Remove Basket	
Replace CDS lid	See Remove CDS Lid	

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5 SUCTION CLEANING

The following is a procedure for emptying the CDS unit using a truck-mounted suction unit (this procedure is shown in Figure 5.1). See Hazard Analysis at Section 5.8.

UNITS FITTED WITH OIL BAFFLES

In the case of Units fitted with an Oil baffle the oil must be removed by eduction prior to de-watering.

Oil will be sitting on the surface at the fluid level inside the screen in the unit; this will be visible through the lid at surface level.

The eduction hose is carefully lowered into the oil, care being taken not to protrude below the oil level and the oil removed by suction.

The depth of the oil on the surface can be gauged by the oil residue on the dipping staff used to establish the level of pollution contained in the sump.

This oil will be securely quarantined or retained in a vessel for disposal

NB: Eduction or the use of absorbent material such as Oil Absorbent Pillows is the only way to remove the oil, the grab or basket method is still a clean out method for the remainder of the pollutant but the oil must be removed first.

Remove lid

5.1	Stop inflow	If necessary, the incoming flow can be blocked using a drop-board or sandbags stacked across the inlet. Ensure that the flow is low enough for a person to safely enter the chamber to place the drop-board. NB If working in a roadway, erect appropriate traffic control measures.
5.2	Pump down the separation chamber	Place a flex drive pump or suction hose in the outlet of the separation chamber, ie outside the screen. This water can be discharged downstream because it has passed through the screen, therefore it has undergone treatment. Other options that may be considered include pumping the water upstream of the inlet. It may be necessary to remove water removed from the unit and transport it by tanker to an approved disposal site or it may be discharged to sewer if approved by local water authority. Do not pump water from the inside of the screen directly downstream. Access to the outside of the screen is via the Diversion Chamber. The water level will drop to the top of the sump.
5.3	Remove debris by suction	Using a "Super sucker" type suction cleaner, remove the debris from the sump (Experience has shown that the common Council Road Sweeper Eductor is not nearly as

efficient at removing the debris).

For larger units, removal by suction may require the assistance of a suitably qualified “Confined Spaces” worker, lowered into the CDS unit to manually direct the nozzle of the suction hose and remove blockages. Any large items or sticks blocking the nozzle may be put to one side and removed manually on completion of the suction process.

Confined spaces legislation requires that the employee in the unit be harnessed to a tripod-type hoist that is permanently manned above, while a third operator mans the suction machine.

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5.4	Disposal of Pollutants	Record the quantity of pollutants removed from the CDS with a visual assessment of the breakdown by type: _____ % silt and sediment _____ % litter _____ % vegetation A note should be made of any unusual or large items, eg. oil, paint, car tyres etc. Dispose of pollutant material at an approved tipping site, ie. a tip which is licensed by the Waste Authority in the relevant state. The free water removed can be discharged back into the CDS unit to minimise transportation and disposal costs. The material should be weighed if possible. Weight should be measured when free water no longer drains out of the material. If this is not possible, an estimation of weight should be made.
5.5	Tidy Site	Tidy the site of any debris prior to leaving.
5.6	Complete and Forward Cleaning Report	Complete Cleaning Report (Appendix B) and forward to CDS owner. If there is any damage or non-functionality, complete Damage or Non-Functionality Report (Appendix C) and forward to the CDS Contact Person listed on the CDS Data Sheet.

Annually the CDS unit should be fully inspected inside and outside the screen to ensure no damage, algal growth or deposition of material has occurred. Any problems should be reported to the CDS owner and to CDS Technologies contact person.

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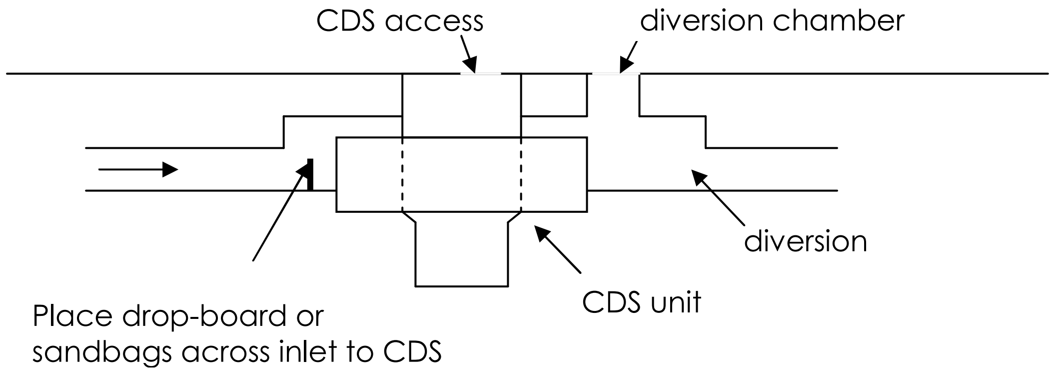
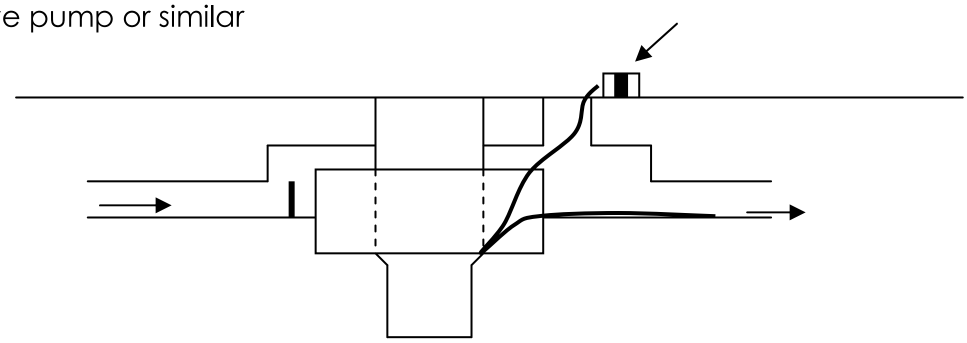
5.7 PROCEDURE

Stop Inflow

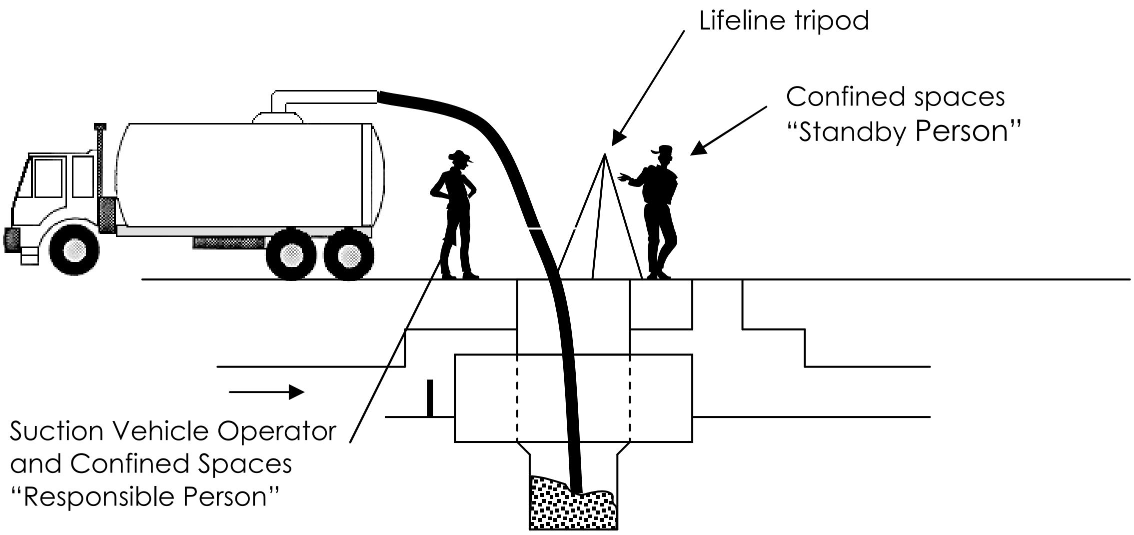


Pump down the separation chamber from the outside of the screen

Flexi-drive pump or similar



Remove debris by suction



NB: A person may be needed inside the CDS unit to guide the head of the suction hose.
All 3 staff in this method require Confined Spaces Training.

5.8 HAZARD ANALYSIS

Activity : Cleaning CDS units by vacuum loading

WHAT CAN GO WRONG	HOW WILL IT BE MANAGED
Proposed Work: Cleaning of C.D.S. units of various sizes by Vacuum Loading at various locations. <u>Consequences</u> Possible Road Work Entry into Confined Spaces	Field staff will be certified through AS2865 and safety inducted prior to commencing fieldwork. A supervisor will issue each crew with a work schedule for the day. The responsible person will ensure each site is handled with extreme care. Should roadwork be required, the crew will have the correct signs, barricades and appropriate dress.
Confined Space Category: Deterioration of air quality may occur within a confined space resulting in a category change. Illegal dumping of trade waste / chemicals may also result in confined space category changes.	The responsible person will ensure: Gas testing is undertaken for the duration of the work. If gas levels are above AS2865 allowable levels postpone work until reasonable levels can be achieved. Force ventilation equipment is available, on site, and can be used if required. Vacuum truck draws fresh air into chamber. Personnel entering the confined space will wear all the appropriate safety gear, including hard hat, steel capped boots, overall, eye protection, gloves and be connected to an approved lifeline/tripod set-up at all times whilst in the confined space. Remove other manhole lids in vicinity of work. Should trade waste chemicals become evident all work will cease, evacuation will proceed. Once evacuation is complete C.D.S. will be notified immediately. Self rescue unit to be worn.

WHAT CAN GO WRONG	HOW WILL IT BE MANAGED
Isolation of Work Site: Partial blockage/diversion boards, installed upstream to divert flows, may fail resulting in increased flow conditions.	The responsible person will ensure: Isolation of the work site by ensuring level of flow is at workable levels prior to confined space entry. The work can be done during low flow conditions. Flow levels are monitored upstream of the work location. Personnel entering the confined space will wear all the appropriate safety gear, including hard hat, steel capped boots, overall, eye protection, gloves and be connected to an approved lifeline/tripod set-up at all times whilst in the confined space.
Pre-entry Inspection: Air quality may exceed As2865 limits. Excessive flow conditions Presence of fumes, smells and noxious gases.	Gas detection will be undertaken prior to commencing confined space work. Gas detection is to continue for the entirety of the work. The work crew will complete an Entry Permit once they have tested for gas. Copy of Entry Permit to be forwarded to C.D.S. Should excessive flows be present work is not to proceed until such time that flows are at acceptable levels.

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Access: Manhole/Access lid dimensions may not comply with Australian Standards. General public and road access routes may be interrupted. Suction hose restricts size of manhole.	The responsible person will ensure: Access will only be undertaken if it is possible, through the manhole opening. Entry will NOT take place into a manhole/confined space if these site-opening sizes do not conform to Australian Standards. The entrant will wear a safety harness. Appropriate signs and barricades will be used around the work area to ensure public and traffic routes are kept to a minimum. All tools, manhole lids and other equipment is to be kept within the barricaded area. Suction hose to be removed whilst assessing/egressing the manhole.
WHAT CAN GO WRONG	***HOW WILL IT BE MANAGED***
Methods of Work: Failure of safety equipment while in use. Noise may impact on the employees and the residents/public.	The responsible person will ensure: Daily inspection of all equipment will take place prior to work commencing. This will ensure equipment is maintained in good condition. Noise levels throughout this contract will comply with the EPA's Noise Control Manual. Personnel will have earplugs available for their use as and when required.
Suitable Workers: Unqualified workers without training working within a Confined Space.	All persons working on a cleaning project will have undertaken and are currently certified to work under AS2865. All staff is trained in the use of the equipment and materials to be used for this project. Other training will include and is not limited to a Safety Induction, First Aid/CPR Training.

	The responsible person will ensure: Only AS2865 certified person could enter a Confined Space to carry out work. All staff members working on-site are carrying their Confined Space tickets.
Rescue Precautions:	The responsible person will ensure: Each field crew will have undertaken a Safety Induction. Each crew will be equipped with a First Aid Kit and a mobile telephone.
Traffic & Public Access: Manholes are located on roads, footpaths and private property. The work may cause disruption to motorists and residents living in the area.	The responsible person will ensure: Traffic control measures including signs, barricades and witches hats are used on roadways. Barricades and pedestrian diversion shall be utilised on footpaths and on private property.

WHAT CAN GO WRONG	***HOW WILL IT BE MANAGED***
Illumination: Poor lighting may result in slips and falls.	The responsible person will ensure: Dolphin torches are used in the confined space in conjunction with miners lights fixed to the entry workers helmet. The stand-by person will have a 12v light that he/she can shine from above to help light up the area.
Ventilation: Fumes, smells and unacceptable gas levels.	The responsible person will ensure: Gas testing is undertaken for the duration of the work. If gas levels are above AS2865 allowable levels postpone work until reasonable levels can be achieved. Force ventilation equipment is available, on site, and can be used if required. Stand-by person will remain at the entry/exit point to allow emergency exit if required. Personnel entering the confined space will wear all the appropriate

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	safety gear, including hard hat, steel capped boots, overalls, eye protection, gloves and be connected to an approved lifeline/tripod set-up at all times whilst in the confined space. Should air quality deteriorate work will cease, evacuation will proceed.
Contents / Hazard: Sharp objects, syringes and hazardous materials.	The responsible person will ensure: Site inspection, prior to commencing confined space work, is to take place. Retrieved hazardous materials and sharp objects or syringes are to be disposed of correctly.
Fire / Explosion Risk: Fuels and Oils	The responsible person will ensure: Confined space is evacuated immediately if the Lower Explosive Limit (LEL) exceeds 5% on Gas Detector.

WHAT CAN GO WRONG	***HOW WILL IT BE MANAGED***
Temperature: No hot work is expected.	N/A
Electrical Isolation: Possibility of electrocution.	The responsible person will ensure: Isolation of electrical equipment. All electrical equipment to be used is inspected prior to undertaking any work. All electrical equipment used in confined spaces shall be low-voltage.
Manual Handling of Manhole:	The responsible person will ensure: Mechanical lifting equipment shall be used. All manhole covers are put back on pits and manholes before leaving site.

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6 CLAMSHELL (GRAB) CLEANING

The following is a procedure for emptying the CDS unit using a tipper-truck-mounted clamshell or grab bucket (this procedure is shown in Figure 6.1). This method is available for 2m & up diameter CDS units due to the physical size of the bucket. Currently only two of the units exists in Australia, based in Sydney and Melbourne, which can service all states. Contact your CDS representative to arrange for a quotation. See Hazard Analysis at Section 6.7.

For units fitted with an Oil Baffle the Oil must be removed using the methodology for Eduction Cleaning prior to the grab process. See Section 5.

6.1	Remove lids	See section 4.1
6.2	Remove debris by clamshell	Ensure clamshell does not contact screen as damage can occur. Clamshell should be perforated and should be lifted clear of water surface and allowed to drain. Using the clamshell, load the waste into the tipping body of the truck. The truck should be positioned so that water draining from the body drains back into the CDS. Drain waste thoroughly before proceeding to tip.
6.3	Scoop floating waste	Using a pool scoop, remove the floating litter from the surface of the water in the separation chamber. Replace lid.

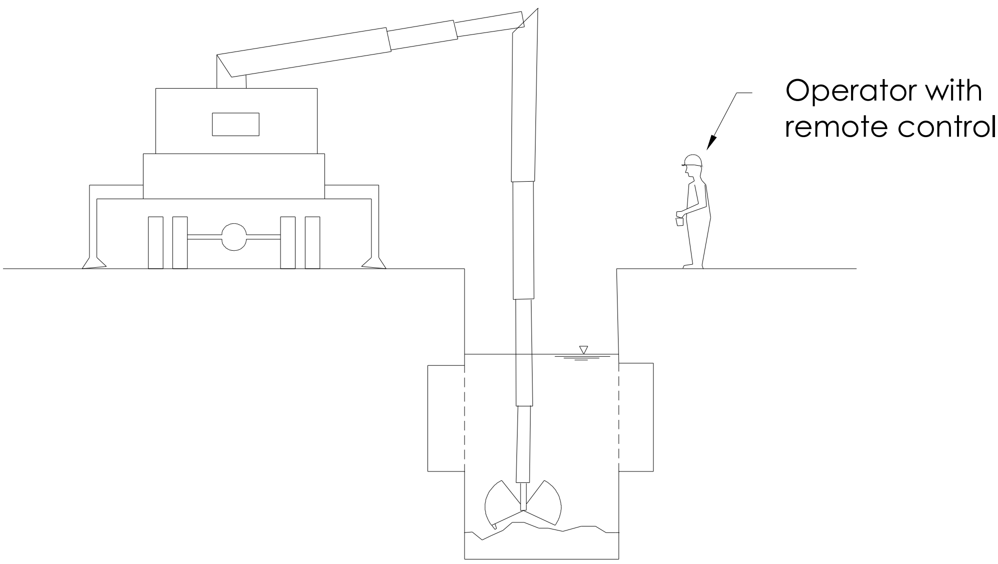

Figure 6.1 Clamshell bucket operation

6.4	Disposal of Pollutants	Record the quantity of pollutants removed from the CDS with a visual assessment of the breakdown by type: _____ % silt and sediment _____ % litter _____ % vegetation A note should be made of any unusual or large items, eg. oil, paint, car tyres etc. Dispose of pollutant material at an approved tipping site, ie. a tip which is licensed by the Waste Authority in the relevant state. Any free water removed can be discharged back into the CDS unit to minimise transportation and disposal costs. The material should be weighed if possible. Weight should be measured when the free water no longer drains out at the material. If this is not possible, an estimation of weight should be made.
6.5	Tidy Site	Tidy the site of any debris prior to leaving.
6.6	Complete and Forward Cleaning Report	Complete Cleaning Report (Appendix B) and forward to CDS owner. If there is any damage or non-functionality, complete Damage or Non-Functionality Report (Appendix C) and forward to the CDS Contact Person listed on the CDS Data Sheet.

Annually the CDS unit should be fully inspected inside and outside the screen to ensure no damage, algal growth or deposition of material has occurred. Any problems should be reported to the CDS owner and to CDS Technologies contact person.

