Richmond+Ross PTY LIMITED
ABN 34 001 485 436
CONSULTING ENGINEERS AND PROJECT LEADERS

1st FLOOR, 38 WILLOUGHBY ROAD
CROWS NEST NSW 2065
PH: (02) 9490 9600 FAX: (02) 9438 1224
EMAIL richross@richmondross.com.au

# STORMWATER MANAGEMENT PLAN FOR PROPOSED HIGHWAY SERVICE CENTRE DEVELOPMENT AT LOT 1, 27782 HUME HIGHWAY, BOWNING, NSW 2582

**Job Ref: 160173**

**Date: July 2018**

**Revision: B**

**Prepared By:** ____________________

**Harshad Varsani**
BE (Hons), GradIEAust

**Checked By:** ____________________

**Nick Mitchell**
BSc, BE (Hons), FIEAust, CPEng, NER

## CONTENTS

## 1.0 INTRODUCTION

Richmond and Ross Pty Ltd, Consulting Engineers, have been engaged to prepare a Stormwater Management Plan for the proposed highway service centre (HSC) on Lot 1, 27782 Hume Highway, Bowning, NSW, 2582. No responsibility to third parties under the law of contract, tort or otherwise for any loss or damage is accepted.

The purpose of this assessment is to provide advice with respect to stormwater management for the proposed HSC. The results of this study are limited to this scope.

This assessment has been prepared by reviewing published topographic maps, physical land survey, hydraulic and hydrological calculations and available Ariel photography of the site.

This report is to be read in conjunction with Architectural and Stormwater concept plans: A100, A101, C100, C101 and the flood study as attached in the Appendix.

## 2.0 SITE LOCATION AND DESCRIPTION

The subject site is located at proposed Lot 1, 27782 Hume Highway, Bowning, NSW, 2582. The total area of the Lot is 19.63 Hectares (Ha) and is currently vacant and undeveloped. The lot generally slopes from the West to the East and is bounded by the Hume Highway to the South. Out of the 19.63Ha, approximately 5.2 Ha will be developed into the HSC. The existing site does not contain any impermeable areas.

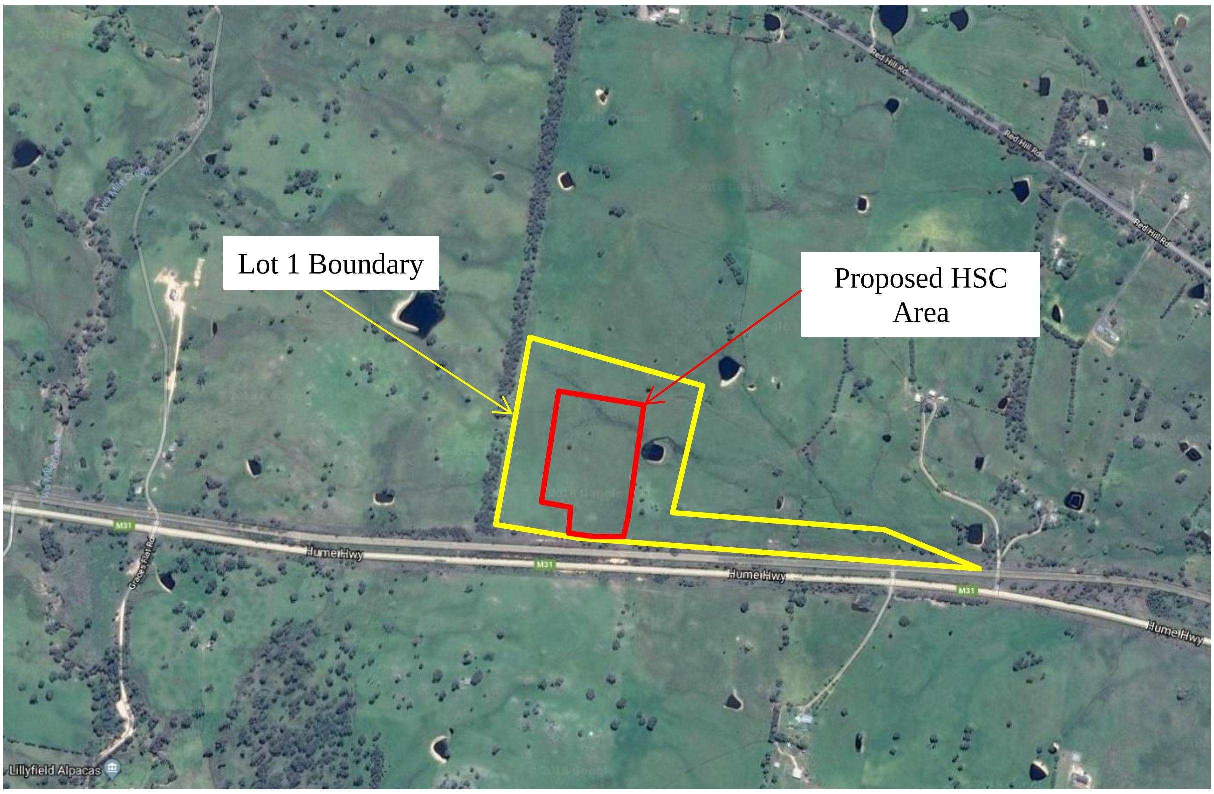



**Figure 1 Proposed Development Location**

## 3.0 DEVELOPMENT PROPOSAL

It is proposed to construct a new HSC on part of proposed Lot 1, 27782 Hume Highway. The development proposes two fuel canopies with a combined area of approximately 1530m$^2$ and a building with a floor area of approximately 2100m$^2$. The building will include a retail area, dining area, a playground and an amenities area for the drivers. New on and off ramps will be constructed outside of the proposed boundaries to allow entry and egress from the site.

## 4.0 EXISTING STOMRWATER NETWORK

The site currently drains naturally through infiltration and surface over flow. The drainage network consists of a system of existing farm dams, swales and intermittent watercourses that direct excess runoff towards Two Mile Creek and Bowning Creek. Refer to flood report for more details.

## 5.0 PROPOSED STORMWATER NETWORK

It is proposed to construct a new stormwater network to convey stormwater from the site and divert upstream flows around the site on the following principles:

- A 730m$^3$ detention is proposed to control peak flows from the site before being discharged in the farm dam to the right of the site.
- Intercept and control external flows through the site via a network of swales, pit and pipes.
- Separate under canopy runoff from general site stormwater runoff.
- A new network of pipes and pits is proposed to convey the runoff from the site to the OSD tank.
- Runoff from roof area of the proposed building and fuel canopies will be drained to rainwater tanks and available for re-use within the building.
- Runoff from the truck parking area will drain to the detention basin after treatment in a swale and bio-retention basin system.
- Runoff from the overflow parking area and part of the site will drain to the detention basin tank after treatment in a separate swale and bio retention basin system.
- The balance of the site will drain via the proposed pipe and pit network directly to the detention basin

## 6.0 STORMWATER QUANTITY MANAGEMENT

A detention basin is proposed to control peak flows from the proposed HSC before being discharged to the farm dam to the east of the site. The site's catchment was modelled in DRAINS in order to determine a suitably sized detention basin. Refer to section 6.1.

## 6.1 HYDRAULIC FLOW MODELLING – DRAINS MODEL

A DRAINS (Stormwater drainage system design and analysis program) model of the catchment was created to allow the determination of a suitably sized detention basin and assess the increased runoff at the downstream farm dam. As a result, discharge volumes from the whole catchment pre and post development have been established. Refer to the flood report for detailed information about the catchment and DRAINS model.

A 730m$^3$ detention basin is proposed to control peak flows and was modelled in DRAINS. Refer to Fig 2 for the location of the proposed detention basin. The results of the DRAINS model are summarized below:

| | |
|---|---|
| Pre-development discharge at the outlet farm dam: | 3.62m$^3$/s |
| Post-development discharge at the outlet farm dam: | 3.78m$^3$/s |
| Percentage difference in discharge: | +4.4% |

Refer to Appendix A for the output of the DRAINS model pre and post development.

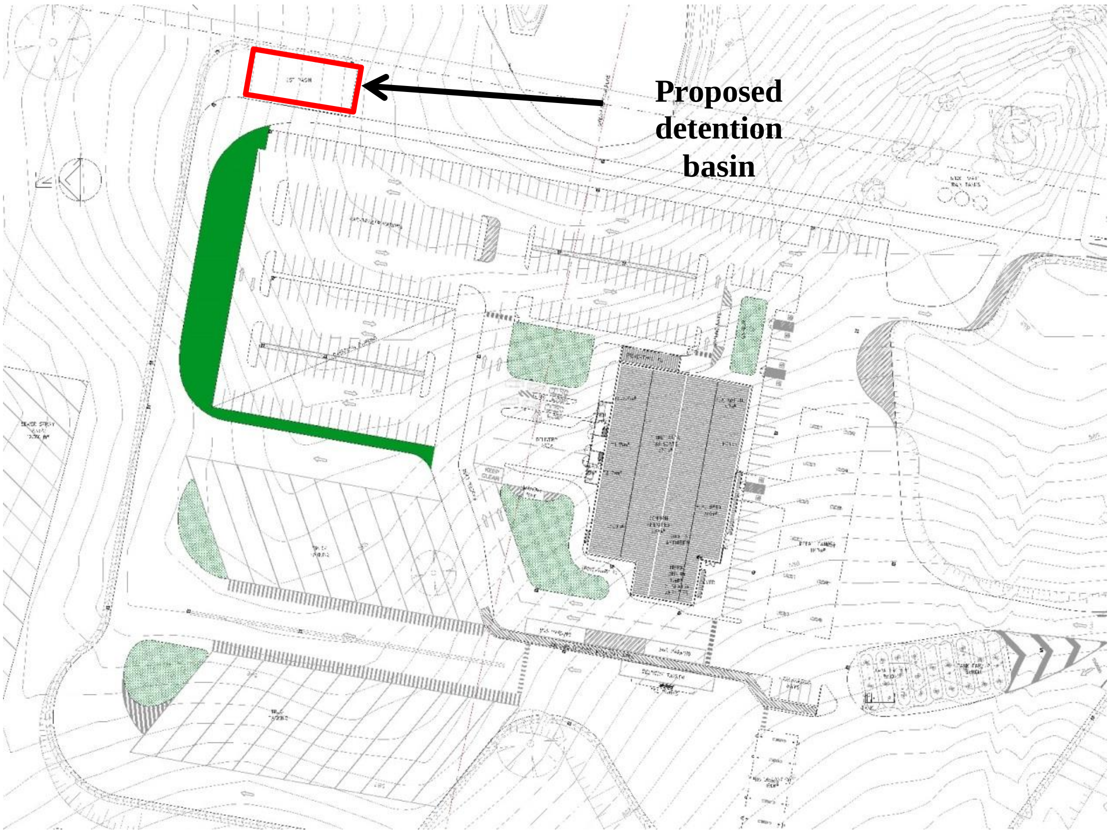



**Figure 2 Location of proposed detention basin (Indicative only)**

## 7.0 STORMWATER QUALITY MANAGEMENT

Due to the extent of impermeable vehicle parking areas within the site, it is proposed to include Water Sensitive Urban Design (WSUD) elements into the stormwater network. These WSUD elements will aim to treat the runoff from parts of the site and consequently reduce the water pollutant load before being discharged off the site. It is proposed to provide two grassed swales, two bio retention basin's and rainwater tanks.

### 7.1 WATER QUALITY OUTCOME – MUSIC MODEL

MUSIC modelling was undertaken for the proposed treatment train. Rainfall data collated by eWater from the Bureau of Meteorology was entered into the model.

Stormwater treatment train setup in the MUSIC model:

- 3 x 10kL above ground rainwater tanks collecting rainwater from the main building roof and fuel canopy roof areas. Reuse of water from these tanks is allowed. This will lead to a reduction in demand of potable water and overall discharge from the site.
- Two separate swales will convey runoff from the truck parking area and the overflow parking area.
- Two separate bio-retention basins will treat the discharge from the swales and finally direct it to the OSD tank.
- A 730m$^3$ detention basin will temporarily detain all the runoff from the site which will facilitate settling of suspended solids.

The overall pollutant removal for the site has been summarised in Table 1 and Figure 4. An improvement in discharged water quality can be expected by installing the proposed treatment train.

**Table 1 Treatment levels for the site**

| | TSS (kg/yr) | TP (kg/yr) | TN (kg/yr) | GP (kg/yr) |
|---|---|---|---|---|
| **Sources** | 1200 | 2.51 | 18 | 249 |
| **Residual Load** | 156 | 0.891 | 12.4 | 0 |
| **% Reduction** | **87.1** | **64.4** | **31.3** | **100** |