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6.7 HAZARD ANALYSIS 1

Activity : Grab Cleaning of CDS Unit

Task	Possible Hazard	Hazard Control
Site Establishment	Traffic Hazards	Implement Traffic Control Plan Obtain Road Closure Approval if necessary
	Risk to Pedestrian	Care to be taken when driving cranes, trucks etc. through public areas. Use assistant to guide reversing vehicle and ward off pedestrians In high pedestrian traffic areas, erect barricades around open CDS unit
Remove CDS Lid	Manual Handling	Correct Manual Lifting Techniques PPE : Steel cap boots, hard hat, gloves Lifting tackle in good condition. Crane in good condition, qualified operators. Crane near overhead electrical cables 3m clearance required to overhead electrical cables
	Person fall into CDS unit	Special care must be taken whilst working around the open CDS unit. Place barricade round open CDS unit. Place wire ladder into CDS unit fixed to truck.
Empty Bucket into truck	Biological contamination Bucket swings hitting employee	Wear gloves and wash hands afterwards with anti-bacterial soap. PPE, hard hat
Replace Basket	See Remove Basket	
Replace CDS lid	See Remove CDS Lid	

7 Safety Regulations

7.1 The safety regulations applying in the State or Territory are to be strictly adhered to.

7.2 The party performing the cleaning is to be fully aware of all applicable safety regulations and ensure that all staff are adequately trained in safe working practices.

7.3 These safety regulations include but are not limited to:

- 7.3.1 Occupational Health and Safety Legislation
- 7.3.2 Confined Spaces Legislation
- 7.3.3 Motor Traffic Legislation
- 7.3.4 Scaffolding and Lifts Regulations
- 7.3.5 Health Regulations dealing with handling of hazardous substances
- 7.3.6 Hazardous Substances Legislation
- 7.3.7 Manual Handling Regulations
- 7.3.8 Plant Operating Instructions
- 7.3.9 Traffic and Pedestrian Safety Standards.

7.4 Adequate insurances should be carried to cover Public Liability and Worker Injury.

8 Environmental Responsibility

8.1 CDS Technologies is committed to improving the environment with its products. It is essential therefore that the process of cleaning the CDS is performed in a manner, which is environmentally responsible. Simply, there must not be any waste left on the site or anything other than the treated water discharged into the environment. The waste must be disposed of in a best practice manner with regard to environmental legislation.

8.2 The party performing the cleaning must be aware of all environmental legislation applicable to these operations and ensure that all employees are trained in work practices complying with the legislation.

8.3 This legislation includes but is not limited to:

8.3.1 Local Government Regulations
8.3.2 Clean Waters Act
8.3.3 Waste Disposal Regulations
8.3.4 Litter Regulations

9 Documentation

9.1 There are only 3 documents generated by the inspection and cleaning of the CDS.

9.2 Inspection Report

Appendix A to be completed for each inspection and copy forwarded to CDS owner.

9.3 Cleaning Report

Appendix B is to be completed for each clean and forwarded to CDS owner.

9.4 Damage or Non-Functionality Report

Appendix C is to be completed upon observance of any damage or extraordinary occurrence affecting the normal operation of the CDS. Examples of these are:

9.4.1 damaged screen
9.4.2 damaged exclusion bars
9.4.3 damaged lids
9.4.4 screen blockage
9.4.5 repeated inlet blockage, and such like.

CDS Technologies will discuss with the CDS owner any remedial action required.

9.5 CDS Data Sheet

Appendix D - This contains relevant information about each CDS and includes contact phone numbers for CDS Contact Personnel including after hours numbers.

9.6 Any damage or non-functionality of the CDS unit should be reported on a Damage or Non-functionality Report (Appendix C) to CDS/Rocla

Inspection Form

Appendix A

Date: ____________________

Cleaning Contractor Company: ____________________

Phone No: ____________________ Fax No: ____________________

Inspection Person: ____________________

Unit Identification: ____________________

Percent cover of floatables on surface: ____________________

State of the screen (if visible): ____________________

Depth from base to lid: ____________________

Depth of accumulated solids: ____________________

Percent full: ____________________

Comments: ____________________

____

____

____

Signed: ____________________

The report is to be faxed to the CDS owner.

CDS Clean Out Report

Appendix B

Date:____

Cleaning Contractor Company:

Phone No:____

Fax No:

Contact Person:

Unit Identification:

Address:____

Method of Cleaning:

Time Taken:

Volume or mass of removed material:

Breakdown of material: ____________Oil Quantity in litres

______________%silt and sand

____%litter

____%vegetation

Safety Procedures implemented in accordance with Hazard Analysis : Yes No

*Comments:*____

____

____

*Signed:*____

This report is to be faxed to the CDS owner.

Any damage or non-functionality of the CDS unit should be reported on a Damage or Non-functionality Report Appendix C to CDS /Rocla

Appendix C

Damage or Non-functionality Report

Date:____

Unit Identification:

Address:___________________

Company doing inspection/cleaning:

Contact Person:

Phone:________________________________Fax:

Nature of damage or problem:

Signed:____

This report is to be faxed to CDS/Rocla

CDS Unit Data Sheet

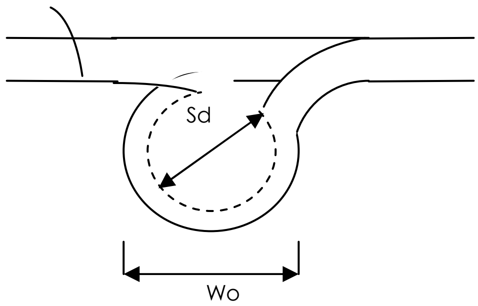
Appendix D

TECHNOLOGIES

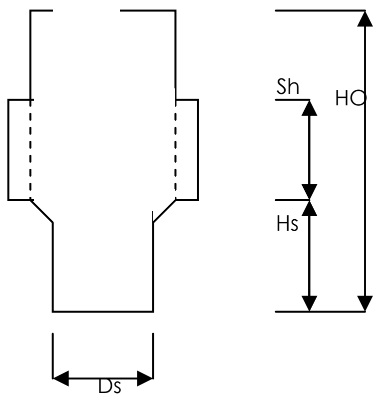
Name:		Unit Name:	
Address:		Unit No:	
		Unit Address:	
Contact Person:		Site:	
Phone:		Truck Instruction:	
Fax:		Keys:	
Mobile:		Lid Type:	
CDS Rep:		Lid Size:	
Phone:		Emptying Method(s):	Oil removed: Yes/No
After Hours:		Date Operational:	

Technical Data

Screen diameter (Sd) =
Screen height (Sh) =
Over all height (H0) =
Over all width (Wo) =
Sump diameter (Ds) =
Sump Height (Hs) =
Sump total volume (Vt) =
Unit weight of solid material (γ) 800t/m^3
Estimate weight of full basket =



Depth from Lid to Pollution	Volume m^3	Weight tonnes	Percent Full
Screen bot			> 100
Sump Top			100
			90
			80
			70
			60
			50
			40
			30
			20
			10
Base =	0.00	0.00	Base Sump



ADDITIONAL NOTES ON CLEANOUT PROCEDURES ETC

Appendix D – MUSIC Results

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Source nodes
Location,Ex Site,ROOF (0.147 ha),ROAD (0.139 ha),GROUND (0.218 ha)
ID,1,6,7,8
Node Type,AgriculturalSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode
Zoning Surface Type,,Mixed,Mixed,Mixed
Total Area (ha),0.504,0.147,0.139,0.218
Area Impervious (ha),0.0261747869648297,0.147,0.111760149253731,0.0430061940298509
Area Pervious (ha),0.47782521303517,0,0.0272398507462687,0.174993805970149
Field Capacity (mm),50,50,50,50
Pervious Area Infiltration Capacity coefficient - a,50,50,50,50
Pervious Area Infiltration Capacity exponent - b,2,2,2,2
Impervious Area Rainfall Threshold (mm/day),1,1,1,1
Pervious Area Soil Storage Capacity (mm),150,150,150,150
Pervious Area Soil Initial Storage (% of Capacity),25,25,25,25
Groundwater Initial Depth (mm),50,50,50,50
Groundwater Daily Recharge Rate (%),0.65,0.65,0.65,0.65
Groundwater Daily Baseflow Rate (%),0.85,0.85,0.85,0.85
Groundwater Daily Deep Seepage Rate (%),0,0,0,0
Stormflow Total Suspended Solids Mean (log mg/L),1.544,2,2,2
Stormflow Total Suspended Solids Standard Deviation (log mg/L),0.32,0.32,0.32,0.32
Stormflow Total Suspended Solids Estimation Method,Mean,Mean,Mean,Mean
Stormflow Total Suspended Solids Serial Correlation,0,0,0,0
Stormflow Total Phosphorus Mean (log mg/L),-1,-0.52,-0.52,-0.52
Stormflow Total Phosphorus Standard Deviation (log mg/L),0.25,0.25,0.25,0.25
Stormflow Total Phosphorus Estimation Method,Mean,Mean,Mean,Mean
Stormflow Total Phosphorus Serial Correlation,0,0,0,0
Stormflow Total Nitrogen Mean (log mg/L),0,0.18,0.18,0.18
Stormflow Total Nitrogen Standard Deviation (log mg/L),0.19,0.19,0.19,0.19
Stormflow Total Nitrogen Estimation Method,Mean,Mean,Mean,Mean
Stormflow Total Nitrogen Serial Correlation,0,0,0,0
Baseflow Total Suspended Solids Mean (log mg/L),1.2,1.2,1.2,1.2
Baseflow Total Suspended Solids Standard Deviation (log mg/L),1.7,0.17,0.17,0.17
Baseflow Total Suspended Solids Estimation Method,Mean,Mean,Mean,Mean
Baseflow Total Suspended Solids Serial Correlation,0,0,0,0
Baseflow Total Phosphorus Mean (log mg/L),-1.3,-0.85,-0.85,-0.85
Baseflow Total Phosphorus Standard Deviation (log mg/L),0.19,0.19,0.19,0.19
Baseflow Total Phosphorus Estimation Method,Mean,Mean,Mean,Mean
Baseflow Total Phosphorus Serial Correlation,0,0,0,0
Baseflow Total Nitrogen Mean (log mg/L),-0.1,0.18,0.18,0.18
Baseflow Total Nitrogen Standard Deviation (log mg/L),0.12,0.12,0.12,0.12
Baseflow Total Nitrogen Estimation Method,Mean,Mean,Mean,Mean
Baseflow Total Nitrogen Serial Correlation,0,0,0,0
Flow based constituent generation - enabled,Off,Off,Off,Off
Flow based constituent generation - flow file, , , ,
Flow based constituent generation - base flow column, , , ,
Flow based constituent generation - pervious flow column, , , ,
Flow based constituent generation - impervious flow column, , , ,
Flow based constituent generation - unit, , , ,
OUT - Mean Annual Flow (ML/yr),1.92,1.49,1.22,1.05
OUT - TSS Mean Annual Load (kg/yr),66.0,149,122,103
OUT - TP Mean Annual Load (kg/yr),0.189,0.450,0.369,0.313
OUT - TN Mean Annual Load (kg/yr),1.91,2.25,1.85,1.59
OUT - Gross Pollutant Mean Annual Load (kg/yr),10.0,36.0,30.5,19.6
Rain In (ML/yr),5.63371,1.64317,1.55374,2.4368
ET Loss (ML/yr),3.7243,0.153762,0.331024,1.39256
Deep Seepage Loss (ML/yr),0,0,0,0
Baseflow Out (ML/yr),0.061785,0,0.003587,0.022505
Imp. Stormflow Out (ML/yr),0.255326,1.48941,1.12668,0.441755
Perv. Stormflow Out (ML/yr),1.60226,0,0.09303,0.583614
Total Stormflow Out (ML/yr),1.85759,1.48941,1.21971,1.02537
Total Outflow (ML/yr),1.91937,1.48941,1.2233,1.04787
Change in Soil Storage (ML/yr),-0.009963,0,-0.000578,-0.003629
TSS Baseflow Out (kg/yr),0.979232,0,0.056856,0.356679
TSS Total Stormflow Out (kg/yr),65.0054,148.94,121.971,102.537
TSS Total Outflow (kg/yr),65.9846,148.94,122.028,102.894
TP Baseflow Out (kg/yr),0.003097,0,0.000507,0.003179
TP Total Stormflow Out (kg/yr),0.185759,0.449793,0.368346,0.309657
TP Total Outflow (kg/yr),0.188856,0.449793,0.368853,0.312836
TN Baseflow Out (kg/yr),0.049078,0,0.00543,0.034063
TN Total Stormflow Out (kg/yr),1.85759,2.2543,1.8461,1.55196
TN Total Outflow (kg/yr),1.90667,2.2543,1.85153,1.58602
GP Total Outflow (kg/yr),10.1419,36.0288,30.5887,19.8192

No Imported Data Source nodes

USTM treatment nodes
Location, BIO BASIN,Rainwater Tank
ID,4,9
Node Type,BioRetentionNodeV4,RainWaterTankNode
Lo-flow bypass rate (cum/sec),0,0
Hi-flow bypass rate (cum/sec),100,100
Inlet pond volume, ,0
Area (sqm),185,25.5
Initial Volume (m^3), ,0
Extended detention depth (m),0.2,0.2
Number of Rainwater tanks, ,15
Permanent Pool Volume (cubic metres), ,45
Proportion vegetated, ,0
Equivalent Pipe Diameter (mm), ,387
Overflow weir width (m),5,10
Notional Detention Time (hrs), ,9.08E-3
Orifice Discharge Coefficient, ,0.6
Weir Coefficient,1.7,1.7
Number of CSTR Cells,2,2
Total Suspended Solids - k (m/yr),8000,400
Total Suspended Solids - C* (mg/L),20,12
Total Suspended Solids - C** (mg/L), ,12
Total Phosphorus - k (m/yr),6000,300
Total Phosphorus - C* (mg/L),0.13,0.13
Total Phosphorus - C** (mg/L), ,0.13
Total Nitrogen - k (m/yr),500,40
Total Nitrogen - C* (mg/L),1.4,1.4
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Total Nitrogen - C** (mg/L), ,1.4
Threshold Hydraulic Loading for C** (m/yr), ,3500
Horizontal Flow Coefficient,3,
Reuse Enabled,Off,On
Max drawdown height (m), ,1.764
Annual Demand Enabled,Off,On
Annual Demand Value (ML/year), ,0.375
Annual Demand Distribution, ,PET
Annual Demand Monthly Distribution: Jan, ,
Annual Demand Monthly Distribution: Feb, ,
Annual Demand Monthly Distribution: Mar, ,
Annual Demand Monthly Distribution: Apr, ,
Annual Demand Monthly Distribution: May, ,
Annual Demand Monthly Distribution: Jun, ,
Annual Demand Monthly Distribution: Jul, ,
Annual Demand Monthly Distribution: Aug, ,
Annual Demand Monthly Distribution: Sep, ,
Annual Demand Monthly Distribution: Oct, ,
Annual Demand Monthly Distribution: Nov, ,
Annual Demand Monthly Distribution: Dec, ,
Daily Demand Enabled,Off,On
Daily Demand Value (ML/day), ,0.0054
Custom Demand Enabled,Off,Off
Custom Demand Time Series File, ,
Custom Demand Time Series Units, ,
Filter area (sqm),185,
Filter perimeter (m),0.1,
Filter depth (m),0.3,
Filter Median Particle Diameter (mm), ,
Saturated Hydraulic Conductivity (mm/hr),125,
Infiltration Media Porosity,0.35,
Length (m), ,
Bed slope, ,
Base Width (m), ,
Top width (m), ,
Vegetation height (m), ,
Vegetation Type,Vegetated with Effective Nutrient Removal Plants,
Total Nitrogen Content in Filter (mg/kg),800,
Orthophosphate Content in Filter (mg/kg),40,
Is Base Lined?,No,
Is Underdrain Present?,Yes,
Is Submerged Zone Present?,No,
Submerged Zone Depth (m), ,
B for Media Soil Texture,13,-9999
Proportion of upstream impervious area treated, ,
Exfiltration Rate (mm/hr),2.5,0
Evaporative Loss as % of PET,100,0
Depth in metres below the drain pipe, ,
TSS A Coefficient, ,
TSS B Coefficient, ,
TP A Coefficient, ,
TP B Coefficient, ,
TN A Coefficient, ,
TN B Coefficient, ,
Sfc,0.61,
S*,0.37,
Sw,0.11,
Sh,0.05,
Emax (m/day),0.008,
Ew (m/day),0.001,
IN - Mean Annual Flow (ML/yr),2.88,1.49
IN - TSS Mean Annual Load (kg/yr),79.2,149
IN - TP Mean Annual Load (kg/yr),0.581,0.450
IN - TN Mean Annual Load (kg/yr),4.35,2.25
IN - Gross Pollutant Mean Annual Load (kg/yr),1.00,36.0
OUT - Mean Annual Flow (ML/yr),2.13,0.607
OUT - TSS Mean Annual Load (kg/yr),4.37,39.1
OUT - TP Mean Annual Load (kg/yr),0.117,0.148
OUT - TN Mean Annual Load (kg/yr),1.28,0.913
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00
Flow In (ML/yr),2.87793,1.4894
ET Loss (ML/yr),0.2197,0
Infiltration Loss (ML/yr),0.524104,0
Low Flow Bypass Out (ML/yr),0,0
High Flow Bypass Out (ML/yr),0,0
Orifice / Filter Out (ML/yr),2.12964,0.606749
Weir Out (ML/yr),0,0
Transfer Function Out (ML/yr),0,0
Reuse Supplied (ML/yr),0,0.760053
Reuse Requested (ML/yr),0,2.346
% Reuse Demand Met,0,32.3978
% Load Reduction,26.0011,59.2622
TSS Flow In (kg/yr),79.1983,148.94
TSS ET Loss (kg/yr),0,0
TSS Infiltration Loss (kg/yr),1.26427,0
TSS Low Flow Bypass Out (kg/yr),0,0
TSS High Flow Bypass Out (kg/yr),0,0
TSS Orifice / Filter Out (kg/yr),4.36639,39.0725
TSS Weir Out (kg/yr),0,0
TSS Transfer Function Out (kg/yr),0,0
TSS Reuse Supplied (kg/yr),0,14.1573
TSS Reuse Requested (kg/yr),0,0
TSS % Reuse Demand Met,0,0
TSS % Load Reduction,94.4868,73.7663
TP Flow In (kg/yr),0.580752,0.449793
TP ET Loss (kg/yr),0,0
TP Infiltration Loss (kg/yr),0.031307,0
TP Low Flow Bypass Out (kg/yr),0,0
TP High Flow Bypass Out (kg/yr),0,0
TP Orifice / Filter Out (kg/yr),0.116596,0.147954
TP Weir Out (kg/yr),0,0
TP Transfer Function Out (kg/yr),0,0
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TP Reuse Supplied (kg/yr),0,0.113047
TP Reuse Requested (kg/yr),0,0
TP % Reuse Demand Met,0,0
TP % Load Reduction,79.9233,67.1062
TN Flow In (kg/yr),4.35082,2.2543
TN ET Loss (kg/yr),0,0
TN Infiltration Loss (kg/yr),0.319319,0
TN Low Flow Bypass Out (kg/yr),0,0
TN High Flow Bypass Out (kg/yr),0,0
TN Orifice / Filter Out (kg/yr),1.28088,0.913259
TN Weir Out (kg/yr),0,0
TN Transfer Function Out (kg/yr),0,0
TN Reuse Supplied (kg/yr),0,1.11446
TN Reuse Requested (kg/yr),0,0
TN % Reuse Demand Met,0,0
TN % Load Reduction,70.56,59.4881
GP Flow In (kg/yr),1.00339,36.0288
GP ET Loss (kg/yr),0,0
GP Infiltration Loss (kg/yr),0,0
GP Low Flow Bypass Out (kg/yr),0,0
GP High Flow Bypass Out (kg/yr),0,0
GP Orifice / Filter Out (kg/yr),0,0
GP Weir Out (kg/yr),0,0
GP Transfer Function Out (kg/yr),0,0
GP Reuse Supplied (kg/yr),0,0
GP Reuse Requested (kg/yr),0,0
GP % Reuse Demand Met,0,0
GP % Load Reduction,100,100
PET Scaling Factor,1,

Generic treatment nodes
Location,GPT (Rocla PL0506)
ID,5
Node Type,GPTNode
Lo-flow bypass rate (cum/sec),0
Hi-flow bypass rate (cum/sec),0.022
Flow Transfer Function
Input (cum/sec),0
Output (cum/sec),0
Input (cum/sec),10
Output (cum/sec),10
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Gross Pollutant Transfer Function
Enabled,True
Input (kg/ML),0
Output (kg/ML),0
Input (kg/ML),100
Output (kg/ML),2
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Total Nitrogen Transfer Function
Enabled,True
Input (mg/L),0
Output (mg/L),0
Input (mg/L),50
Output (mg/L),50
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Total Phosphorus Transfer Function
```

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Enabled,True
Input (mg/L),0
Output (mg/L),0
Input (mg/L),10
Output (mg/L),7
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Total Suspended Solids Transfer Function
Enabled,True
Input (mg/L),0
Output (mg/L),0
Input (mg/L),1000
Output (mg/L),300
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
TSS Flow based Efficiency Enabled,Off
TSS Flow based Efficiency,
TP Flow based Efficiency Enabled,Off
TP Flow based Efficiency,
TN Flow based Efficiency Enabled,Off
TN Flow based Efficiency,
GP Flow based Efficiency Enabled,Off
GP Flow based Efficiency,
IN - Mean Annual Flow (ML/yr),2.88
IN - TSS Mean Annual Load (kg/yr),264
IN - TP Mean Annual Load (kg/yr),0.830
IN - TN Mean Annual Load (kg/yr),4.35
IN - Gross Pollutant Mean Annual Load (kg/yr),50.2
OUT - Mean Annual Flow (ML/yr),2.88
OUT - TSS Mean Annual Load (kg/yr),79.2
OUT - TP Mean Annual Load (kg/yr),0.581
OUT - TN Mean Annual Load (kg/yr),4.35
OUT - Gross Pollutant Mean Annual Load (kg/yr),1.00
Flow In (ML/yr),2.87793
ET Loss (ML/yr),0
Infiltration Loss (ML/yr),0
Low Flow Bypass Out (ML/yr),0
High Flow Bypass Out (ML/yr),0
Orifice / Filter Out (ML/yr),0
Weir Out (ML/yr),0
Transfer Function Out (ML/yr),2.87793
Reuse Supplied (ML/yr),0
Reuse Requested (ML/yr),0
% Reuse Demand Met,0
% Load Reduction,0
TSS Flow In (kg/yr),263.995
TSS ET Loss (kg/yr),0
TSS Infiltration Loss (kg/yr),0
TSS Low Flow Bypass Out (kg/yr),0
TSS High Flow Bypass Out (kg/yr),0
TSS Orifice / Filter Out (kg/yr),0
TSS Weir Out (kg/yr),0
TSS Transfer Function Out (kg/yr),79.1983
TSS Reuse Supplied (kg/yr),0
TSS Reuse Requested (kg/yr),0
TSS % Reuse Demand Met,0
TSS % Load Reduction,70
TP Flow In (kg/yr),0.829645
TP ET Loss (kg/yr),0
TP Infiltration Loss (kg/yr),0
TP Low Flow Bypass Out (kg/yr),0
TP High Flow Bypass Out (kg/yr),0
TP Orifice / Filter Out (kg/yr),0
TP Weir Out (kg/yr),0
TP Transfer Function Out (kg/yr),0.580752
TP Reuse Supplied (kg/yr),0
TP Reuse Requested (kg/yr),0
TP % Reuse Demand Met,0
TP % Load Reduction,29.9999
TN Flow In (kg/yr),4.35083
TN ET Loss (kg/yr),0
TN Infiltration Loss (kg/yr),0
TN Low Flow Bypass Out (kg/yr),0
TN High Flow Bypass Out (kg/yr),0
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TN Orifice / Filter Out (kg/yr),0
TN Weir Out (kg/yr),0
TN Transfer Function Out (kg/yr),4.35083
TN Reuse Supplied (kg/yr),0
TN Reuse Requested (kg/yr),0
TN % Reuse Demand Met,0
TN % Load Reduction,0
GP Flow In (kg/yr),50.1696
GP ET Loss (kg/yr),0
GP Infiltration Loss (kg/yr),0
GP Low Flow Bypass Out (kg/yr),0
GP High Flow Bypass Out (kg/yr),0
GP Orifice / Filter Out (kg/yr),0
GP Weir Out (kg/yr),0
GP Transfer Function Out (kg/yr),1.00339
GP Reuse Supplied (kg/yr),0
GP Reuse Requested (kg/yr),0
GP % Reuse Demand Met,0
GP % Load Reduction,100

Other nodes
Location,Pre-Development Node,Post-Development Node
ID,2,3
Node Type,PreDevelopmentNode,PostDevelopmentNode
IN - Mean Annual Flow (ML/yr),1.92,2.13
IN - TSS Mean Annual Load (kg/yr),66.0,4.37
IN - TP Mean Annual Load (kg/yr),0.189,0.117
IN - TN Mean Annual Load (kg/yr),1.91,1.28
IN - Gross Pollutant Mean Annual Load (kg/yr),10.0,0.00
OUT - Mean Annual Flow (ML/yr),1.92,2.13
OUT - TSS Mean Annual Load (kg/yr),66.0,4.37
OUT - TP Mean Annual Load (kg/yr),0.189,0.117
OUT - TN Mean Annual Load (kg/yr),1.91,1.28
OUT - Gross Pollutant Mean Annual Load (kg/yr),10.0,0.00
% Load Reduction,0.00,43.4
TSS % Load Reduction,0.00,98.8
TN % Load Reduction,0.00,77.5
TP % Load Reduction,0.00,89.7
GP % Load Reduction,0.00,100

Links
Location,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link
Source node ID,1,8,7,5,4,6,9
Target node ID,2,5,5,4,3,9,5
Muskingum-Cunge Routing,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed
Muskingum K, , , , , , ,
Muskingum theta, , , , , , ,
IN - Mean Annual Flow (ML/yr),1.92,1.05,1.22,2.88,2.13,1.49,0.607
IN - TSS Mean Annual Load (kg/yr),66.0,103,122,79.2,4.37,149,39.1
IN - TP Mean Annual Load (kg/yr),0.189,0.313,0.369,0.581,0.117,0.450,0.148
IN - TN Mean Annual Load (kg/yr),1.91,1.59,1.85,4.35,1.28,2.25,0.913
IN - Gross Pollutant Mean Annual Load (kg/yr),10.0,19.6,30.5,1.00,0.00,36.0,0.00
OUT - Mean Annual Flow (ML/yr),1.92,1.05,1.22,2.88,2.13,1.49,0.607
OUT - TSS Mean Annual Load (kg/yr),66.0,103,122,79.2,4.37,149,39.1
OUT - TP Mean Annual Load (kg/yr),0.189,0.313,0.369,0.581,0.117,0.450,0.148
OUT - TN Mean Annual Load (kg/yr),1.91,1.59,1.85,4.35,1.28,2.25,0.913
OUT - Gross Pollutant Mean Annual Load (kg/yr),10.0,19.6,30.5,1.00,0.00,36.0,0.00

Catchment Details
Catchment Name,076-18-DA-WSUD-001-10thperc
Timestep,Day
Start Date,1/01/2002
End Date,31/12/2002
Rainfall Station, 066183_Ingleside_2002_Daily
ET Station,User-defined monthly PET
Mean Annual Rainfall (mm), 1118
Mean Annual ET (mm), 1260
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Source nodes
Location,Ex Site,ROOF (0.147 ha),ROAD (0.139 ha),GROUND (0.218 ha)
ID,1,6,7,8
Node Type,AgriculturalSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode
Zoning Surface Type,,Mixed,Mixed,Mixed
Total Area (ha),0.504,0.147,0.139,0.218
Area Impervious (ha),0.0261747869648297,0.147,0.111760149253731,0.0430061940298509
Area Pervious (ha),0.47782521303517,0,0.0272398507462687,0.174993805970149
Field Capacity (mm),50,50,50,50
Pervious Area Infiltration Capacity coefficient - a,50,50,50,50
Pervious Area Infiltration Capacity exponent - b,2,2,2,2
Impervious Area Rainfall Threshold (mm/day),1,1,1,1
Pervious Area Soil Storage Capacity (mm),150,150,150,150
Pervious Area Soil Initial Storage (% of Capacity),25,25,25,25
Groundwater Initial Depth (mm),50,50,50,50
Groundwater Daily Recharge Rate (%),0.65,0.65,0.65,0.65
Groundwater Daily Baseflow Rate (%),0.85,0.85,0.85,0.85
Groundwater Daily Deep Seepage Rate (%),0,0,0,0
Stormflow Total Suspended Solids Mean (log mg/L),1.544,2,2,2
Stormflow Total Suspended Solids Standard Deviation (log mg/L),0.32,0.32,0.32,0.32
Stormflow Total Suspended Solids Estimation Method,Mean,Mean,Mean,Mean
Stormflow Total Suspended Solids Serial Correlation,0,0,0,0
Stormflow Total Phosphorus Mean (log mg/L),-1,-0.52,-0.52,-0.52
Stormflow Total Phosphorus Standard Deviation (log mg/L),0.25,0.25,0.25,0.25
Stormflow Total Phosphorus Estimation Method,Mean,Mean,Mean,Mean
Stormflow Total Phosphorus Serial Correlation,0,0,0,0
Stormflow Total Nitrogen Mean (log mg/L),0,0.18,0.18,0.18
Stormflow Total Nitrogen Standard Deviation (log mg/L),0.19,0.19,0.19,0.19
Stormflow Total Nitrogen Estimation Method,Mean,Mean,Mean,Mean
Stormflow Total Nitrogen Serial Correlation,0,0,0,0
Baseflow Total Suspended Solids Mean (log mg/L),1.2,1.2,1.2,1.2
Baseflow Total Suspended Solids Standard Deviation (log mg/L),1.7,0.17,0.17,0.17
Baseflow Total Suspended Solids Estimation Method,Mean,Mean,Mean,Mean
Baseflow Total Suspended Solids Serial Correlation,0,0,0,0
Baseflow Total Phosphorus Mean (log mg/L),-1.3,-0.85,-0.85,-0.85
Baseflow Total Phosphorus Standard Deviation (log mg/L),0.19,0.19,0.19,0.19
Baseflow Total Phosphorus Estimation Method,Mean,Mean,Mean,Mean
Baseflow Total Phosphorus Serial Correlation,0,0,0,0
Baseflow Total Nitrogen Mean (log mg/L),-0.1,0.18,0.18,0.18
Baseflow Total Nitrogen Standard Deviation (log mg/L),0.12,0.12,0.12,0.12
Baseflow Total Nitrogen Estimation Method,Mean,Mean,Mean,Mean
Baseflow Total Nitrogen Serial Correlation,0,0,0,0
Flow based constituent generation - enabled,Off,Off,Off,Off
Flow based constituent generation - flow file, , , ,
Flow based constituent generation - base flow column, , , ,
Flow based constituent generation - pervious flow column, , , ,
Flow based constituent generation - impervious flow column, , , ,
Flow based constituent generation - unit, , , ,
OUT - Mean Annual Flow (ML/yr),2.97,1.98,1.65,1.55
OUT - TSS Mean Annual Load (kg/yr),99.2,198,164,147
OUT - TP Mean Annual Load (kg/yr),0.285,0.599,0.497,0.452
OUT - TN Mean Annual Load (kg/yr),2.92,3.00,2.50,2.34
OUT - Gross Pollutant Mean Annual Load (kg/yr),16.1,47.9,40.8,27.3
Rain In (ML/yr),7.44408,2.17119,2.05303,3.21986
ET Loss (ML/yr),4.47439,0.187131,0.399486,1.67359
Deep Seepage Loss (ML/yr),0,0,0,0
Baseflow Out (ML/yr),0.243554,0,0.014141,0.088713
Imp. Stormflow Out (ML/yr),0.340124,1.98406,1.50087,0.588469
Perv. Stormflow Out (ML/yr),2.38389,0,0.138413,0.868318
Total Stormflow Out (ML/yr),2.72401,1.98406,1.63928,1.45679
Total Outflow (ML/yr),2.96757,1.98406,1.65342,1.5455
Change in Soil Storage (ML/yr),0.002121,0,0.000123,0.000772
TSS Baseflow Out (kg/yr),3.86007,0,0.224123,1.40601
TSS Total Stormflow Out (kg/yr),95.3256,198.406,163.928,145.679
TSS Total Outflow (kg/yr),99.1856,198.406,164.152,147.085
TP Baseflow Out (kg/yr),0.012207,0,0.001997,0.012531
TP Total Stormflow Out (kg/yr),0.272401,0.599176,0.495055,0.439943
TP Total Outflow (kg/yr),0.284608,0.599176,0.497052,0.452474
TN Baseflow Out (kg/yr),0.193462,0,0.021404,0.134273
TN Total Stormflow Out (kg/yr),2.72402,3.00299,2.48115,2.20494
TN Total Outflow (kg/yr),2.91748,3.00299,2.50255,2.33921
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GP Total Outflow (kg/yr),16.3751,47.9077,40.9185,27.9396
No Imported Data Source nodes
USTM treatment nodes
Location, BIO BASIN,Rainwater Tank
ID,4,9
Node Type,BioRetentionNodeV4,RainWaterTankNode
Lo-flow bypass rate (cum/sec),0,0
Hi-flow bypass rate (cum/sec),100,100
Inlet pond volume, ,0
Area (sqm),185,25.5
Initial Volume (m^3), ,0
Extended detention depth (m),0.2,0.2
Number of Rainwater tanks, ,15
Permanent Pool Volume (cubic metres), ,45
Proportion vegetated, ,0
Equivalent Pipe Diameter (mm), ,387
Overflow weir width (m),5,10
Notional Detention Time (hrs), ,9.08E-3
Orifice Discharge Coefficient, ,0.6
Weir Coefficient,1.7,1.7
Number of CSTR Cells,2,2
Total Suspended Solids - k (m/yr),8000,400
Total Suspended Solids - C* (mg/L),20,12
Total Suspended Solids - C** (mg/L), ,12
Total Phosphorus - k (m/yr),6000,300
Total Phosphorus - C* (mg/L),0.13,0.13
Total Phosphorus - C** (mg/L), ,0.13
Total Nitrogen - k (m/yr),500,40
Total Nitrogen - C* (mg/L),1.4,1.4
Total Nitrogen - C** (mg/L), ,1.4
Threshold Hydraulic Loading for C** (m/yr), ,3500
Horizontal Flow Coefficient,3,
Reuse Enabled,Off,On
Max drawdown height (m), ,1.764
Annual Demand Enabled,Off,On
Annual Demand Value (ML/year), ,0.375
Annual Demand Distribution, ,PET
Annual Demand Monthly Distribution: Jan, ,
Annual Demand Monthly Distribution: Feb, ,
Annual Demand Monthly Distribution: Mar, ,
Annual Demand Monthly Distribution: Apr, ,
Annual Demand Monthly Distribution: May, ,
Annual Demand Monthly Distribution: Jun, ,
Annual Demand Monthly Distribution: Jul, ,
Annual Demand Monthly Distribution: Aug, ,
Annual Demand Monthly Distribution: Sep, ,
Annual Demand Monthly Distribution: Oct, ,
Annual Demand Monthly Distribution: Nov, ,
Annual Demand Monthly Distribution: Dec, ,
Daily Demand Enabled,Off,On
Daily Demand Value (ML/day), ,0.0054
Custom Demand Enabled,Off,Off
Custom Demand Time Series File, ,
Custom Demand Time Series Units, ,
Filter area (sqm),185,
Filter perimeter (m),0.1,
Filter depth (m),0.3,
Filter Median Particle Diameter (mm), ,
Saturated Hydraulic Conductivity (mm/hr),125,
Infiltration Media Porosity,0.35,
Length (m), ,
Bed slope, ,
Base Width (m), ,
Top width (m), ,
Vegetation height (m), ,
Vegetation Type,Vegetated with Effective Nutrient Removal Plants,
Total Nitrogen Content in Filter (mg/kg),800,
Orthophosphate Content in Filter (mg/kg),40,
Is Base Lined?,No,
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Is Underdrain Present?,Yes,
Is Submerged Zone Present?,No,
Submerged Zone Depth (m), ,
B for Media Soil Texture,13,-9999
Proportion of upstream impervious area treated, ,
Exfiltration Rate (mm/hr),2.5,0
Evaporative Loss as % of PET,100,0
Depth in metres below the drain pipe, ,
TSS A Coefficient, ,
TSS B Coefficient, ,
TP A Coefficient, ,
TP B Coefficient, ,
TN A Coefficient, ,
TN B Coefficient, ,
Sfc,0.61,
S*,0.37,
Sw,0.11,
Sh,0.05,
Emax (m/day),0.008,
Ew (m/day),0.001,
IN - Mean Annual Flow (ML/yr),3.98,1.98
IN - TSS Mean Annual Load (kg/yr),105,198
IN - TP Mean Annual Load (kg/yr),0.784,0.599
IN - TN Mean Annual Load (kg/yr),6.01,3.00
IN - Gross Pollutant Mean Annual Load (kg/yr),1.36,47.9
OUT - Mean Annual Flow (ML/yr),2.93,0.778
OUT - TSS Mean Annual Load (kg/yr),5.95,39.2
OUT - TP Mean Annual Load (kg/yr),0.160,0.170
OUT - TN Mean Annual Load (kg/yr),1.76,1.17
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00
Flow In (ML/yr),3.97713,1.98406
ET Loss (ML/yr),0.228826,0
Infiltration Loss (ML/yr),0.80409,0
Low Flow Bypass Out (ML/yr),0,0
High Flow Bypass Out (ML/yr),0,0
Orifice / Filter Out (ML/yr),2.93391,0.778187
Weir Out (ML/yr),0,0
Transfer Function Out (ML/yr),0,0
Reuse Supplied (ML/yr),0,1.01675
Reuse Requested (ML/yr),0,2.35243
% Reuse Demand Met,0,43.2213
% Load Reduction,26.2305,60.7781
TSS Flow In (kg/yr),105.144,198.406
TSS ET Loss (kg/yr),0,0
TSS Infiltration Loss (kg/yr),1.83143,0
TSS Low Flow Bypass Out (kg/yr),0,0
TSS High Flow Bypass Out (kg/yr),0,0
TSS Orifice / Filter Out (kg/yr),5.94941,39.2404
TSS Weir Out (kg/yr),0,0
TSS Transfer Function Out (kg/yr),0,0
TSS Reuse Supplied (kg/yr),0,20.3703
TSS Reuse Requested (kg/yr),0,0
TSS % Reuse Demand Met,0,0
TSS % Load Reduction,94.3416,80.2222
TP Flow In (kg/yr),0.783621,0.599176
TP ET Loss (kg/yr),0,0
TP Infiltration Loss (kg/yr),0.046541,0
TP Low Flow Bypass Out (kg/yr),0,0
TP High Flow Bypass Out (kg/yr),0,0
TP Orifice / Filter Out (kg/yr),0.15972,0.169926
TP Weir Out (kg/yr),0,0
TP Transfer Function Out (kg/yr),0,0
TP Reuse Supplied (kg/yr),0,0.155214
TP Reuse Requested (kg/yr),0,0
TP % Reuse Demand Met,0,0
TP % Load Reduction,79.6177,71.6401
TN Flow In (kg/yr),6.00781,3.00299
TN ET Loss (kg/yr),0,0
TN Infiltration Loss (kg/yr),0.484443,0
TN Low Flow Bypass Out (kg/yr),0,0
TN High Flow Bypass Out (kg/yr),0,0
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TN Orifice / Filter Out (kg/yr),1.76076,1.16602
TN Weir Out (kg/yr),0,0
TN Transfer Function Out (kg/yr),0,0
TN Reuse Supplied (kg/yr),0,1.49484
TN Reuse Requested (kg/yr),0,0
TN % Reuse Demand Met,0,0
TN % Load Reduction,70.6922,61.1714
GP Flow In (kg/yr),1.36164,47.9077
GP ET Loss (kg/yr),0,0
GP Infiltration Loss (kg/yr),0,0
GP Low Flow Bypass Out (kg/yr),0,0
GP High Flow Bypass Out (kg/yr),0,0
GP Orifice / Filter Out (kg/yr),0,0
GP Weir Out (kg/yr),0,0
GP Transfer Function Out (kg/yr),0,0
GP Reuse Supplied (kg/yr),0,0
GP Reuse Requested (kg/yr),0,0
GP % Reuse Demand Met,0,0
GP % Load Reduction,100,100
PET Scaling Factor,1,

Generic treatment nodes
Location,GPT (Rocla PL0506)
ID,5
Node Type,GPTNode
Lo-flow bypass rate (cum/sec),0
Hi-flow bypass rate (cum/sec),0.022
Flow Transfer Function
Input (cum/sec),0
Output (cum/sec),0
Input (cum/sec),10
Output (cum/sec),10
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Input (cum/sec),
Output (cum/sec),
Gross Pollutant Transfer Function
Enabled,True
Input (kg/ML),0
Output (kg/ML),0
Input (kg/ML),100
Output (kg/ML),2
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Total Nitrogen Transfer Function
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Enabled,True
Input (mg/L),0
Output (mg/L),0
Input (mg/L),50
Output (mg/L),50
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Total Phosphorus Transfer Function
Enabled,True
Input (mg/L),0
Output (mg/L),0
Input (mg/L),10
Output (mg/L),7
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Total Suspended Solids Transfer Function
Enabled,True
Input (mg/L),0
Output (mg/L),0
Input (mg/L),1000
Output (mg/L),300
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
TSS Flow based Efficiency Enabled,Off
TSS Flow based Efficiency,
TP Flow based Efficiency Enabled,Off
TP Flow based Efficiency,
TN Flow based Efficiency Enabled,Off
TN Flow based Efficiency,
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GP Flow based Efficiency Enabled,Off
GP Flow based Efficiency,
IN - Mean Annual Flow (ML/yr),3.98
IN - TSS Mean Annual Load (kg/yr),350
IN - TP Mean Annual Load (kg/yr),1.12
IN - TN Mean Annual Load (kg/yr),6.01
IN - Gross Pollutant Mean Annual Load (kg/yr),68.1
OUT - Mean Annual Flow (ML/yr),3.98
OUT - TSS Mean Annual Load (kg/yr),105
OUT - TP Mean Annual Load (kg/yr),0.784
OUT - TN Mean Annual Load (kg/yr),6.01
OUT - Gross Pollutant Mean Annual Load (kg/yr),1.36
Flow In (ML/yr),3.97713
ET Loss (ML/yr),0
Infiltration Loss (ML/yr),0
Low Flow Bypass Out (ML/yr),0
High Flow Bypass Out (ML/yr),0
Orifice / Filter Out (ML/yr),0
Weir Out (ML/yr),0
Transfer Function Out (ML/yr),3.97713
Reuse Supplied (ML/yr),0
Reuse Requested (ML/yr),0
% Reuse Demand Met,0
% Load Reduction,0
TSS Flow In (kg/yr),350.479
TSS ET Loss (kg/yr),0
TSS Infiltration Loss (kg/yr),0
TSS Low Flow Bypass Out (kg/yr),0
TSS High Flow Bypass Out (kg/yr),0
TSS Orifice / Filter Out (kg/yr),0
TSS Weir Out (kg/yr),0
TSS Transfer Function Out (kg/yr),105.144
TSS Reuse Supplied (kg/yr),0
TSS Reuse Requested (kg/yr),0
TSS % Reuse Demand Met,0
TSS % Load Reduction,70
TP Flow In (kg/yr),1.11946
TP ET Loss (kg/yr),0
TP Infiltration Loss (kg/yr),0
TP Low Flow Bypass Out (kg/yr),0
TP High Flow Bypass Out (kg/yr),0
TP Orifice / Filter Out (kg/yr),0
TP Weir Out (kg/yr),0
TP Transfer Function Out (kg/yr),0.78362
TP Reuse Supplied (kg/yr),0
TP Reuse Requested (kg/yr),0
TP % Reuse Demand Met,0
TP % Load Reduction,30
TN Flow In (kg/yr),6.00781
TN ET Loss (kg/yr),0
TN Infiltration Loss (kg/yr),0
TN Low Flow Bypass Out (kg/yr),0
TN High Flow Bypass Out (kg/yr),0
TN Orifice / Filter Out (kg/yr),0
TN Weir Out (kg/yr),0
TN Transfer Function Out (kg/yr),6.00781
TN Reuse Supplied (kg/yr),0