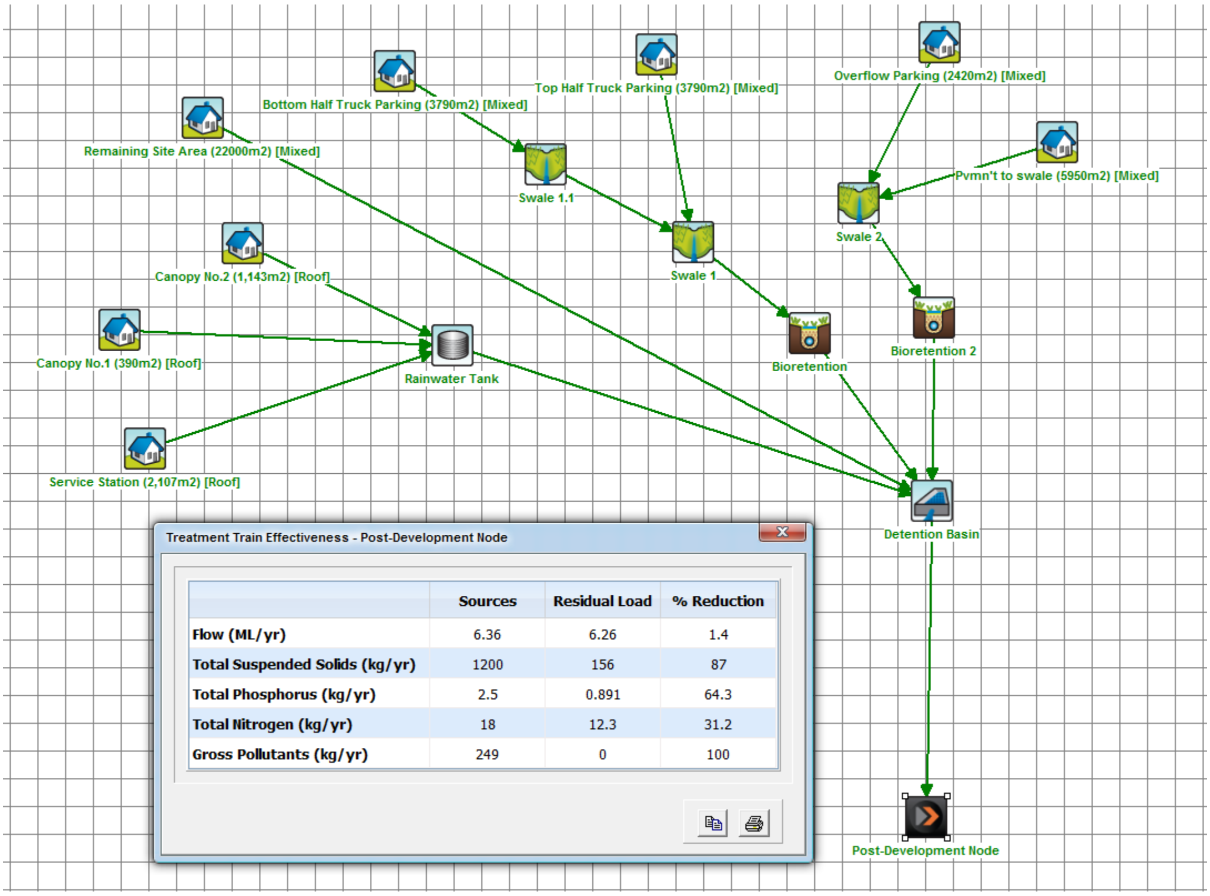


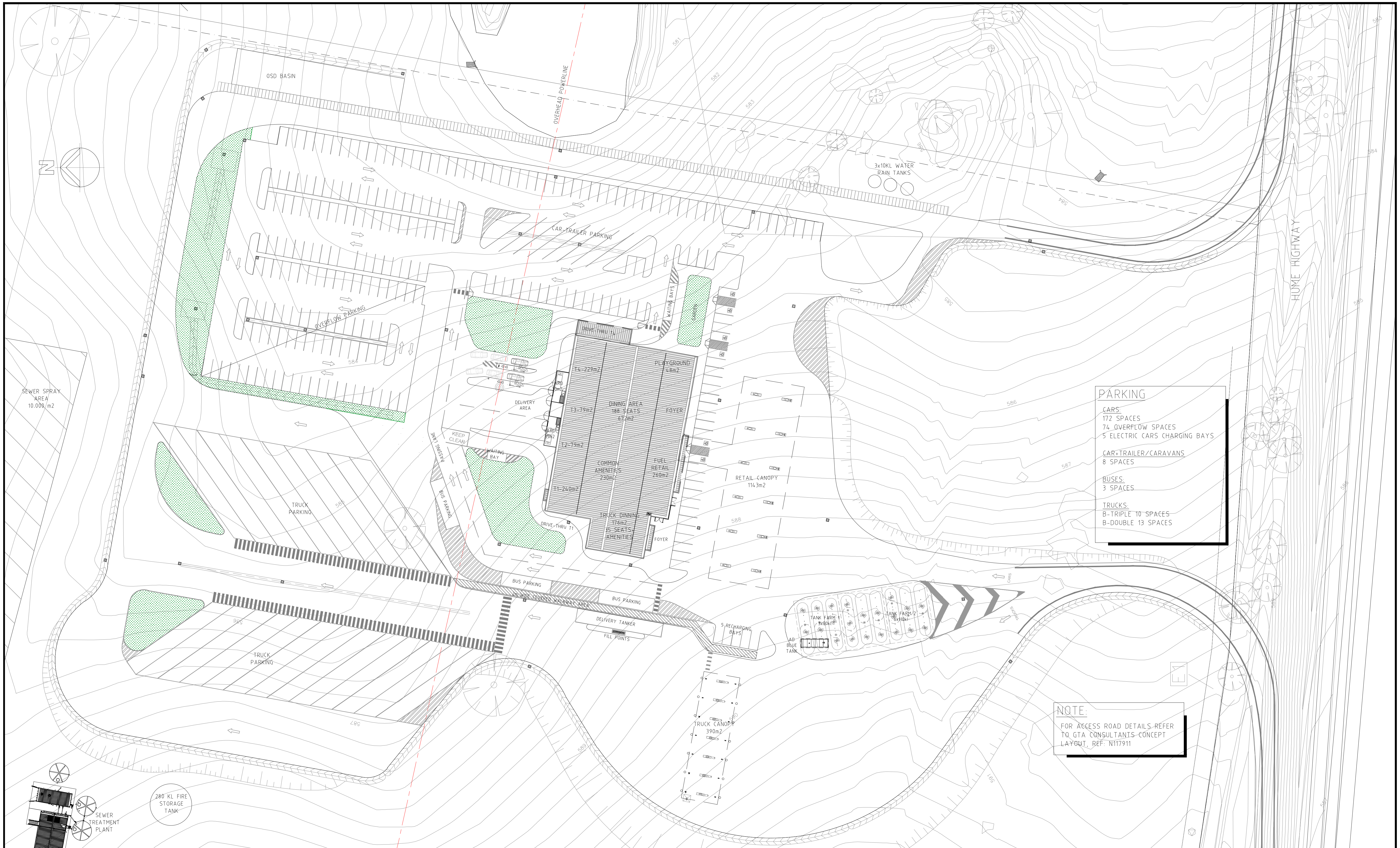

**Figure 3 Treatment train and pollution removal as modelled in MUSIC**

## 8.0 CONCLUSION

A system has been proposed for the control of stormwater on the subject site, which considers the requirements for water pollution control and quantity control.

The proposed system will result in adequate environment protection and reduction in water pollutant loads based on modelling. The flows within the catchment are controlled so that only a negligible increase in peak flows (4.5%) occurs at the downstream farm dam. Refer to flood study for further details.

**APPENDIX A – Site Plans**




| REV No. | COMMENTS | DATE | INIT. |
|---|---|---|---|
| F | SURVEY ADDED, BUILDING RELOCATED CLEAR FROM POWER LINES | 16.09.16 | DM |
| G | ENTRY LAYOUT REVISED | 17.11.16 | SK |
| H | REVISED SITE PLAN - UPDATED SLIP LANE | 23.01.17 | DM |
| I | REZONING ISSUE | 14.02.17 | DM |
| J | REVISED REZONING ISSUE | 27.03.18 | DM |
| K | REVISED REZONING ISSUE | 25.05.18 | DM |
| L | REVISED REZONING ISSUE | 04.06.18 | DM |
| M | ISSUE FOR REZONING APPROVAL | 10.07.18 | DM |

0 10000 20000 40000 60000

SCALE (mm) 1:1000

REZONING
ISSUE

PROJECT:
HIGHWAY SERVICE CENTRE
BOWNING, NSW

CLIENT:


**Richmond+Ross** PTY LIMITED
ABN 34 001 485 436

CONSULTING ENGINEERS
38 WILLOUGHBY ROAD,
CROWS NEST, NSW 2065
TEL : (02) 9490 9600
FAX : (02) 9438 1224


# PROPOSED SITE PLAN

DATE: MAY 2016
SCALE: 1:1000 @ A3
JOB No. 160173
DRG.No. A100
REV M


| REV No. | COMMENTS | DATE | INIT. |
|---|---|---|---|
| A | CIRCULATION ISSUE | 16.09.16 | DM |
| B | CIRCULATION ISSUE | 17.11.16 | SK |
| C | REVISED CIRCULATION ISSUE - SLIP LANE REVISED | 23.01.17 | DM |
| D | REZONING ISSUE | 14.02.17 | DM |
| E | REVISED REZONING ISSUE | 27.03.18 | DM |
| F | REVISED REZONING ISSUE | 25.05.18 | DM |
| G | ISSUE FOR REZONING APPROVAL | 10.07.18 | DM |

0 40 80 160 240
SCALE (m) 1:4000

REZONING
ISSUE

PROJECT:
HIGHWAY SERVICE CENTRE
BOWNING, NSW

CLIENT:

**Richmond + Ross** PTY LIMITED
ABN 34 001 485 436
CONSULTING ENGINEERS
38 WILLOUGHBY ROAD,
CROWS NEST, NSW 2065
TEL : (02) 9490 9600
FAX : (02) 9438 1224

# OVERALL SITE PLAN

| | |
|---|---|
| DATE: | SEPT 2016 |
| SCALE: | 1:4000 @ A3 |
| JOB No. | 160173 |
| DRG.No. | A101 |
| | REV. G |


10000 5000 0 10000 20000 30000 40000 50000

SCALE 1 : 500

REZONING ISSUE

| REV No. | COMMENTS | DATE | INIT. |
|---|---|---|---|
| A | ISSUE FOR REZONING APPROVAL | 10.07.18 | DM |

PROJECT:
HIGHWAY SERVICE CENTRE
BOWNING, NSW

CLIENT:
-

Richmond+Ross PTY LIMITED
CONSULTING ENGINEERS
ABN 34 001 485 436
38 WILLOUGHBY ROAD,
CROWS NEST, NSW 2065
TEL : (02) 9490 9600
FAX : (02) 9438 1224

# PROPOSED STORMWATER CONCEPT PLAN

| | | |
|---|---|---|
| DATE: | JULY 2018 | DRG.No. |
| SCALE: | 1:500 @ A1 | C100 |
| JOB No. | 160173 | REV A |

## STORMWATER NOTES

1. THIS IS A STORMWATER DRAINAGE PLAN ONLY. REFER TO ARCHITECTURAL DRAWINGS FOR ALL SETOUT INFORMATION.

2. ALL DRAINAGE LAYOUTS, LEVELS & DETAILS ARE DIAGRAMMATIC AND INDICATIVE ONLY. NOTE ONLY MAJOR LINES ARE SHOWN.

3. ALL PIPES TO BE 150 DIA UPVC LAID AT 1.0% MIN GRADE. UPVC PIPES TO BE SOLVENT WELDED JOINTS U.N.O.

4. ALL PITS AND COVERS TO PROPRIETARY PRECAST ITEMS, COVER LEVELS TO MATCH SURFACE U.N.O.

5. ALL GRATED DRAINS TO HAVE BASE GRADED 1.0% MIN WITH HEAVY DUTY GRATES.

6. IT IS THE BUILDERS RESPONSIBILITY TO LAY ALL PIPES IN ACCORDANCE WITH ALL RELEVANT AUTHORITY REQUIREMENTS (EG. COUNCIL, EPA, SYDNEY WATER).

7. CONTRACTOR SHALL LOCATE EXISTING SERVICES ON SITE PRIOR TO CONSTRUCTION AND SHALL TAKE EXTREME CAUTION DURING CONSTRUCTION.

## STORMWATER DISPOSAL PHILOSOPHY

1. COLLECT ALL SITE RUNOFF FROM SURFACE GRADES, SUMPS AND UNDERGROUND DRAINS AND DISCHARGE TO EXISTING STORMWATER SYSTEM.

## FLOW CALCULATIONS

USING FORMULA $Q = 0.00028\ CAI$

WHERE $Q$ = DISCHARGE IN LITRES PER SECOND

$C$ = A RUNOFF COEFFICIENT (SEE TABLE)

$A$ = CATCHMENT AREA IN SQ.M.

$I$ = RAINFALL INTENSITY IN MILLIMETRES PER HOUR

$^{100}I_{5}$ = 196mm/HR FOR 100 YEAR RETURN PERIOD 5 MINUTE DURATION STORM

## FLOW CALCULATION SCHEDULE

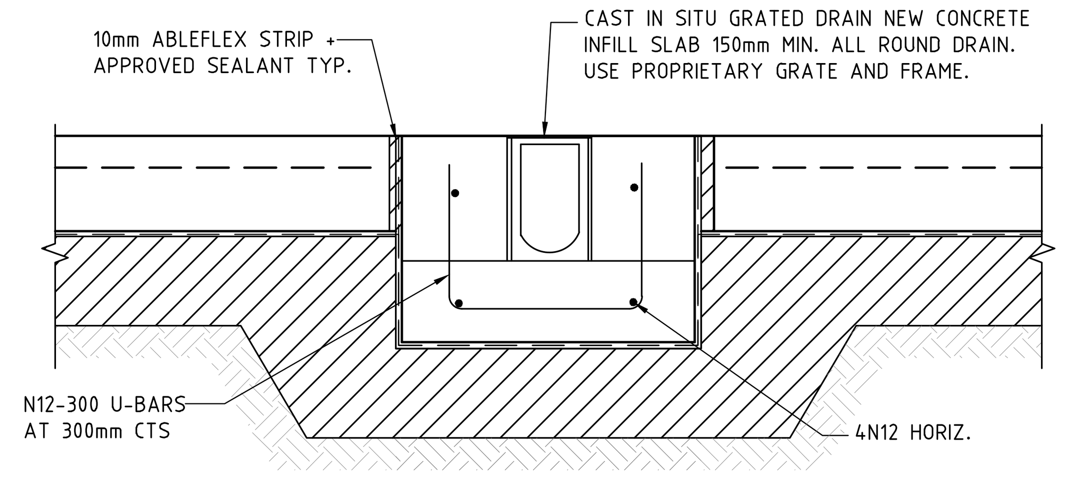
| LINE | CATCHMENT AREA (SQM) (OVERLAND FLOWS) | | | FLOW INTO LINE FROM CATCHMENT (L/S) | | | TOTAL FLOW (L/S) | MINIMUM PIPE REQUIREMENT | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ROOF | PAVE'T | L'SCAPE | ROOF C=1.00 | PAVEMENT C=0.95 | LANDSCAPE C=0.65 | | SIZE (mm) | GRADE (MIN) | CAPACITY (L/S) |
| 1 | | 3000 | | | 155.29 | | 155.29 | 375 | 1:93 | 207.54 |
| 2 | | 1935 | | | 100.16 | | 100.16 | 300 | 1:98 | 112.22 |
| 3 | | 2341 | | | 121.18 | | 376.63 | 525 | 1:86 | 523.27 |
| 4 | | 852 | | | 44.10 | | 44.10 | 225 | 1:79 | 58.51 |
| 5 | | 353 | | | 18.27 | | 62.38 | 300 | 1:86 | 119.87 |
| 6 | | | | | | | 439.01 | 525 | 1:66 | 597.83 |
| 7 | | 1090 | | | 56.42 | | 56.42 | 300 | 1:178 | 82.97 |
| 8 | 3180 | 1486 | | 173.27 | 76.92 | | 745.62 | 675 | 1:148 | 770.26 |
| 9 | | 528 | | | 27.33 | | 27.33 | 225 | 1:77 | 59.27 |
| 10 | | 381 | | | 19.72 | | 47.05 | 225 | 1:51 | 72.98 |
| 11 | | 920 | | | 47.62 | | 47.62 | 225 | 1:70 | 62.20 |
| 12 | | 2130 | 140 | | 110.26 | 4.96 | 955.51 | 750 | 1:103 | 1218.80 |
| 13 | | 501 | | | 25.93 | | 25.93 | 225 | 1:114 | 48.60 |
| 14 | | 260 | | | 13.46 | | 13.46 | 150 | 1:100 | 17.73 |
| 15 | | 2288 | | | 118.44 | | 118.44 | 450 | 1:66 | 398.64 |
| 16 | | 435 | 150 | | 22.52 | 5.31 | 185.66 | 450 | 1:66 | 398.64 |
| 17 | | 1615 | 570 | | 83.60 | 20.19 | 289.44 | 525 | 1:81 | 539.29 |
| 18 | | 452 | | | 23.40 | | 23.40 | 150 | 1:52 | 24.69 |
| 19 | | 515 | | | 26.66 | | 50.06 | 225 | 1:95 | 53.30 |
| 20 | | 1124 | | | 58.18 | | 397.68 | 600 | 1:136 | 589.97 |
| 21 | | 1765 | | | 91.36 | | 91.36 | 300 | 1:88 | 118.49 |
| 22 | | 2265 | | | 117.24 | | 208.61 | 375 | 1:61 | 256.69 |
| 23 | | 1731 | 440 | | 89.60 | 15.58 | 105.19 | 300 | 1:54 | 151.58 |
| 24 | | 4105 | 200 | | 212.49 | 7.08 | 533.37 | 600 | 1:70 | 824.20 |
| 25 | | | 650 | | | 23.02 | 954.07 | 750 | 1:102 | 1224.79 |
| 26 | | 1215 | | | 62.89 | | 62.89 | 225 | 1:61 | 66.68 |
| 27 | | 2785 | | | 144.16 | | 2116.64 | 1200 | 1:240 | 2727.11 |
| 28 | | | | | | | 139.00 | 375 | 1:87 | 214.64 |
| 29 | | | | | | | 298.00 | 450 | 1:61 | 414.76 |
| 30 | | | | | | | 497.00 | 525 | 1:82 | 535.97 |
| 31 | | | | | | | 696.00 | 600 | 1:72 | 812.60 |
| 32 | | | | | | | 2812.64 | 900 | 1:56 | 2669.30 |
| 33 | | | | | | | 123.00 | 375 | 1:103 | 197.12 |
| 34 | | | | | | | 253.00 | 525 | 1:175 | 365.75 |