TN Reuse Requested (kg/yr),0
TN % Reuse Demand Met,0
TN % Load Reduction,0
GP Flow In (kg/yr),68.082
GP ET Loss (kg/yr),0
GP Infiltration Loss (kg/yr),0
GP Low Flow Bypass Out (kg/yr),0
GP High Flow Bypass Out (kg/yr),0
GP Orifice / Filter Out (kg/yr),0
GP Weir Out (kg/yr),0
GP Transfer Function Out (kg/yr),1.36164
GP Reuse Supplied (kg/yr),0
GP Reuse Requested (kg/yr),0
GP % Reuse Demand Met,0
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GP % Load Reduction,100

Other nodes
Location,Pre-Development Node,Post-Development Node
ID,2,3
Node Type,PreDevelopmentNode,PostDevelopmentNode
IN - Mean Annual Flow (ML/yr),2.97,2.93
IN - TSS Mean Annual Load (kg/yr),99.2,5.95
IN - TP Mean Annual Load (kg/yr),0.285,0.160
IN - TN Mean Annual Load (kg/yr),2.92,1.76
IN - Gross Pollutant Mean Annual Load (kg/yr),16.1,0.00
OUT - Mean Annual Flow (ML/yr),2.97,2.93
OUT - TSS Mean Annual Load (kg/yr),99.2,5.95
OUT - TP Mean Annual Load (kg/yr),0.285,0.160
OUT - TN Mean Annual Load (kg/yr),2.92,1.76
OUT - Gross Pollutant Mean Annual Load (kg/yr),16.1,0.00
% Load Reduction,0.00,43.4
TSS % Load Reduction,0.00,98.8
TN % Load Reduction,0.00,77.6
TP % Load Reduction,0.00,89.7
GP % Load Reduction,0.00,100

Links
Location,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link
Source node ID,1,8,7,5,4,6,9
Target node ID,2,5,5,4,3,9,5
Muskingum-Cunge Routing,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed
Muskingum K, , , , , , ,
Muskingum theta, , , , , , ,
IN - Mean Annual Flow (ML/yr),2.97,1.55,1.65,3.98,2.93,1.98,0.778
IN - TSS Mean Annual Load (kg/yr),99.2,147,164,105,5.95,198,39.2
IN - TP Mean Annual Load (kg/yr),0.285,0.452,0.497,0.784,0.160,0.599,0.170
IN - TN Mean Annual Load (kg/yr),2.92,2.34,2.50,6.01,1.76,3.00,1.17
IN - Gross Pollutant Mean Annual Load (kg/yr),16.1,27.3,40.8,1.36,0.00,47.9,0.00
OUT - Mean Annual Flow (ML/yr),2.97,1.55,1.65,3.98,2.93,1.98,0.778
OUT - TSS Mean Annual Load (kg/yr),99.2,147,164,105,5.95,198,39.2
OUT - TP Mean Annual Load (kg/yr),0.285,0.452,0.497,0.784,0.160,0.599,0.170
OUT - TN Mean Annual Load (kg/yr),2.92,2.34,2.50,6.01,1.76,3.00,1.17
OUT - Gross Pollutant Mean Annual Load (kg/yr),16.1,27.3,40.8,1.36,0.00,47.9,0.00

Catchment Details
Catchment Name,076-18-DA-WSUD-001-50thperc
Timestep,Day
Start Date,1/01/1984
End Date,31/12/1984
Rainfall Station, 066183_Ingleside_1984_Daily
ET Station,User-defined monthly PET
Mean Annual Rainfall (mm), 1477
Mean Annual ET (mm), 1265
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Source nodes
Location,Ex Site,ROOF (0.147 ha),ROAD (0.139 ha),GROUND (0.218 ha)
ID,1,6,7,8
Node Type,AgriculturalSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode
Zoning Surface Type,,Mixed,Mixed,Mixed
Total Area (ha),0.504,0.147,0.139,0.218
Area Impervious (ha),0.0261747869648297,0.147,0.111760149253731,0.0430061940298509
Area Pervious (ha),0.47782521303517,0,0.0272398507462687,0.174993805970149
Field Capacity (mm),50,50,50,50
Pervious Area Infiltration Capacity coefficient - a,50,50,50,50
Pervious Area Infiltration Capacity exponent - b,2,2,2,2
Impervious Area Rainfall Threshold (mm/day),1,1,1,1
Pervious Area Soil Storage Capacity (mm),150,150,150,150
Pervious Area Soil Initial Storage (% of Capacity),25,25,25,25
Groundwater Initial Depth (mm),50,50,50,50
Groundwater Daily Recharge Rate (%),0.65,0.65,0.65,0.65
Groundwater Daily Baseflow Rate (%),0.85,0.85,0.85,0.85
Groundwater Daily Deep Seepage Rate (%),0,0,0,0
Stormflow Total Suspended Solids Mean (log mg/L),1.544,2,2,2
Stormflow Total Suspended Solids Standard Deviation (log mg/L),0.32,0.32,0.32,0.32
Stormflow Total Suspended Solids Estimation Method,Mean,Mean,Mean,Mean
Stormflow Total Suspended Solids Serial Correlation,0,0,0,0
Stormflow Total Phosphorus Mean (log mg/L),-1,-0.52,-0.52,-0.52
Stormflow Total Phosphorus Standard Deviation (log mg/L),0.25,0.25,0.25,0.25
Stormflow Total Phosphorus Estimation Method,Mean,Mean,Mean,Mean
Stormflow Total Phosphorus Serial Correlation,0,0,0,0
Stormflow Total Nitrogen Mean (log mg/L),0,0.18,0.18,0.18
Stormflow Total Nitrogen Standard Deviation (log mg/L),0.19,0.19,0.19,0.19
Stormflow Total Nitrogen Estimation Method,Mean,Mean,Mean,Mean
Stormflow Total Nitrogen Serial Correlation,0,0,0,0
Baseflow Total Suspended Solids Mean (log mg/L),1.2,1.2,1.2,1.2
Baseflow Total Suspended Solids Standard Deviation (log mg/L),1.7,0.17,0.17,0.17
Baseflow Total Suspended Solids Estimation Method,Mean,Mean,Mean,Mean
Baseflow Total Suspended Solids Serial Correlation,0,0,0,0
Baseflow Total Phosphorus Mean (log mg/L),-1.3,-0.85,-0.85,-0.85
Baseflow Total Phosphorus Standard Deviation (log mg/L),0.19,0.19,0.19,0.19
Baseflow Total Phosphorus Estimation Method,Mean,Mean,Mean,Mean
Baseflow Total Phosphorus Serial Correlation,0,0,0,0
Baseflow Total Nitrogen Mean (log mg/L),-0.1,0.18,0.18,0.18
Baseflow Total Nitrogen Standard Deviation (log mg/L),0.12,0.12,0.12,0.12
Baseflow Total Nitrogen Estimation Method,Mean,Mean,Mean,Mean
Baseflow Total Nitrogen Serial Correlation,0,0,0,0
Flow based constituent generation - enabled,Off,Off,Off,Off
Flow based constituent generation - flow file, , , ,
Flow based constituent generation - base flow column, , , ,
Flow based constituent generation - pervious flow column, , , ,
Flow based constituent generation - impervious flow column, , , ,
Flow based constituent generation - unit, , , ,
OUT - Mean Annual Flow (ML/yr),6.53,2.86,2.52,3.05
OUT - TSS Mean Annual Load (kg/yr),221,286,250,293
OUT - TP Mean Annual Load (kg/yr),0.634,0.864,0.756,0.898
OUT - TN Mean Annual Load (kg/yr),6.45,4.33,3.81,4.62
OUT - Gross Pollutant Mean Annual Load (kg/yr),22.1,51.1,43.4,30.8
Rain In (ML/yr),10.4731,3.05466,2.88842,4.53004
ET Loss (ML/yr),3.94516,0.192864,0.373038,1.48216
Deep Seepage Loss (ML/yr),0,0,0,0
Baseflow Out (ML/yr),0.391545,0,0.022734,0.142618
Imp. Stormflow Out (ML/yr),0.490594,2.8618,2.16484,0.848805
Perv. Stormflow Out (ML/yr),5.65176,0,0.328151,2.05862
Total Stormflow Out (ML/yr),6.14235,2.8618,2.49299,2.90742
Total Outflow (ML/yr),6.5339,2.8618,2.51573,3.05004
Change in Soil Storage (ML/yr),-0.005943,0,-0.000345,-0.002165
TSS Baseflow Out (kg/yr),6.20557,0,0.360307,2.26034
TSS Total Stormflow Out (kg/yr),214.949,286.18,249.299,290.742
TSS Total Outflow (kg/yr),221.154,286.18,249.66,293.003
TP Baseflow Out (kg/yr),0.019624,0,0.003211,0.020145
TP Total Stormflow Out (kg/yr),0.614235,0.864249,0.752872,0.878028
TP Total Outflow (kg/yr),0.633859,0.864249,0.756083,0.898173
TN Baseflow Out (kg/yr),0.311015,0,0.034409,0.215861
TN Total Stormflow Out (kg/yr),6.14235,4.3315,3.7733,4.40057
TN Total Outflow (kg/yr),6.45337,4.3315,3.80771,4.61643
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GP Total Outflow (kg/yr),22.3355,51.1003,43.6953,31.7418

No Imported Data Source nodes

USTM treatment nodes
Location, BIO BASIN,Rainwater Tank
ID,4,9
Node Type,BioRetentionNodeV4,RainWaterTankNode
Lo-flow bypass rate (cum/sec),0,0
Hi-flow bypass rate (cum/sec),100,100
Inlet pond volume, ,0
Area (sqm),185,25.5
Initial Volume (m^3), ,0
Extended detention depth (m),0.2,0.2
Number of Rainwater tanks, ,15
Permanent Pool Volume (cubic metres), ,45
Proportion vegetated, ,0
Equivalent Pipe Diameter (mm), ,387
Overflow weir width (m),5,10
Notional Detention Time (hrs), ,9.08E-3
Orifice Discharge Coefficient, ,0.6
Weir Coefficient,1.7,1.7
Number of CSTR Cells,2,2
Total Suspended Solids - k (m/yr),8000,400
Total Suspended Solids - C* (mg/L),20,12
Total Suspended Solids - C** (mg/L), ,12
Total Phosphorus - k (m/yr),6000,300
Total Phosphorus - C* (mg/L),0.13,0.13
Total Phosphorus - C** (mg/L), ,0.13
Total Nitrogen - k (m/yr),500,40
Total Nitrogen - C* (mg/L),1.4,1.4
Total Nitrogen - C** (mg/L), ,1.4
Threshold Hydraulic Loading for C** (m/yr), ,3500
Horizontal Flow Coefficient,3,
Reuse Enabled,Off,On
Max drawdown height (m), ,1.764
Annual Demand Enabled,Off,On
Annual Demand Value (ML/year), ,0.375
Annual Demand Distribution, ,PET
Annual Demand Monthly Distribution: Jan, ,
Annual Demand Monthly Distribution: Feb, ,
Annual Demand Monthly Distribution: Mar, ,
Annual Demand Monthly Distribution: Apr, ,
Annual Demand Monthly Distribution: May, ,
Annual Demand Monthly Distribution: Jun, ,
Annual Demand Monthly Distribution: Jul, ,
Annual Demand Monthly Distribution: Aug, ,
Annual Demand Monthly Distribution: Sep, ,
Annual Demand Monthly Distribution: Oct, ,
Annual Demand Monthly Distribution: Nov, ,
Annual Demand Monthly Distribution: Dec, ,
Daily Demand Enabled,Off,On
Daily Demand Value (ML/day), ,0.0054
Custom Demand Enabled,Off,Off
Custom Demand Time Series File, ,
Custom Demand Time Series Units, ,
Filter area (sqm),185,
Filter perimeter (m),0.1,
Filter depth (m),0.3,
Filter Median Particle Diameter (mm), ,
Saturated Hydraulic Conductivity (mm/hr),125,
Infiltration Media Porosity,0.35,
Length (m), ,
Bed slope, ,
Base Width (m), ,
Top width (m), ,
Vegetation height (m), ,
Vegetation Type,Vegetated with Effective Nutrient Removal Plants,
Total Nitrogen Content in Filter (mg/kg),800,
Orthophosphate Content in Filter (mg/kg),40,
Is Base Lined?,No,
```

```
Is Underdrain Present?,Yes,
Is Submerged Zone Present?,No,
Submerged Zone Depth (m), ,
B for Media Soil Texture,13,-9999
Proportion of upstream impervious area treated, ,
Exfiltration Rate (mm/hr),2.5,0
Evaporative Loss as % of PET,100,0
Depth in metres below the drain pipe, ,
TSS A Coefficient, ,
TSS B Coefficient, ,
TP A Coefficient, ,
TP B Coefficient, ,
TN A Coefficient, ,
TN B Coefficient, ,
Sfc,0.61,
S*,0.37,
Sw,0.11,
Sh,0.05,
Emax (m/day),0.008,
Ew (m/day),0.001,
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IN - TSS Mean Annual Load (kg/yr),195,286
IN - TP Mean Annual Load (kg/yr),1.44,0.864
IN - TN Mean Annual Load (kg/yr),10.9,4.33
IN - Gross Pollutant Mean Annual Load (kg/yr),1.48,51.1
OUT - Mean Annual Flow (ML/yr),6.11,1.63
OUT - TSS Mean Annual Load (kg/yr),17.1,108
OUT - TP Mean Annual Load (kg/yr),0.353,0.401
OUT - TN Mean Annual Load (kg/yr),3.89,2.45
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00
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ET Loss (ML/yr),0.231571,0
Infiltration Loss (ML/yr),0.8593,0
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High Flow Bypass Out (ML/yr),0,0
Orifice / Filter Out (ML/yr),5.84971,1.63185
Weir Out (ML/yr),0.256523,0
Transfer Function Out (ML/yr),0,0
Reuse Supplied (ML/yr),0,1.05789
Reuse Requested (ML/yr),0,2.346
% Reuse Demand Met,0,45.0934
% Load Reduction,15.1636,42.9782
TSS Flow In (kg/yr),195.325,286.18
TSS ET Loss (kg/yr),0,0
TSS Infiltration Loss (kg/yr),1.87294,0
TSS Low Flow Bypass Out (kg/yr),0,0
TSS High Flow Bypass Out (kg/yr),0,0
TSS Orifice / Filter Out (kg/yr),11.7303,108.418
TSS Weir Out (kg/yr),5.39627,0
TSS Transfer Function Out (kg/yr),0,0
TSS Reuse Supplied (kg/yr),0,22.5796
TSS Reuse Requested (kg/yr),0,0
TSS % Reuse Demand Met,0,0
TSS % Load Reduction,91.2317,62.1155
TP Flow In (kg/yr),1.43861,0.864249
TP ET Loss (kg/yr),0,0
TP Infiltration Loss (kg/yr),0.048576,0
TP Low Flow Bypass Out (kg/yr),0,0
TP High Flow Bypass Out (kg/yr),0,0
TP Orifice / Filter Out (kg/yr),0.316639,0.400898
TP Weir Out (kg/yr),0.036811,0
TP Transfer Function Out (kg/yr),0,0
TP Reuse Supplied (kg/yr),0,0.163988
TP Reuse Requested (kg/yr),0,0
TP % Reuse Demand Met,0,0
TP % Load Reduction,75.4312,53.6131
TN Flow In (kg/yr),10.8756,4.3315
TN ET Loss (kg/yr),0,0
TN Infiltration Loss (kg/yr),0.515717,0
TN Low Flow Bypass Out (kg/yr),0,0
TN High Flow Bypass Out (kg/yr),0,0
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TN Orifice / Filter Out (kg/yr),3.50982,2.45143
TN Weir Out (kg/yr),0.382201,0
TN Transfer Function Out (kg/yr),0,0
TN Reuse Supplied (kg/yr),0,1.55595
TN Reuse Requested (kg/yr),0,0
TN % Reuse Demand Met,0,0
TN % Load Reduction,64.2132,43.4046
GP Flow In (kg/yr),1.48396,51.1003
GP ET Loss (kg/yr),0,0
GP Infiltration Loss (kg/yr),0,0
GP Low Flow Bypass Out (kg/yr),0,0
GP High Flow Bypass Out (kg/yr),0,0
GP Orifice / Filter Out (kg/yr),0,0
GP Weir Out (kg/yr),0,0
GP Transfer Function Out (kg/yr),0,0
GP Reuse Supplied (kg/yr),0,0
GP Reuse Requested (kg/yr),0,0
GP % Reuse Demand Met,0,0
GP % Load Reduction,100,100
PET Scaling Factor,1,

Generic treatment nodes
Location,GPT (Rocla PL0506)
ID,5
Node Type,GPTNode
Lo-flow bypass rate (cum/sec),0
Hi-flow bypass rate (cum/sec),0.022
Flow Transfer Function
Input (cum/sec),0
Output (cum/sec),0
Input (cum/sec),10
Output (cum/sec),10
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Input (cum/sec),
Output (cum/sec),
Gross Pollutant Transfer Function
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Output (kg/ML),0
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Output (kg/ML),2
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Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Input (kg/ML),
Output (kg/ML),
Total Nitrogen Transfer Function
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Output (mg/L),50
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Output (mg/L),
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Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Total Phosphorus Transfer Function
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Output (mg/L),0
Input (mg/L),10
Output (mg/L),7
Input (mg/L),
Output (mg/L),
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Output (mg/L),
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Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Input (mg/L),
Output (mg/L),
Total Suspended Solids Transfer Function
Enabled,True
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Output (mg/L),0
Input (mg/L),1000
Output (mg/L),300
Input (mg/L),
Output (mg/L),
Input (mg/L),
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Output (mg/L),
Input (mg/L),
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Input (mg/L),
Output (mg/L),
TSS Flow based Efficiency Enabled,Off
TSS Flow based Efficiency,
TP Flow based Efficiency Enabled,Off
TP Flow based Efficiency,
TN Flow based Efficiency Enabled,Off
TN Flow based Efficiency,
```

```
GP Flow based Efficiency Enabled,Off
GP Flow based Efficiency,
IN - Mean Annual Flow (ML/yr),7.20
IN - TSS Mean Annual Load (kg/yr),651
IN - TP Mean Annual Load (kg/yr),2.06
IN - TN Mean Annual Load (kg/yr),10.9
IN - Gross Pollutant Mean Annual Load (kg/yr),74.2
OUT - Mean Annual Flow (ML/yr),7.20
OUT - TSS Mean Annual Load (kg/yr),195
OUT - TP Mean Annual Load (kg/yr),1.44
OUT - TN Mean Annual Load (kg/yr),10.9
OUT - Gross Pollutant Mean Annual Load (kg/yr),1.48
Flow In (ML/yr),7.19764
ET Loss (ML/yr),0
Infiltration Loss (ML/yr),0
Low Flow Bypass Out (ML/yr),0
High Flow Bypass Out (ML/yr),0
Orifice / Filter Out (ML/yr),0
Weir Out (ML/yr),0
Transfer Function Out (ML/yr),7.19764
Reuse Supplied (ML/yr),0
Reuse Requested (ML/yr),0
% Reuse Demand Met,0
% Load Reduction,0
TSS Flow In (kg/yr),651.083
TSS ET Loss (kg/yr),0
TSS Infiltration Loss (kg/yr),0
TSS Low Flow Bypass Out (kg/yr),0
TSS High Flow Bypass Out (kg/yr),0
TSS Orifice / Filter Out (kg/yr),0
TSS Weir Out (kg/yr),0
TSS Transfer Function Out (kg/yr),195.325
TSS Reuse Supplied (kg/yr),0
TSS Reuse Requested (kg/yr),0
TSS % Reuse Demand Met,0
TSS % Load Reduction,70
TP Flow In (kg/yr),2.05516
TP ET Loss (kg/yr),0
TP Infiltration Loss (kg/yr),0
TP Low Flow Bypass Out (kg/yr),0
TP High Flow Bypass Out (kg/yr),0
TP Orifice / Filter Out (kg/yr),0
TP Weir Out (kg/yr),0
TP Transfer Function Out (kg/yr),1.43861
TP Reuse Supplied (kg/yr),0
TP Reuse Requested (kg/yr),0
TP % Reuse Demand Met,0
TP % Load Reduction,30
TN Flow In (kg/yr),10.8756
TN ET Loss (kg/yr),0
TN Infiltration Loss (kg/yr),0
TN Low Flow Bypass Out (kg/yr),0
TN High Flow Bypass Out (kg/yr),0
TN Orifice / Filter Out (kg/yr),0
TN Weir Out (kg/yr),0
TN Transfer Function Out (kg/yr),10.8756
TN Reuse Supplied (kg/yr),0
TN Reuse Requested (kg/yr),0
TN % Reuse Demand Met,0
TN % Load Reduction,0
GP Flow In (kg/yr),74.1982
GP ET Loss (kg/yr),0
GP Infiltration Loss (kg/yr),0
GP Low Flow Bypass Out (kg/yr),0
GP High Flow Bypass Out (kg/yr),0
GP Orifice / Filter Out (kg/yr),0
GP Weir Out (kg/yr),0
GP Transfer Function Out (kg/yr),1.48396
GP Reuse Supplied (kg/yr),0
GP Reuse Requested (kg/yr),0
GP % Reuse Demand Met,0
```

```
GP % Load Reduction,100

Other nodes
Location,Pre-Development Node,Post-Development Node
ID,2,3
Node Type,PreDevelopmentNode,PostDevelopmentNode
IN - Mean Annual Flow (ML/yr),6.53,6.11
IN - TSS Mean Annual Load (kg/yr),221,17.1
IN - TP Mean Annual Load (kg/yr),0.634,0.353
IN - TN Mean Annual Load (kg/yr),6.45,3.89
IN - Gross Pollutant Mean Annual Load (kg/yr),22.1,0.00
OUT - Mean Annual Flow (ML/yr),6.53,6.11
OUT - TSS Mean Annual Load (kg/yr),221,17.1
OUT - TP Mean Annual Load (kg/yr),0.634,0.353
OUT - TN Mean Annual Load (kg/yr),6.45,3.89
OUT - Gross Pollutant Mean Annual Load (kg/yr),22.1,0.00
% Load Reduction,0.00,27.5
TSS % Load Reduction,0.00,97.9
TN % Load Reduction,0.00,69.5
TP % Load Reduction,0.00,86.0
GP % Load Reduction,0.00,100

Links
Location,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link
Source node ID,1,8,7,5,4,6,9
Target node ID,2,5,5,4,3,9,5
Muskingum-Cunge Routing,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed
Muskingum K, , , , , , ,
Muskingum theta, , , , , , ,
IN - Mean Annual Flow (ML/yr),6.53,3.05,2.52,7.20,6.11,2.86,1.63
IN - TSS Mean Annual Load (kg/yr),221,293,250,195,17.1,286,108
IN - TP Mean Annual Load (kg/yr),0.634,0.898,0.756,1.44,0.353,0.864,0.401
IN - TN Mean Annual Load (kg/yr),6.45,4.62,3.81,10.9,3.89,4.33,2.45
IN - Gross Pollutant Mean Annual Load (kg/yr),22.1,30.8,43.4,1.48,0.00,51.1,0.00
OUT - Mean Annual Flow (ML/yr),6.53,3.05,2.52,7.20,6.11,2.86,1.63
OUT - TSS Mean Annual Load (kg/yr),221,293,250,195,17.1,286,108
OUT - TP Mean Annual Load (kg/yr),0.634,0.898,0.756,1.44,0.353,0.864,0.401
OUT - TN Mean Annual Load (kg/yr),6.45,4.62,3.81,10.9,3.89,4.33,2.45
OUT - Gross Pollutant Mean Annual Load (kg/yr),22.1,30.8,43.4,1.48,0.00,51.1,0.00

Catchment Details
Catchment Name,076-18-DA-WSUD-001-90thperc
Timestep,Day
Start Date,1/01/1998
End Date,31/12/1998
Rainfall Station, 066183_Ingleside_1998_Daily
ET Station,User-defined monthly PET
Mean Annual Rainfall (mm), 2078
Mean Annual ET (mm), 1260
```