## LINE SCHEDULE

| TAG | UPSTREAM INVERT | SIZE Ø (mm) | MATERIAL | LENGTH (m) | GRADE (ACTUAL) | DOWN-STREAM INVERT |
|---|---|---|---|---|---|---|
| 1 | 585.66 | 375 | CONCRETE | 45.60 | 1:93 | 585.17 |
| 2 | 585.47 | 300 | UPVC | 29.40 | 1:98 | 585.17 |
| 3 | 585.02 | 525 | CONCRETE | 62.00 | 1:86 | 584.30 |
| 4 | 585.37 | 225 | UPVC | 37.20 | 1:79 | 584.90 |
| 5 | 584.70 | 300 | CONCRETE | 34.40 | 1:86 | 584.30 |
| 6 | 584.05 | 525 | CONCRETE | 29.50 | 1:66 | 583.60 |
| 7 | 583.75 | 300 | CONCRETE | 80.00 | 1:178 | 583.30 |
| 8 | 583.30 | 675 | CONCRETE | 57.70 | 1:148 | 582.91 |
| 9 | 584.20 | 225 | UPVC | 14.70 | 1:77 | 584.01 |
| 10 | 583.71 | 225 | UPVC | 20.80 | 1:51 | 583.30 |
| 11 | 583.20 | 225 | UPVC | 7.70 | 1:70 | 583.09 |
| 12 | 582.91 | 750 | CONCRETE | 83.50 | 1:103 | 582.10 |
| 13 | 585.72 | 225 | UPVC | 38.60 | 1:114 | 585.38 |
| 14 | 585.59 | 150 | UPVC | 20.90 | 1:100 | 585.38 |
| 15 | 585.75 | 450 | CONCRETE | 24.40 | 1:66 | 585.38 |
| 16 | 585.38 | 450 | CONCRETE | 63.20 | 1:66 | 584.42 |
| 17 | 584.42 | 525 | CONCRETE | 58.80 | 1:81 | 583.69 |
| 18 | 584.20 | 150 | UPVC | 16.70 | 1:52 | 583.88 |
| 19 | 583.88 | 225 | UPVC | 18.00 | 1:95 | 583.69 |
| 20 | 583.69 | 600 | CONCRETE | 15.00 | 1:136 | 583.58 |
| 21 | 585.38 | 300 | UPVC | 30.00 | 1:88 | 585.04 |
| 22 | 585.04 | 375 | CONCRETE | 57.00 | 1:61 | 584.10 |
| 23 | 583.80 | 300 | UPVC | 24.20 | 1:54 | 583.35 |
| 24 | 583.20 | 600 | CONCRETE | 45.80 | 1:70 | 582.55 |
| 25 | 582.47 | 750 | CONCRETE | 12.30 | 1:102 | 582.35 |
| 26 | 582.62 | 225 | UPVC | 16.50 | 1:61 | 582.35 |
| 27 | 582.10 | 1200 | CONCRETE | 24.00 | 1:240 | 582.00 |
| 28 | 586.16 | 375 | CONCRETE | 125.80 | 1:87 | 584.72 |
| 29 | 584.72 | 450 | CONCRETE | 65.70 | 1:61 | 583.65 |
| 30 | 583.65 | 600 | CONCRETE | 78.20 | 1:82 | 582.70 |
| 31 | 582.40 | 525 | CONCRETE | 35.80 | 1:72 | 581.90 |
| 32 | 581.90 | 900 | CONCRETE | 50.00 | 1:56 | 581.00 |
| 33 | 585.10 | 375 | CONCRETE | 118.30 | 1:103 | 583.95 |
| 34 | 583.95 | 525 | CONCRETE | 35.00 | 1:175 | 583.75 |

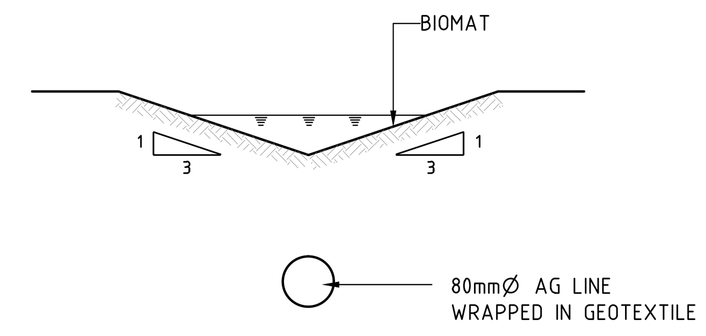
## PIT SCHEDULE

| TAG | TYPE | SIZE | RL TOP | IL | COVER | NOTES |
|---|---|---|---|---|---|---|
| A | INLET | 900X900 | 586.50 | 585.66 | CLASS D GRATE | |
| B | INLET | 600x900 | 586.66 | 585.47 | CLASS D GRATE | |
| C | INLET | 600x900 | 586.00 | 585.02 | CLASS D GRATE | BACKDROP PIT |
| D | INLET | 600x600 | 586.25 | 585.37 | CLASS D GRATE | |
| E | INLET | 900x900 | 586.25 | 584.70 | CLASS D GRATE | BACKDROP PIT |
| F | JUNCTION PIT | 900x900 | 585.93 | 584.05 | CLASS D SEALED LID | BACKDROP PIT |
| G | INLET | 600x600 | 584.50 | 583.75 | CLASS D GRATE | |
| H | INLET | 900x900 | 585.30 | 583.30 | CLASS D GRATE | BACKDROP PIT |
| J | INLET | 900x900 | 585.42 | 584.20 | CLASS D GRATE | |
| K | INLET | 900x900 | 585.25 | 583.71 | CLASS D GRATE | BACKDROP PIT |
| L | INLET | 600x900 | 584.25 | 583.20 | CLASS D GRATE | |
| M | INLET | 900x900 | 584.42 | 582.91 | CLASS D GRATE | BACKDROP PIT |
| N | INLET | 600x600 | 586.40 | 585.72 | CLASS D GRATE | |
| P | INLET | 600x600 | 586.40 | 585.59 | CLASS D GRATE | |
| Q | INLET | 600x600 | 586.65 | 585.75 | CLASS D GRATE | |
| R | INLET | 600x900 | 586.35 | 585.38 | CLASS D GRATE | |
| S | INLET | 600x900 | 585.50 | 584.42 | CLASS D GRATE | |
| T | INLET | 600x600 | 585.00 | 584.20 | CLASS D GRATE | |
| U | INLET | 600x900 | 584.84 | 583.88 | CLASS D GRATE | |
| V | INLET | 600x600 | 584.59 | 583.69 | CLASS D GRATE | BACKDROP PIT |
| W | HEADWALL | Enter RL | | 583.58 | | |
| Y | INLET | 600x600 | 586.13 | 585.38 | CLASS D GRATE | |
| Z | INLET | 600x600 | 585.87 | 585.04 | CLASS D GRATE | |
| AA | HEADWALL | Enter RL | | 584.10 | | |
| AB | INLET | 900x900 | 585.00 | 583.80 | CLASS D GRATE | |
| AC | INLET | 600x600 | 584.10 | 583.20 | CLASS D GRATE | BACKDROP PIT |
| AD | INLET | 600x900 | 583.62 | 582.47 | CLASS D GRATE | BACKDROP PIT |
| AE | INLET | 900x900 | 583.99 | 582.62 | CLASS D GRATE | |
| AF | INLET | 900x900 | 584.19 | 582.00 | CLASS D GRATE | |
| AG | INLET | 600x600 | 587.00 | 586.16 | CLASS D GRATE | |
| AH | INLET | 600x600 | 585.55 | 584.72 | CLASS D GRATE | |
| AJ | INLET | 600x600 | 584.55 | 583.65 | CLASS D GRATE | |
| AK | INLET | 900x900 | 583.70 | 582.40 | CLASS D GRATE | BACKDROP PIT |
| AL | INLET | 600x900 | 583.00 | 581.90 | CLASS D GRATE | |
| AM | HEADWALL | Enter RL | | 581.00 | | |
| AN | INLET | 900x900 | 586.60 | 585.10 | CLASS D GRATE | |
| AP | INLET | 450x450 | 584.30 | 583.95 | CLASS D GRATE | |
| AQ | HEADWALL | Enter RL | | 583.75 | | |




## TYPICAL GRATED DRAIN DETAIL

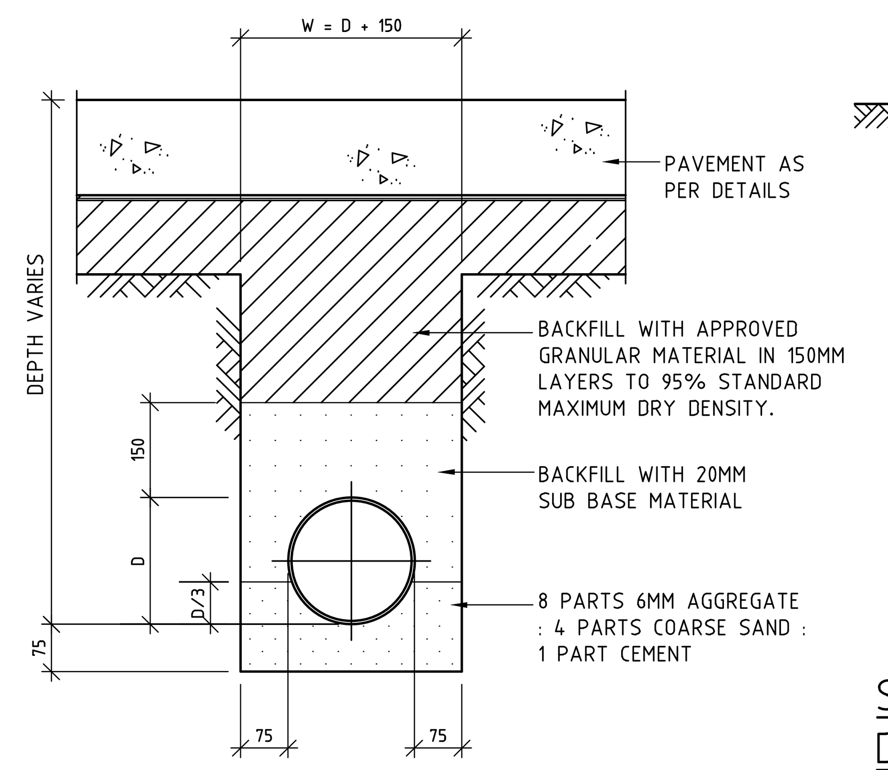
GRATINGS TO BE HEELGUARD D.I. ADJACENT TO CANOPIES AND WALKWAYS & EXTRA HEAVY DUTY SLOTTED D.I.TO ROAD RESERVE CROSSOVER. PROVIDE LOCK DOWNS AS SPECIFIED BY MANUFACTURER. ALONG WITH RUBBER GASKETS TO GRATES.




## SWALE/AG DRAIN

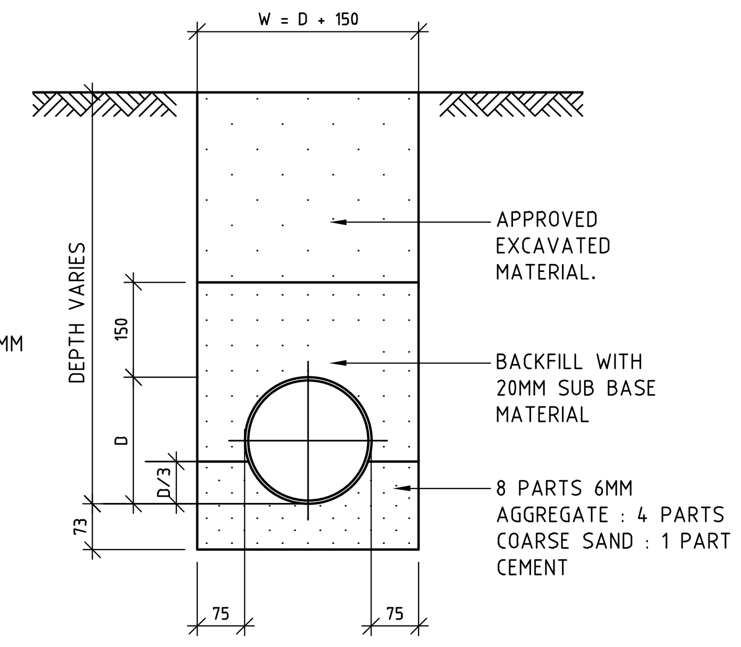
MIN GRADE 1%

SCALE 1:10



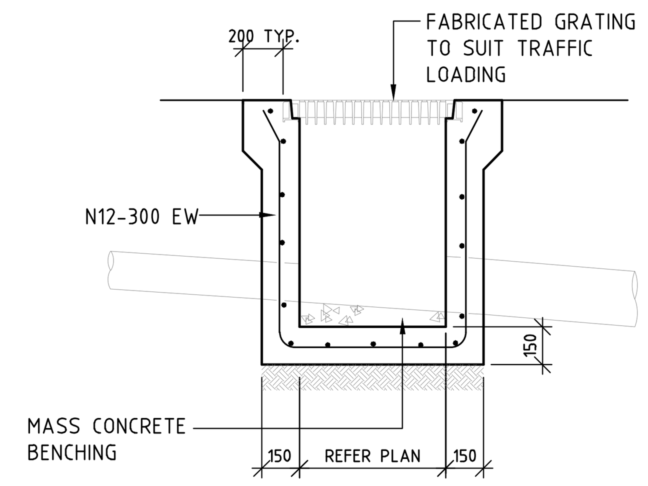

## STORMWATER PIPE BEDDING DETAIL

SCALE 1:10




## STORMWATER PIPE BEDDING DETAIL UNDER GROUND

SCALE 1:10




## TYPICAL CONCRETE STORMWATER DRAINAGE PIT

SCALE 1:25

REZONING ISSUE

| REV No. | COMMENTS | DATE | INIT. |
|---|---|---|---|
| A | ISSUE FOR REZONING APPROVAL | 10.07.18 | DM |

PROJECT:
HIGHWAY SERVICE CENTRE
BOWNING, NSW

CLIENT:
-


Richmond+Ross PTY LIMITED
CONSULTING ENGINEERS
ABN 34 001 485 436
38 WILLOUGHBY ROAD, CROWS NEST, NSW 2065
TEL : (02) 9490 9600
FAX : (02) 9438 1224