Appendix E – Flood Study

Bringing engineering to life

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53A & 53B Warriewood Road, Warriewood - Flood Study

Report Prepared for:
Craig & Rhodes

Project No. 2170

Prepared by:
Storm Consulting

SUSTAINABLE WATER
STORMWATER & RUNOFF
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1.0 INTRODUCTION

1.1. Background

Storm Consulting was commissioned by Craig & Rhodes to provide a flood risk assessment for the proposed development at 53A & 53B Warriewood Road, Warriewood (herein referred to as the Site). This report outlines the flood impact assessment for the proposed development based on an existing TUFLOW model. The existing TUFLOW model was obtained from Council and was prepared by BMT WBM for the Narrabeen Lagoon Flood Study in September 2013.

This report outlines the flood assessment undertaken for the proposed development at 53A & 53B Warriewood Road, Warriewood.

1.2. Proposed Development

The proposed development earthworks include the addition of a fill area in the north-eastern half of the Site to support development as well as a water management basin. The low-lying floodplain area in the southern portion of the site is largely unchanged from existing conditions. In addition, creek modification of Narrabeen Creek is proposed to increase the flood storage.

1.3. Catchment Description

The site is located within the Narrabeen Lagoon catchment which occupies a 55 km^2 and drains to the Tasman sea through a narrow channel. The catchment topography is undulating and ranges from steep slopes in the upper areas to flat floodplain areas around Narrabeen Lagoon and Warriewood Valley (the location of the site). The catchment land use is a mixture of urban, rural, recreational and bushland.

2.0 METHODOLOGY AND RESULTS

2.1. General

This section of the report outlines the methodology used to complete the flood impact assessment, including the relevant background information and details of the existing TUFLOW hydraulic model. It also outlines the existing flood behaviour, details of the developed case flood modelling and the impact of the proposed development on the existing flood behaviour.

The overall methodology for this study was undertaken in three stages and is summarised below.

- Review Narrabeen Lagoon Flood Study and cut-down model to develop Baseline model. Validate Baseline model to the results of the Narrabeen Lagoon Flood Study.
- Modify Baseline model to include updated ground survey data and neighbouring new developments to represent the Existing Case flood conditions.
- Modify Existing Case model to include the proposed development design in order to represent the Developed Case flood conditions.

This project will assess the 20% Annual Exceedance Probability (AEP), 10% AEP, 5% AEP, 1% AEP, 1% + Climate Change and the Probable Maximum Flood (PMF) design storm events. The climate change scenario is represented by a 30% increase in rainfall combined with the year 2100 sea level rise.

2.2. Summary of Narrabeen Lagoon Flood Study

For full details on the model development, assumptions and results, refer to the Final Report by BMT WBM - 'Narrabeen Lagoon Flood Study' R.N2070.005.04 September 2013.

The Narrabeen Lagoon Flood Study was prepared by BMT WBM for Warringah and Pittwater Councils. The primary objective of the study was to define the flood behaviour under historical, existing and future conditions (incorporating potential impacts of climate change) in the Narrabeen Lagoon catchment for a full range of design flood events.

The flooding is represented by a hydrologic model and a linked 1D/2D hydraulic model which simulated the flow behaviour. The hydraulic model incorporates the available survey and local topographical and hydraulic controls and extends from the Lagoon entrance (the model outlet) up to the head of the catchment (the catchment in its entirety).

The model was primarily calibrated by BMT WBM to the April 1998 historical flood event and also validated to the March 2011 and August 1998 historical flood events. Sensitivity testing of the modelled lagoon entrance berm conditions; the coincident catchment and ocean flooding conditions; structure blockages and changes in the adopted roughness parameters was undertaken by BMT WBM.

The impacts of future climate change represented by sea level rise and increased rainfall intensity were incorporated into the assessment of future flooding conditions. The climate change scenarios assessed were:

- Increases in rainfall intensity for flood producing events;
- Higher ocean water levels (tide and storm surge) under sea level rise;
- Higher entrance berm heights under sea level rise; and
- Higher initial Lagoon water levels under sea level rise.

XP-RAFTS software was used to develop the hydrological model using the physical characteristics of the catchment, these being the area, slope and roughness. The majority of the model adopts the XP-RAFTS sub-catchment inflows, while a small portion in the lower part of the catchment adopts the Direct Rainfall method.

The hydraulic model was developed using the software TUFLOW. A linked 1D/2D model was prepared using a 6 m grid resolution with smaller channels and culverts being represented using 1D elements linked to the 2D floodplain. The Manning's roughness grid was delineated using aerial photography and cadastral data.

Boundary conditions were applied as sub-catchment inflows (flow vs. time inputs) at inflow points along modelled watercourses and as a water level time series at the downstream end of the model.

The modelled durations include the 0.5 hour, 1 hour, 1.5 hour, 2 hour, 3 hour, 4.5 hour, 6 hour, 9 hour, 12 hour, 18 hour and 24 hour durations. The critical duration in the Narrabeen Creek sub-catchment (in which the subject site is located) is the 2 hour event for the 1 % AEP (100 year Average Recurrence Interval) design storm event.

2.3. Baseline Cut-Down Model

The Narrabeen Lagoon Flood Study model was cut down and updated to derive the baseline flood condition.

The Narrabeen Lagoon Flood Study model (herein referred to as the Narrabeen Model) was cut-down in order to reduce run times by placing PO (print out) lines at boundary condition locations and re-running the model to produce additional PO outputs. The PO outputs were then extracted as flow vs. time for the upstream inflows and water level vs. time for the downstream boundaries and were then used as the cut-down model boundary condition inputs.

The creek, in this section of the Narrabeen Model, is represented by a 1D channel linked to the 2D floodplain. As such, the 1d_Q (1D Flow) results for the 1D domain were extracted from the Narrabeen Model and used as inputs to the cut-down model in the 1D domain.

The relevant model GIS layers were then cut-down and the code boundary reduced to cover only the relevant area for this study. Minor changes were made to the Narrabeen Model to attempt to stabilise the model (i.e. reducing the 1D timestep). The Morphology module was also turned off as it wasn't relevant to the current project.

A layout of the Narrabeen Model and the cut-down model hydraulic boundary is included as Figure 1.

The cut-down baseline model results were then compared to the results of the Narrabeen Model for the 1% AEP event. The flood extents remained consistent while the flood levels in the vicinity of the site were within 5 mm of the Narrabeen Model results, with the remainder of the model within 20mm of the Narrabeen Model results, which was considered a good match. As such, the cut-down baseline model was validated to the Narrabeen Model.

Storm

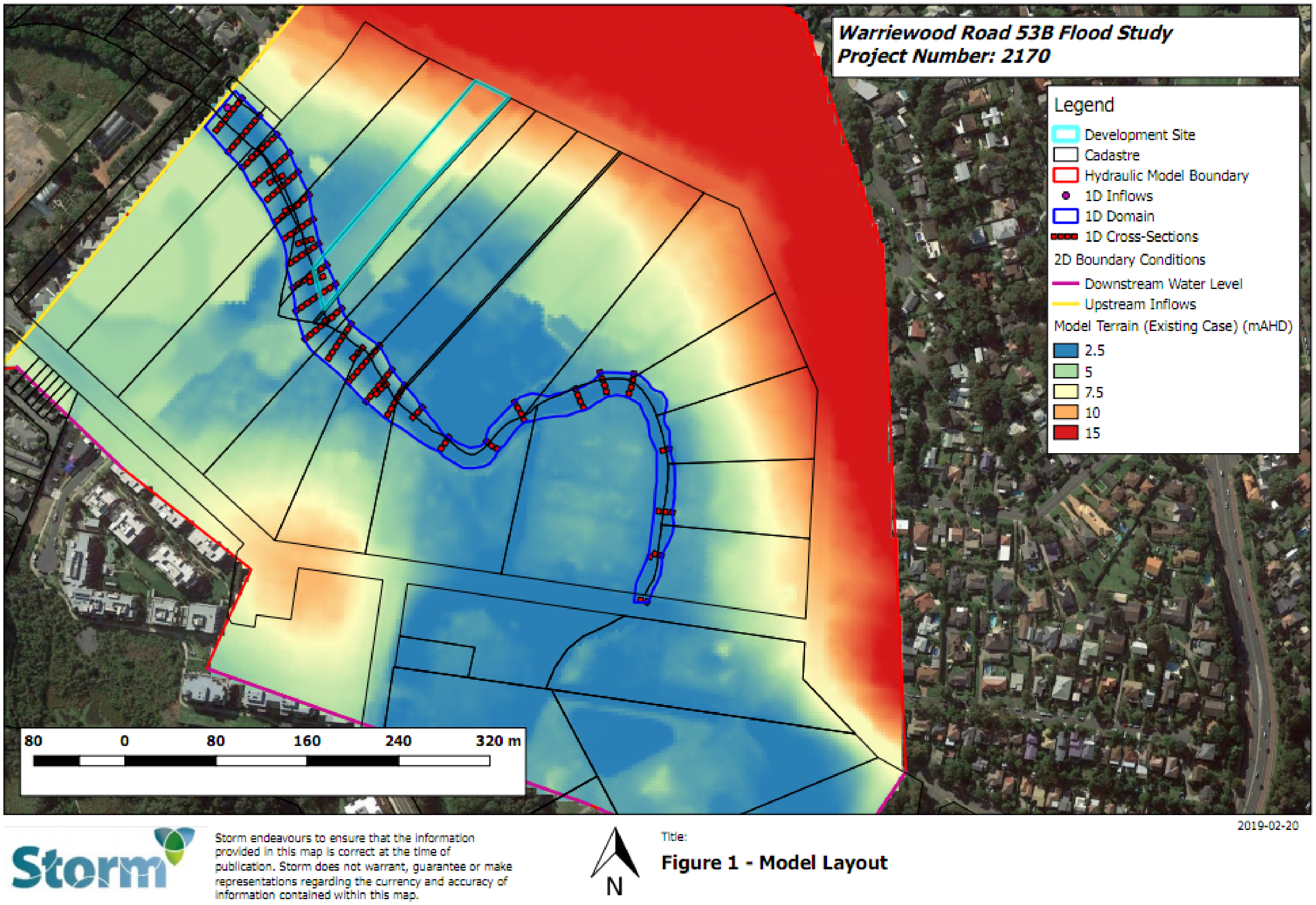


Figure 1 **Narrabeen Lagoon Flood Study Layout**

2.4. Revised Existing Case Flood Condition

2.4.1. Methodology

The baseline model topography was defined by a combination of LiDAR and site survey, however it did not include the site survey for 53A & 53B Warriewood Road or the site survey and design tin of the recently developed neighbouring lot to the east – 41 Warriewood Road (including Narrabeen Creek modification works). Therefore, the baseline model was updated to include the survey for 53A & 53B Warriewood Road and the survey and design tin for 41 Warriewood Road. These files were provided by Craig & Rhodes and a 0.5m cell size DEM was extracted from each for use in the TUFLOW model.

2.4.1. Flood Behaviour

Modelled Existing Case condition peak levels at the centre of the site are presented in **Table 1** for the full range of design flood events considered. All results provided are the maximum of the full flood envelope (all design flood events considered).

The existing case 1% AEP, 1% AEP + Climate Change (CC) and PMF design flood event maps are provided in Figures A1 to A4 in Appendix A. It should be noted that the existing case condition includes the recent development at 41 Warriewood Road incorporating the creek modifications.

Table 1 Simulated Existing Case Peak Flood Levels

Design Event (AEP)	Peak Flood Level (m AHD)
20% *	3.775
10%	3.922
5%	4.121
1%	4.308
1% + Climate Change	4.440
PMF	5.359

* This event is actually the 5 year ARI which equates to a 18.13 % AEP, however 20% AEP is used for ease of reading.

The flood levels are relatively consistent across the site due to the floodplain nature of the area, however there is a slight gradient, which follows the topography, from the road down to the creek invert.

As demonstrated in Figures A1 to A3, the Narrabeen Creek capacity is exceeded in these events (as it does in the 20% AEP, the 10% AEP and the 5% AEP). The creek banks are breached causing the low-lying floodplain storage to be activated and subsequently filling a significant portion of the site. In the PMF event, there is widespread inundation on both sides of Narrabeen Creek.

Downstream of the site, peak flood levels are impacted by the level in the Narrabeen Lagoon. However, the site itself is not significantly impacted by the Narrabeen Lagoon tailwater levels. This is due to the Macpherson Street Bridge downstream.

2.4.2. Hydraulic Categorisation

The hydraulic categories for the existing case were derived using the 1% AEP results and a map is provided in Figure A4 in Appendix A. The hydraulic categories are in accordance with Council's DCP and are defined in **Table 2**.

53A & 53B Warriewood Road is within the flood fringe categorisation for the majority of the site. Some localised areas close to the creek (the western boundary of the site) are classified as floodway.

Table 2 Hydraulic Categorisation Criteria

Category	Criteria	Description
Floodway	Velocity x Depth > 0.5 m2/s	Areas and flow paths where a significant proportion of floodwaters are conveyed (including all bank-to-bank creek sections).
Flood Storage	Velocity x Depth < 0.5 and Depth > 0.5 m	Areas where floodwaters accumulate before being conveyed downstream. These areas are important for detention and attenuation of flood peaks.
Flood Fringe	Velocity x Depth <0.5 and Depth < 0.5m	Areas that are low-velocity backwaters within the floodplain. Filling of these areas generally has little consequence to overall flood behaviour.

2.5. Developed Case Flood Condition

2.5.1. Modelling Approach

The developed case flood conditions were assessed by modifying the Existing Case model to represent the post-development conditions at 53A & 53B Warriewood Road. This included updating the topography with the proposed design triangulation model (TIN – model of finished ground levels for the proposed development), the proposed basin TIN and the proposed creek modification works TIN provided by Craig & Rhodes. A 0.5 m DEM was extracted from the design tins and input to the TUFLOW model. A number of iterations were undertaken to optimise the flood impacts of the development.

The Developed Case model does not include proposed drainage on the site.

2.5.2. Modelling Results

The modelled developed case peak flood levels through the centre of the site is presented in **Table 3** for the full range of design flood events considered. All results provided are the maximum of the full flood envelope (all design flood events considered).

The developed case 1% AEP, 1% AEP + Climate Change and PMF design flood event maps are provided on Figure B1 to B4 in Appendix B. It should be noted that the developed case condition includes the recent development at 41 Warriewood Road incorporating the creek modifications for both 41 and 53A & 53B Warriewood Road.

The results presented in Table 3 indicate that the flood levels at the site are generally reduced by up to 100mm as a result of the proposed development.

Table 3 Simulated Developed Case Peak Flood Levels

Design Event (AEP)	Peak Flood Level (m AHD)
20% *	3.76 (-0.02)
10%	3.86 (-0.058)
5%	4.02 (-0.106)
1%	4.24 (-0.094)
1% + Climate Change	4.36 (-0.079)
PMF	5.36 (0)

* This event is actually the 5 year ARI which equates to a 18.13 % AEP, however 20% AEP is used for ease of reading.
Note: Bracketed value is change in peak flood level from existing case conditions.

The hydraulic categories for the developed case were derived using the 1% AEP results and a map is provided in Figure B4 in Appendix B. 53A & 53B Warriewood Road is within the flood fringe categorisation for the majority of the site. Some localised areas close to the creek (the western boundary of the site) are classified as flood storage or floodway.

The afflux (change in water surface level) map for the 1% AEP design event is provided on Figure B5 in Appendix B. It shows that the proposed development has negligible impacts on the simulated existing condition peak design flood levels across the site, as well as upstream and downstream of the site. The modelling results demonstrated that the impacts to flood levels are limited to +7 mm for all design events considered, which is deemed to be within reasonable tolerance for a flood model of this size when considering the use of the combinations of survey data (detailed survey, LiDAR surface models, etc.) and modelling parameters (grid size, timestep, etc.).

The afflux map for the 1% AEP + CC design event is provided on Figure B6 in Appendix B. It shows that the propose development locally increases flood levels in Narrabeen Creek by up to a maximum of +7 mm in this event. The 1 % AEP + CC design event is the critical event of the design storm events modelled in terms of afflux impacts.

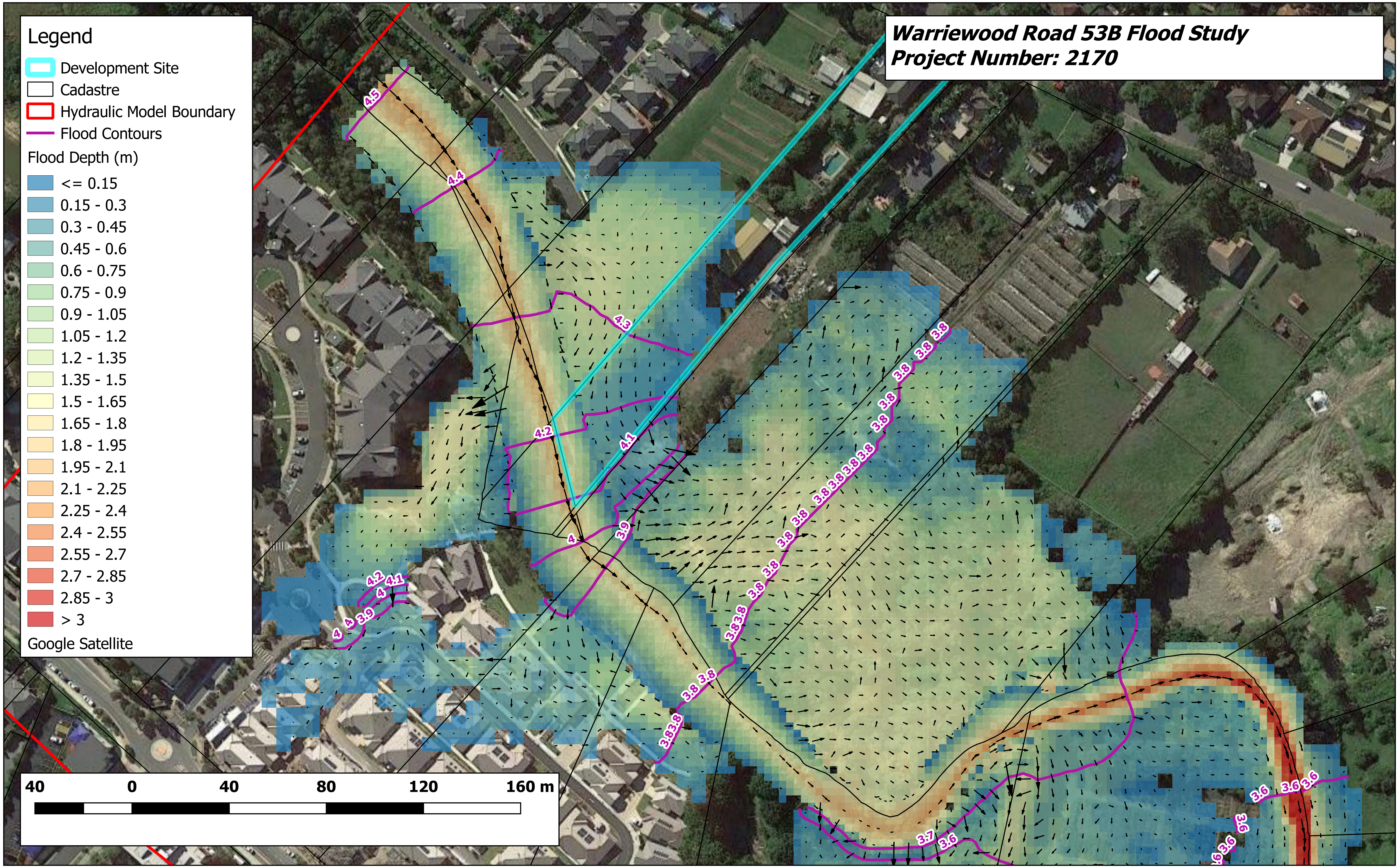
3.0 DISCUSSION & CONCLUSION

Based on the flood planning considerations that are applicable to the site, the revised flood impact assessment has shown that:

- There is no adverse flood impact on surrounding properties or on flooding processes for any event assessed up to the PMF event.
- There is a slight decrease in the combined 1% AEP event floodway/flood storage volume as a result of the proposed subdivision earthworks. However, this slight reduction in storage volume is offset by the earthworks associated with the Narrabeen Creek rehabilitation works which amounts to a marginal net increase in flood storage and does not result in adverse flood impacts on surrounding properties at the 1% AEP event.
- The adopted Flood Planning Level (FPL) for the site was calculated by adding a 0.5m freeboard allowance to the simulated 1% AEP+CC developed peak flood level (refer Table 3). The adopted FPL for the site is 4.86 m AHD.
- There are no additional flood prone lots (i.e. lots located below the FPL) created within the proposed Subdivision.

APPENDIX A

Existing Case Flood Mapping



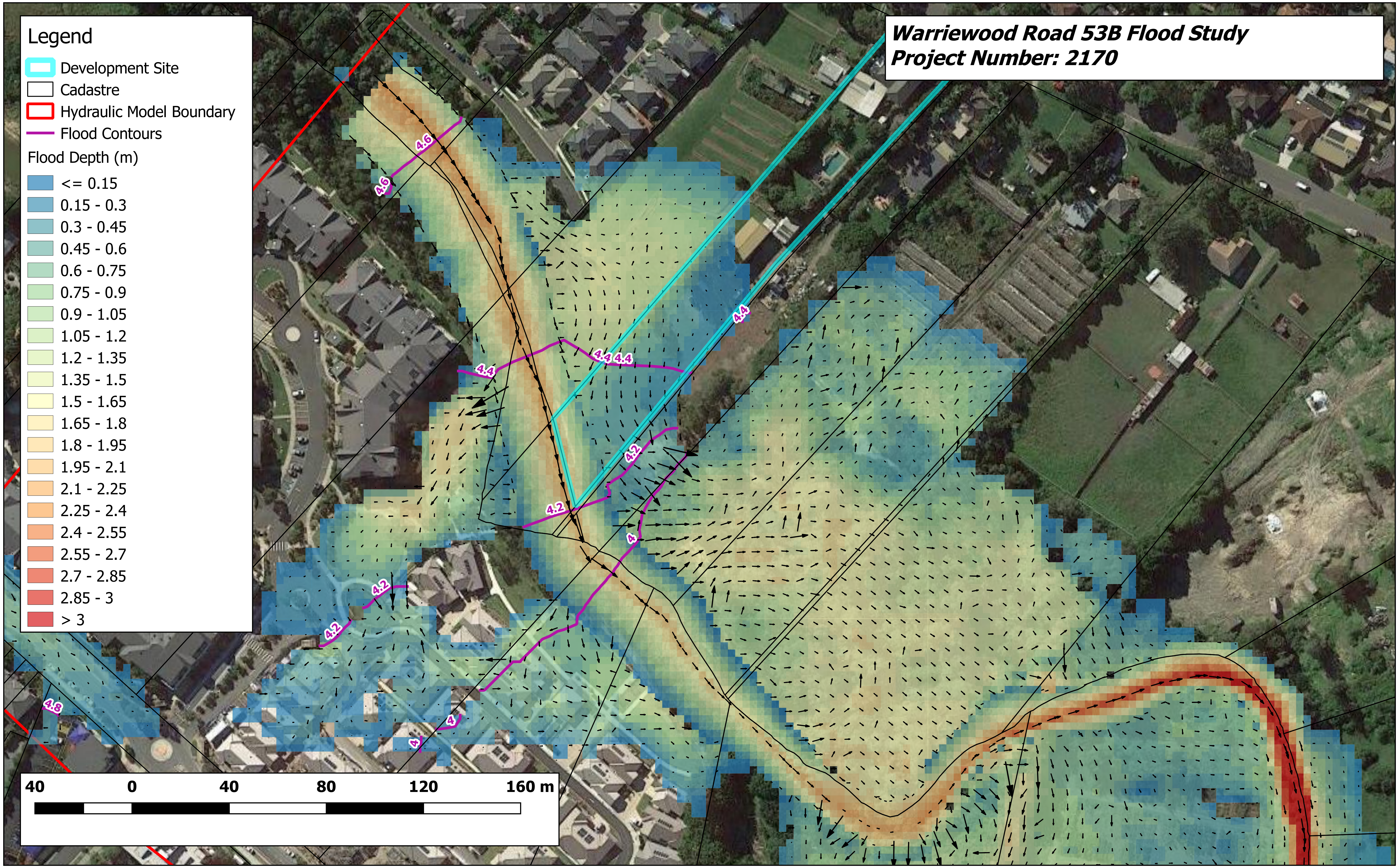
2019-02-20

Storm endeavours to ensure that the information provided in this map is correct at the time of publication. Storm does not warrant, guarantee or make representations regarding the currency and accuracy of information contained within this map.