PROPOSED STORMWATER DETAILS AND SCHEDULES

| | | |
|---|---|---|
| DATE: | JULY 2018 | DRG.No. |
| SCALE: | AS SHOWN @ A1 | C101 |
| JOB No. | 160173 | REV A |

## APPENDIX B – DRAINS Output

(Refer flood report for model details)

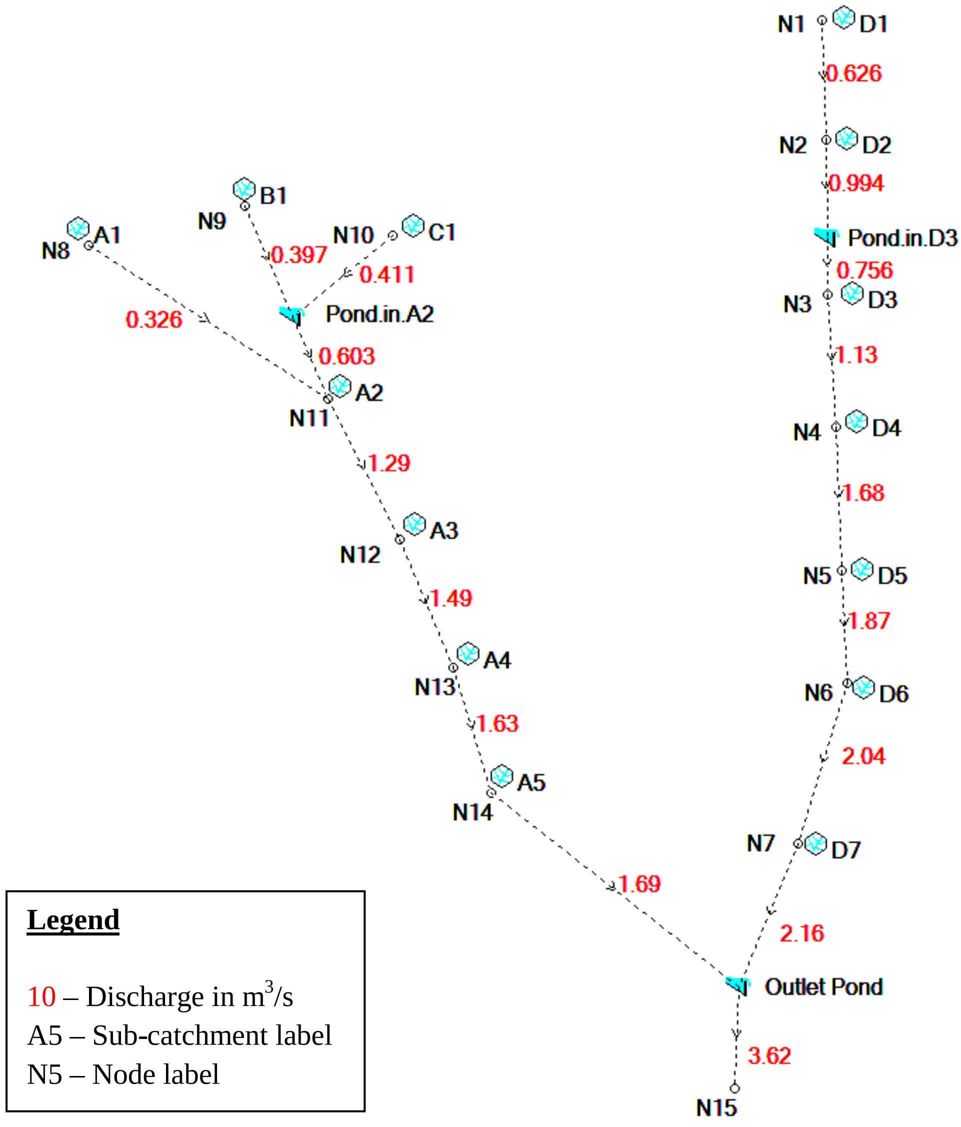



**Figure 4 Pre-Development DRAINS Model and Output**

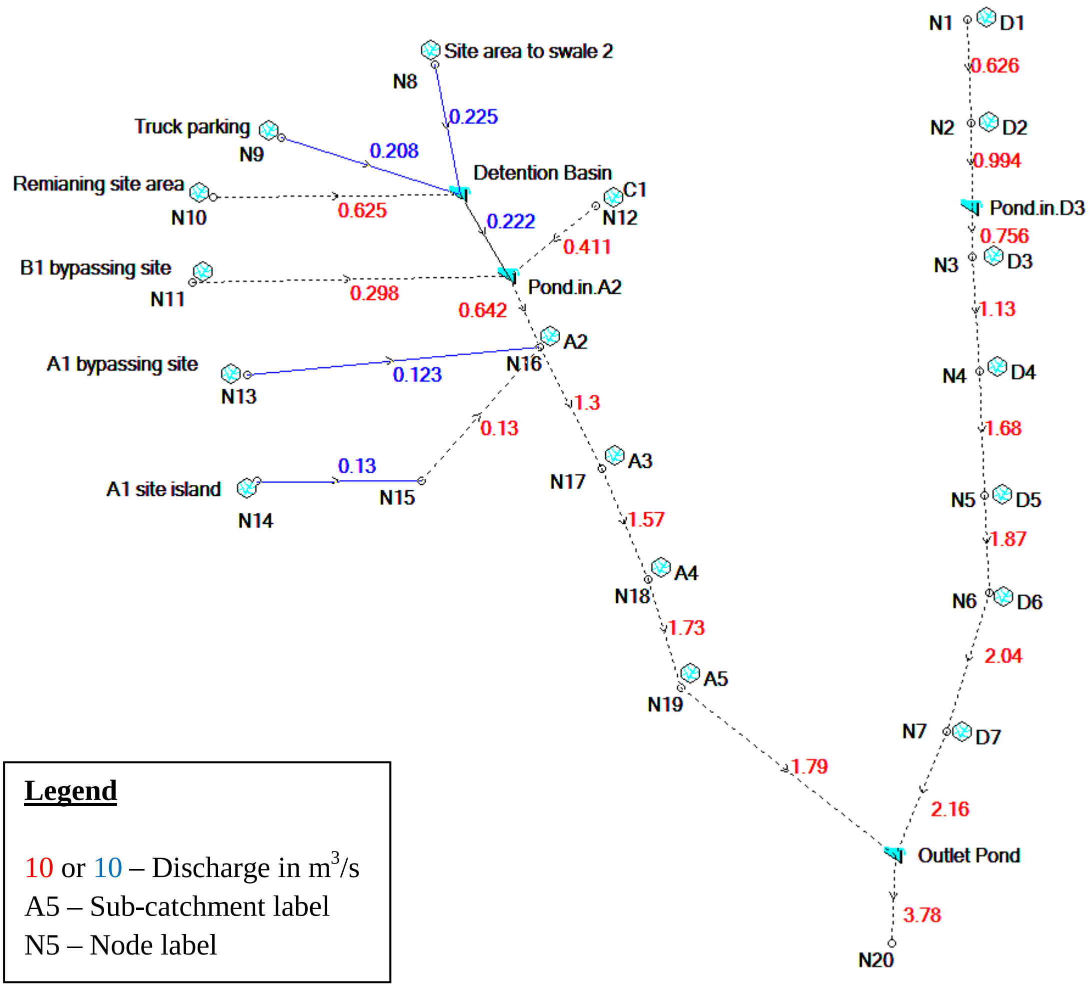



**Figure 5 Post-Development DRAINS Model and Output**

**APPENDIX C – Flood Study and Impact Assessment**

Richmond+Ross PTY LIMITED
ABN 34 001 485 436
CONSULTING ENGINEERS AND PROJECT LEADERS

1st FLOOR, 38 WILLOUGHBY ROAD
CROWS NEST NSW 2065
PH: (02) 9490 9600 FAX: (02) 9438 1224
EMAIL richross@richmondross.com.au

# FLOOD STUDY FOR PROPOSED HIGHWAY SERVICE CENTRE DEVELOPMENT AT LOT 1, 27782 HUME HIGHWAY, BOWNING, NSW 2582

**Job Ref: 160173**

**Date: July 2018**

**Revision: B**

**Prepared By:** ____________________

**Harshad Varsani**
BE (Hons), GradIEAust

**Checked By:** ____________________

**Nick Mitchell**
BSc, BE (Hons), FIEAust, CPEng, NER

## CONTENTS

## 1.0 INTRODUCTION

Richmond and Ross Pty Ltd, Consulting Engineers, have been engaged to carry out a flood study for the proposed highway service centre (HSC) on Lot 1, 27782 Hume Highway, Bowning, NSW, 2582. No responsibility to third parties under the law of contract, tort or otherwise for any loss or damage is accepted.

The purpose of this assessment is to provide advice with respect to flooding for the proposed HSC and the downstream farm dams. The results of this study are limited to this scope.

This assessment has been prepared by reviewing published topographic maps, physical land survey, hydraulic and hydrological calculations and available Ariel photography of the site.

This report is to be read in conjunction with Architectural and Stormwater concept plans: A100, A101, C100 and C101 as attached in the Appendix.