N

Title:

Figure A1 - 1% AEP Design Storm Event
Peak Flood Conditions Existing Case (Baseline)



2019-02-19

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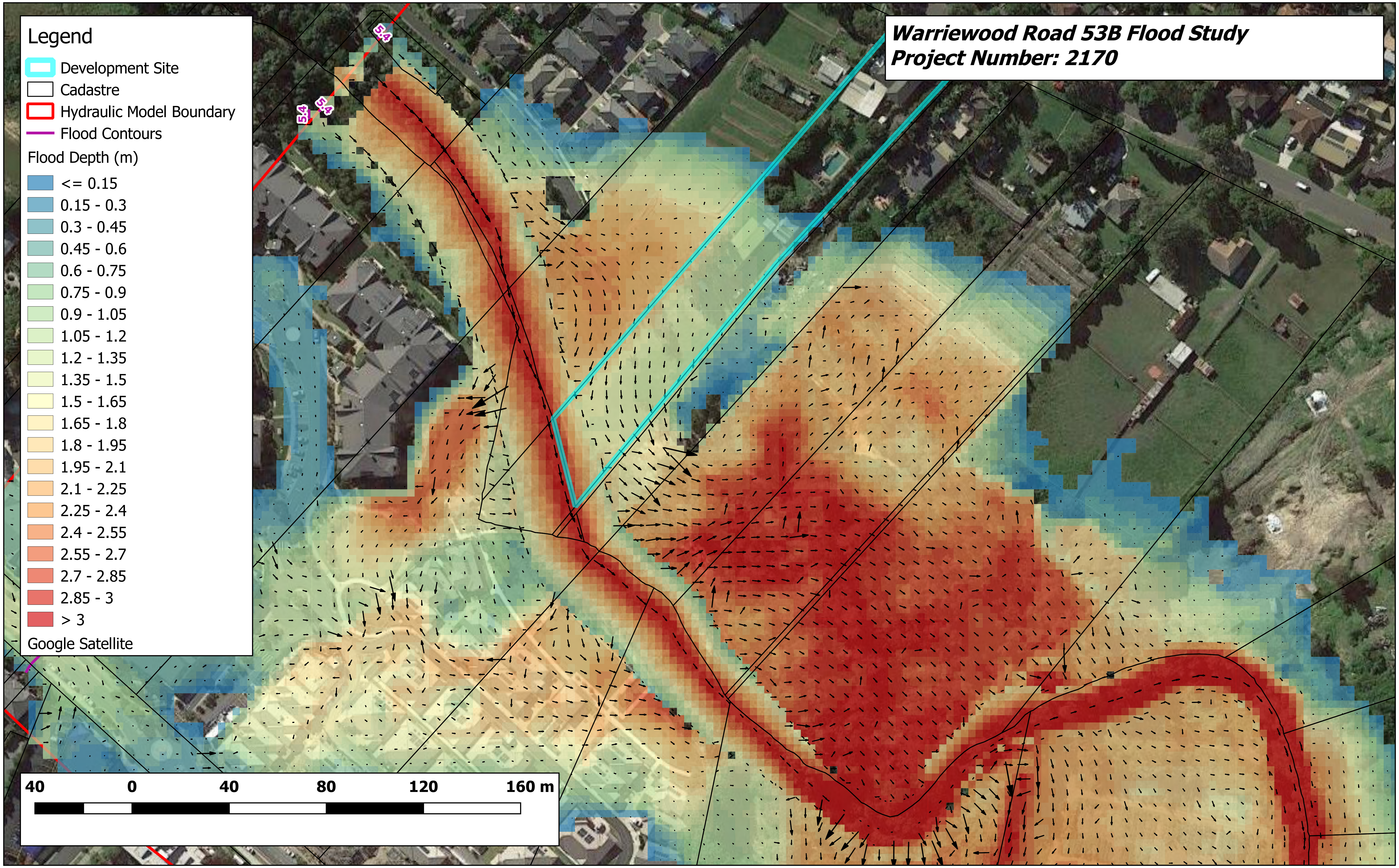
N

Title:

Figure A2 - 1% AEP + CC Design Storm Event Peak Flood Conditions Existing Case (Baseline)



2019-02-20

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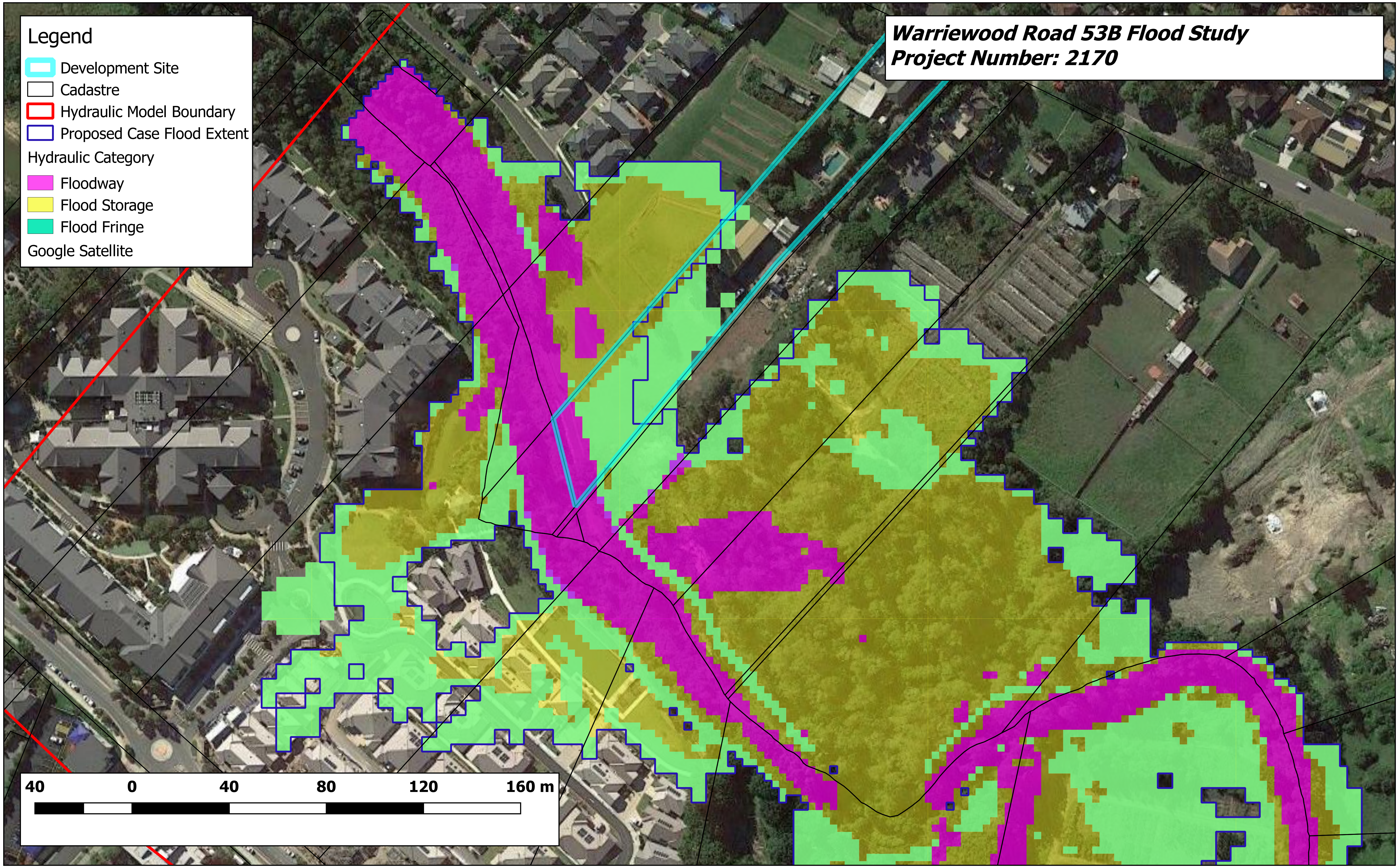
Title:

Figure A3 - PMF Design Storm Event
Peak Flood Conditions Existing Case (Baseline)



2019-02-20

Storm

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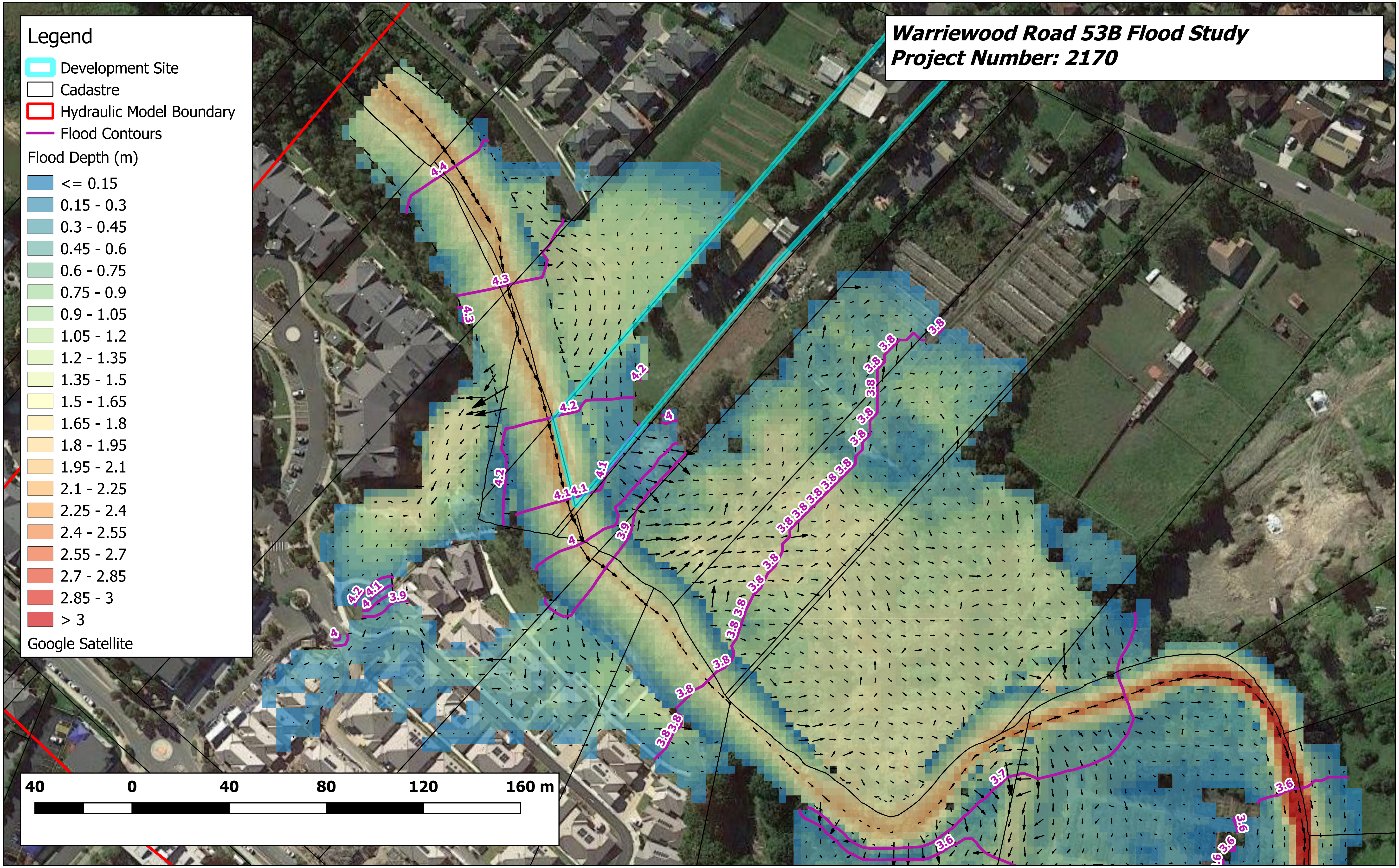
N

Title:

Figure A4 - 1% AEP Design Storm Event Hydraulic Category Existing Case (Baseline)

APPENDIX B

Developed Case Flood Mapping



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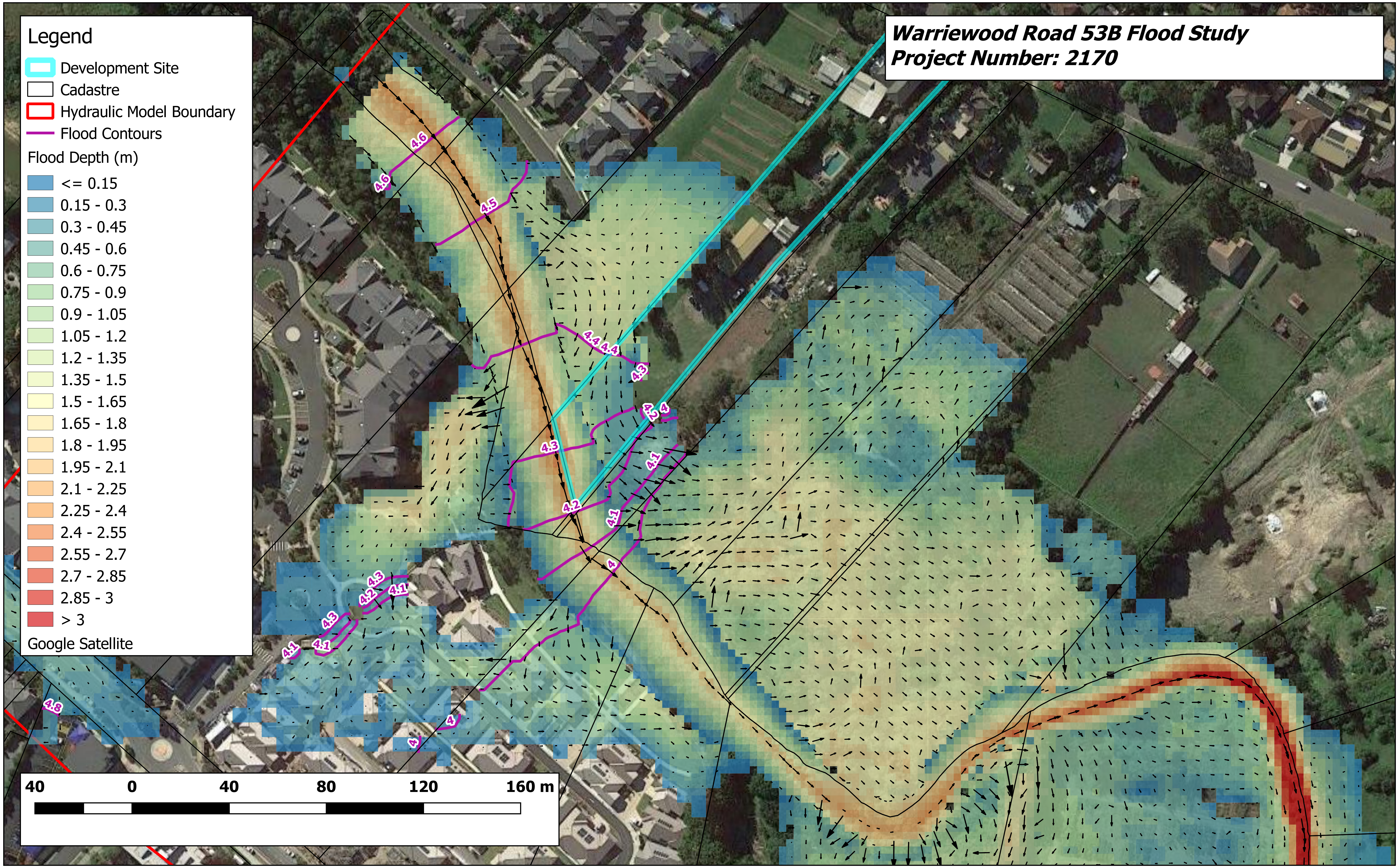
N

Title:

Figure B1 - 1% AEP Design Storm Event Peak Flood Conditions Developed Case



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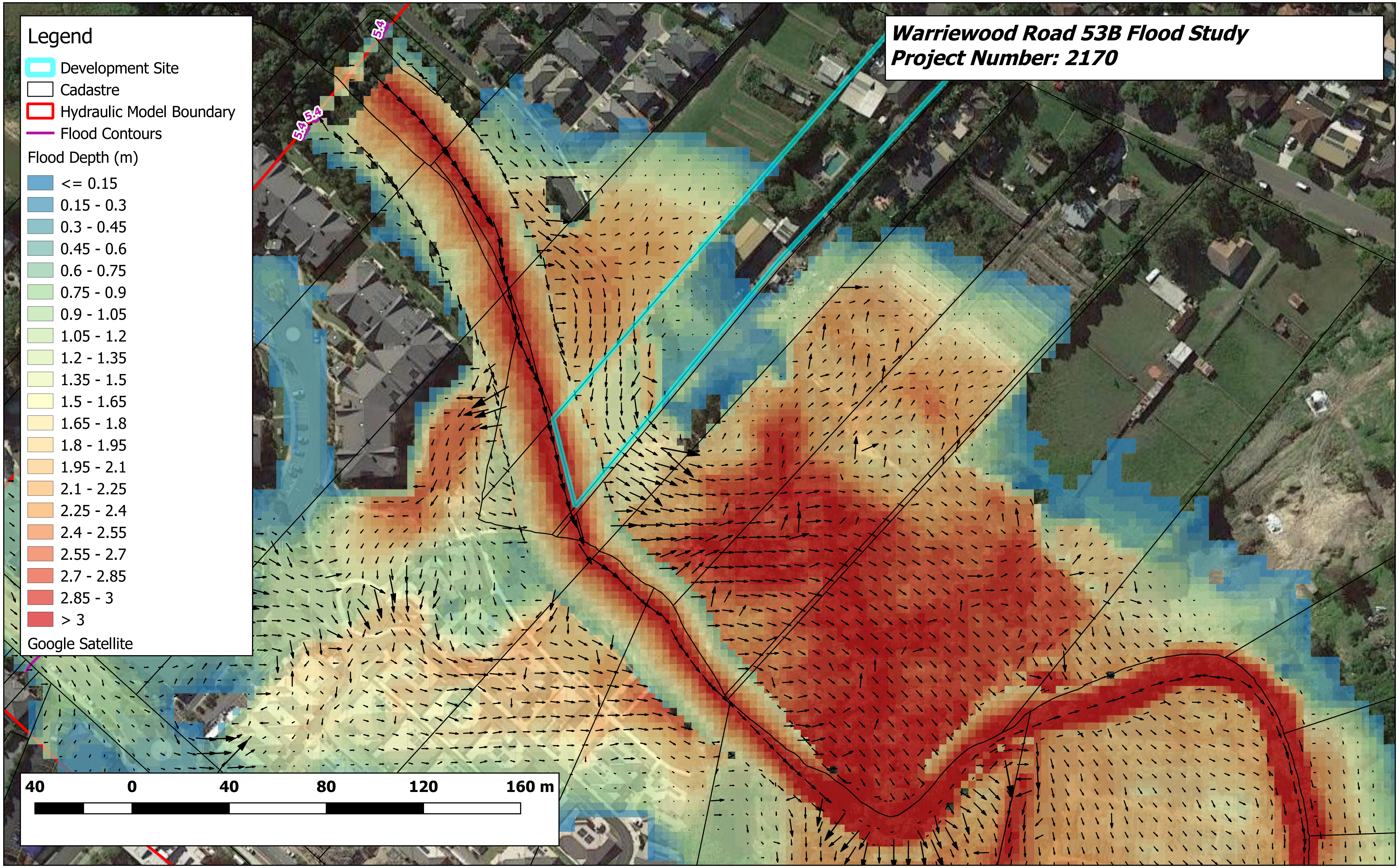
Title:

Figure B2 - 1% AEP + CC Design Storm Event
Peak Flood Conditions Developed Case



2019-02-20

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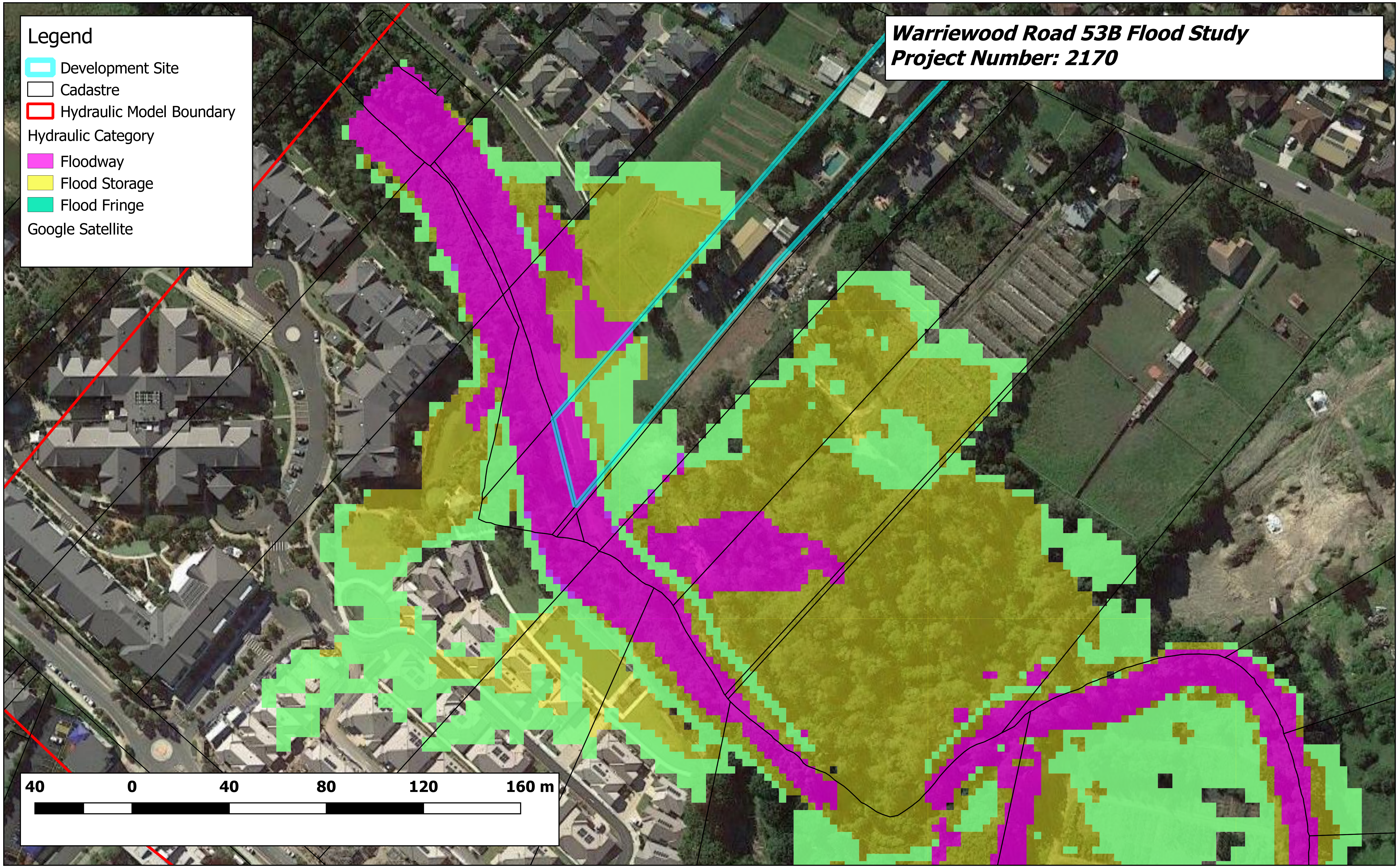
N

Title:

Figure B3 - PMF Design Storm Event
Peak Flood Conditions Developed Case



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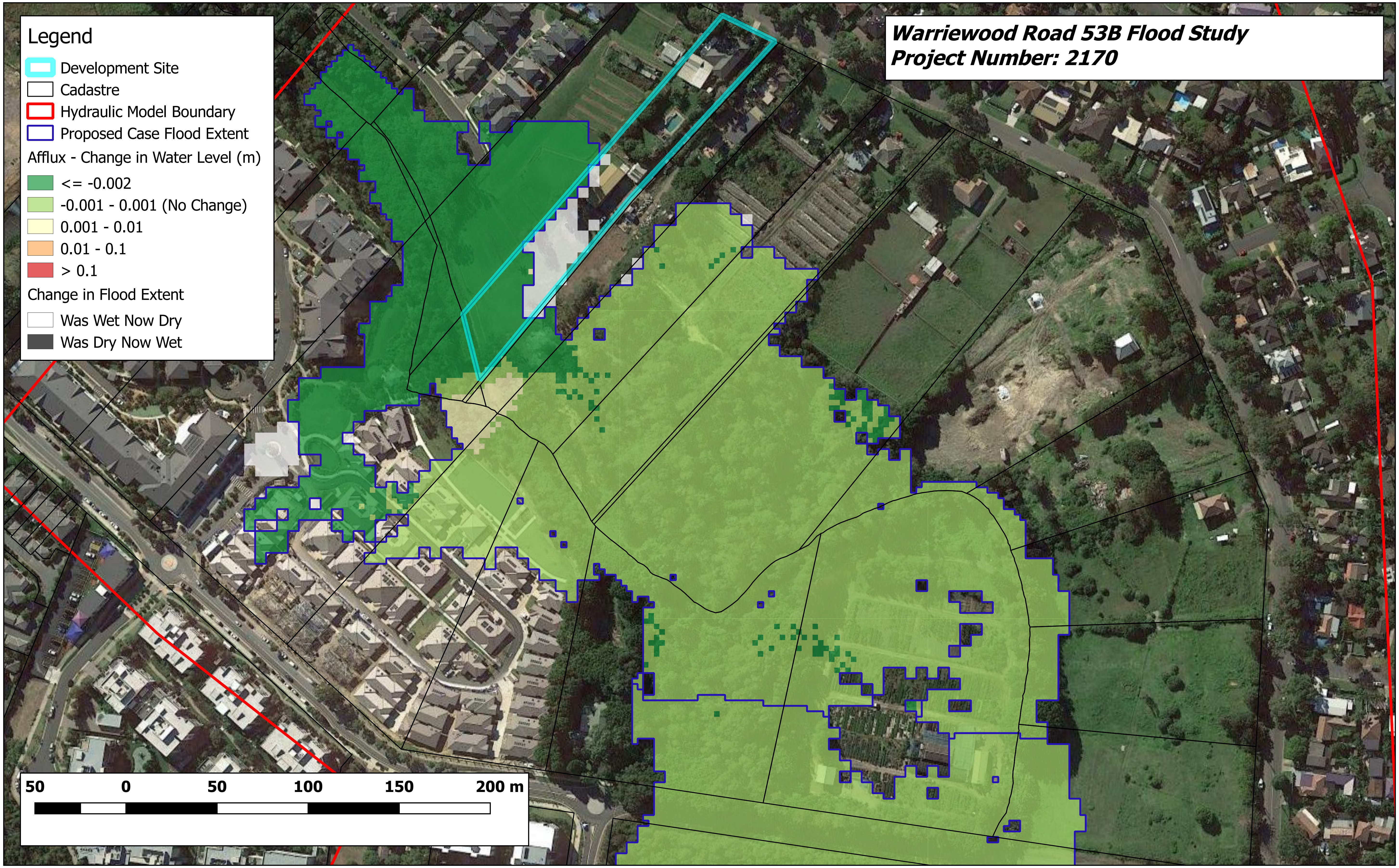
Title:

Figure B4 - 1% AEP Design Storm Event Hydraulic Category Developed Case



2019-02-20

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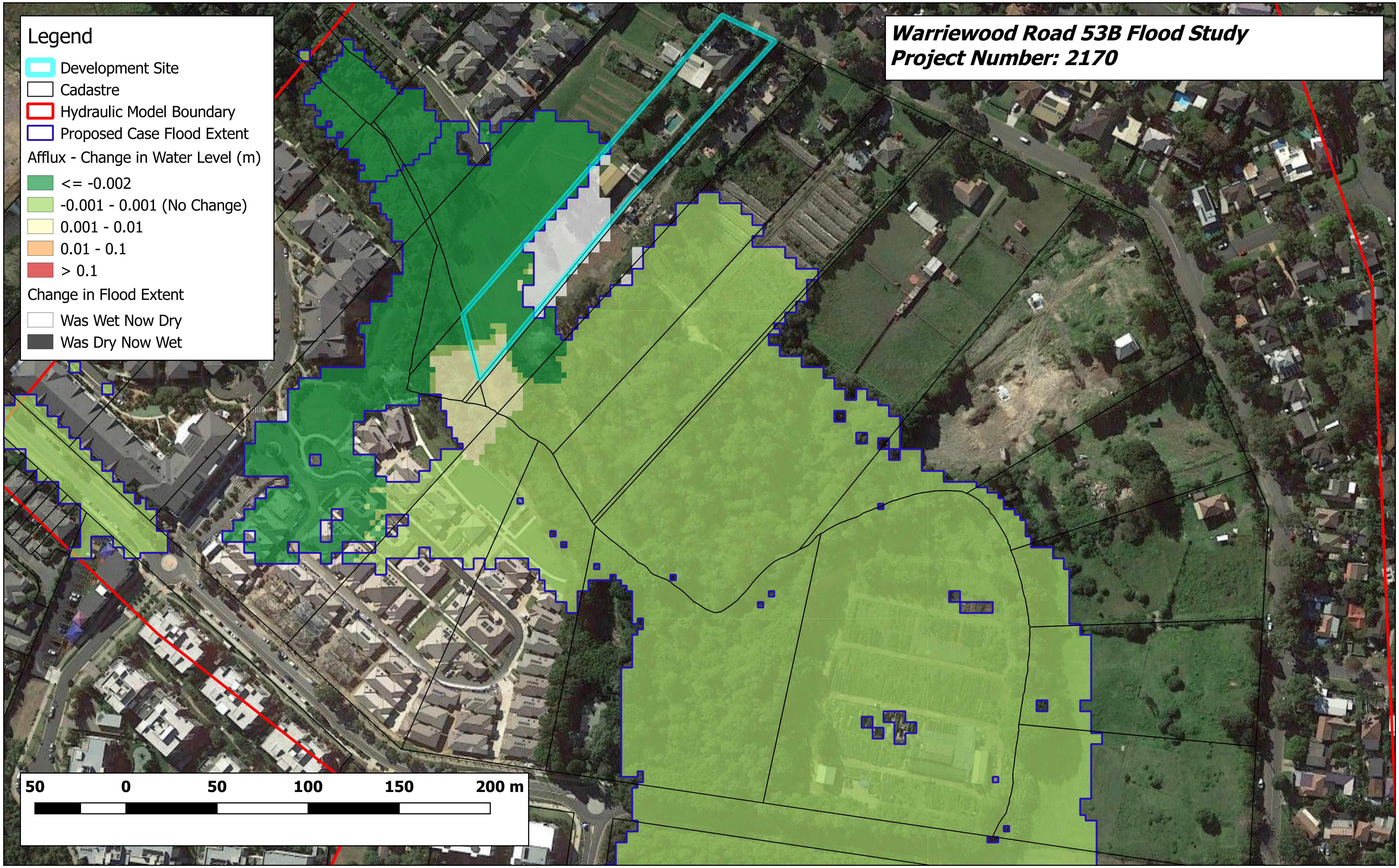
Title:

Figure B5 - 1% AEP Flood Envelope - Change in Water Level (Afflux) Proposed Development Case minus Base Case



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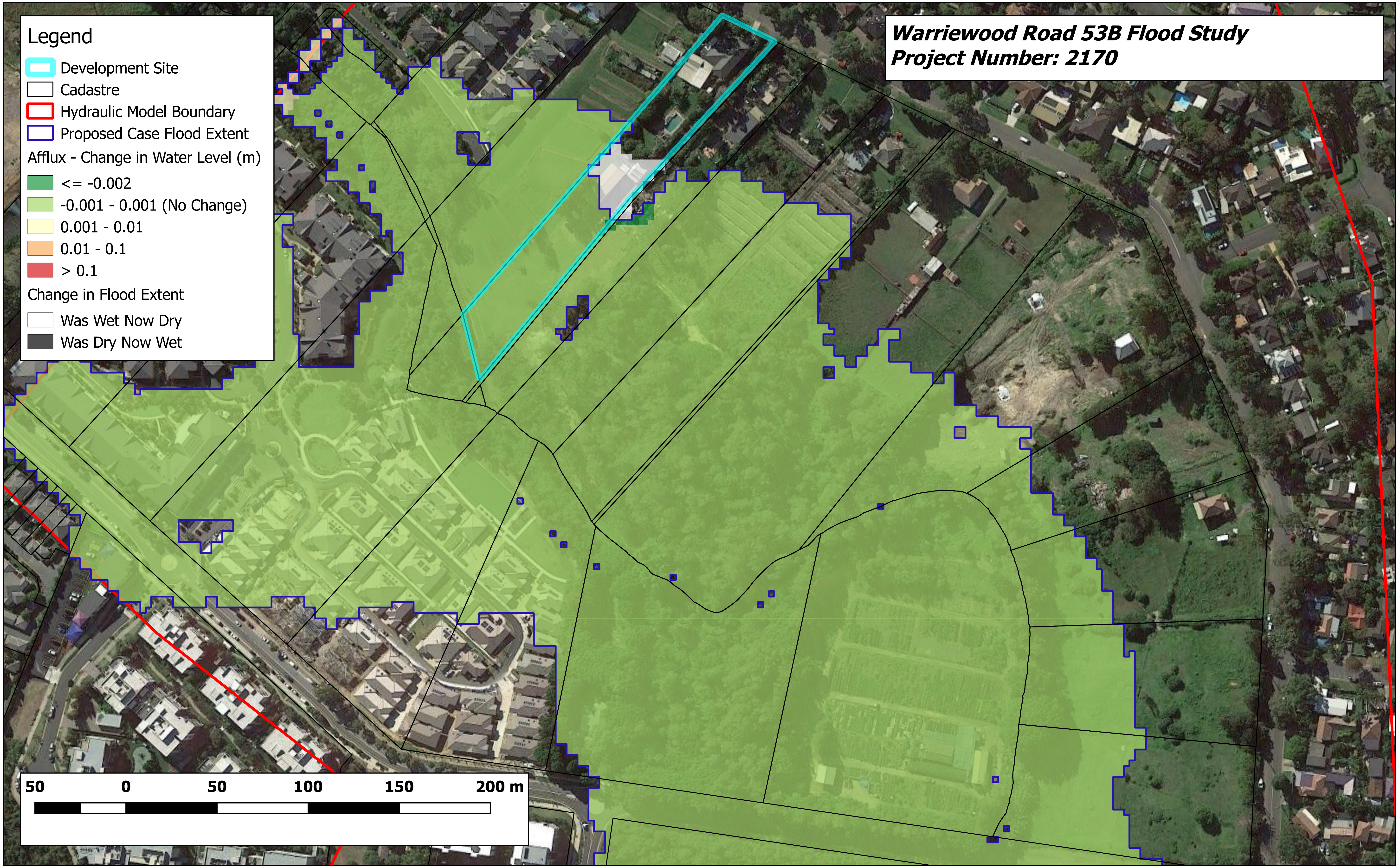
Title:

Figure B6 - 1% AEP + CC Flood Envelope - Change in Water Level (Afflux) Proposed Development Case minus Base Case



2019-02-20

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Title:

Figure B7 - PMF Flood Envelope - Change in Water Level (Afflux)
Proposed Development Case minus Base Case