## 2.0 SITE LOCATION AND DESCRIPTION

The subject site is located at proposed Lot 1, 27782 Hume Highway, Bowning, NSW, 2582. The total area of the Lot is 19.63 Hectares (Ha) and is currently vacant and undeveloped. The lot generally slopes from the West to the East and is bounded by the Hume Highway to the South. Out of the 19.63Ha, approximately 5.2 Ha will be developed into the HSC. The existing site does not contain any impermeable areas.

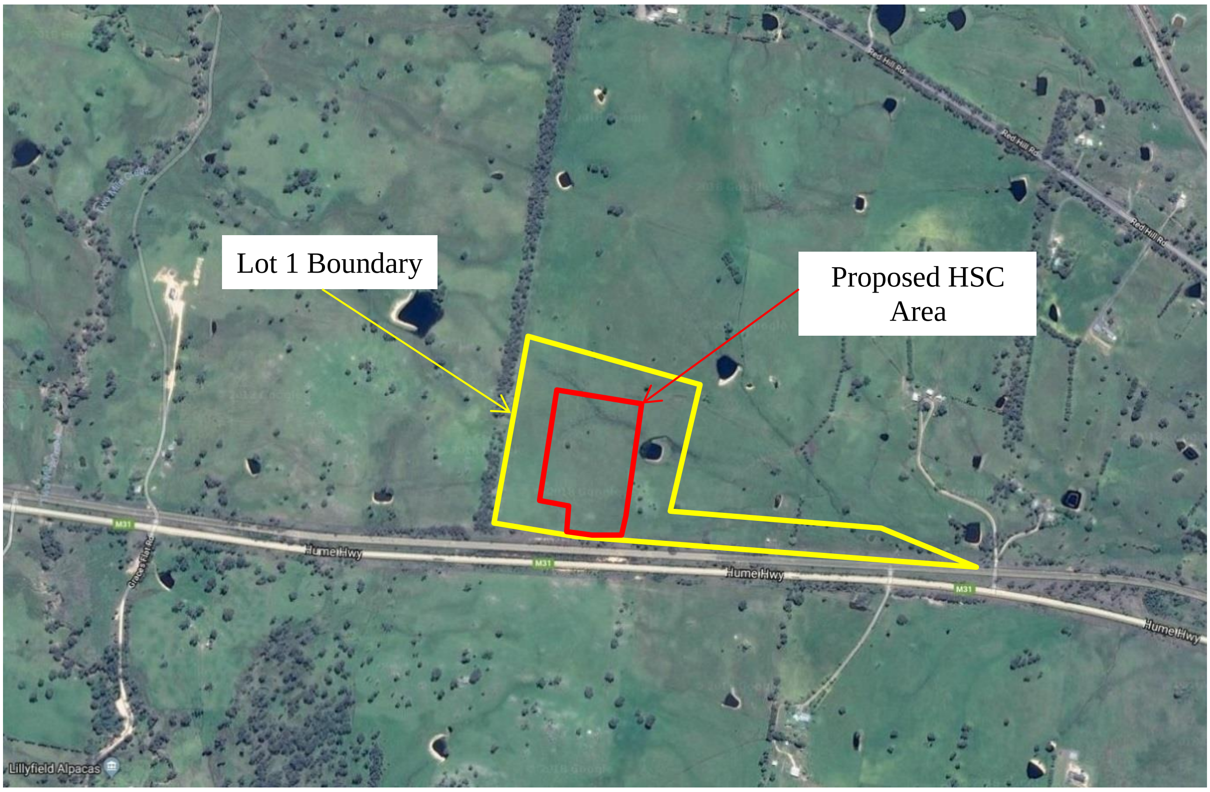



**Figure 1 Proposed Development Location**

## 3.0 STUDY DATA

The following data has been processed in a Geographic Information System (GIS) software package and used in developing hydrologic and hydraulic models for this study:

- Architectural plans
- Existing ground survey (Ariel LiDAR survey of whole catchment and peg-out survey within property boundary)
- Civil drawings for proposed ground levels
- Ariel imagery

## 4.0 DEVELOPMENT PROPOSAL

It is proposed to construct a new highway service centre on part of Lot 1, 27782 Hume Highway. The development proposes two fuel canopies with a combined area of approximately 1530m$^2$ and a building with a floor area of approximately 2100m$^2$. The building will include a retail area, dining area, a playground and an amenities area for the drivers.

## 5.0 HYDRAULIC MODELLING

A hydraulic model of the catchment was created in DRAINS (Stormwater drainage system design and analysis program) to assess the impact of the development on the peak discharge at the downstream farm dam. As a result, discharge rates from the whole catchment pre and post development have been established.

### 5.1 Model Detail and Extent

The catchment was subdivided into sub catchments as shown in Fig 2. A number of assumptions were made when creating the DRAINS model. These are:

- Three major farm dams within the catchment were modelled. The remaining smaller farm dams are assumed to have a negligible impact on the discharge volume from the catchment and therefore not modelled. The areas and elevations of the three major farm dams are estimated from Ariel and Topographic imagery.
- The outlet farm dam is assumed to have a 5m long outlet overflow weir and the other two farm dams (Those in sub-catchments A2 and D3) are assumed to have a 2.5m overflow weir.

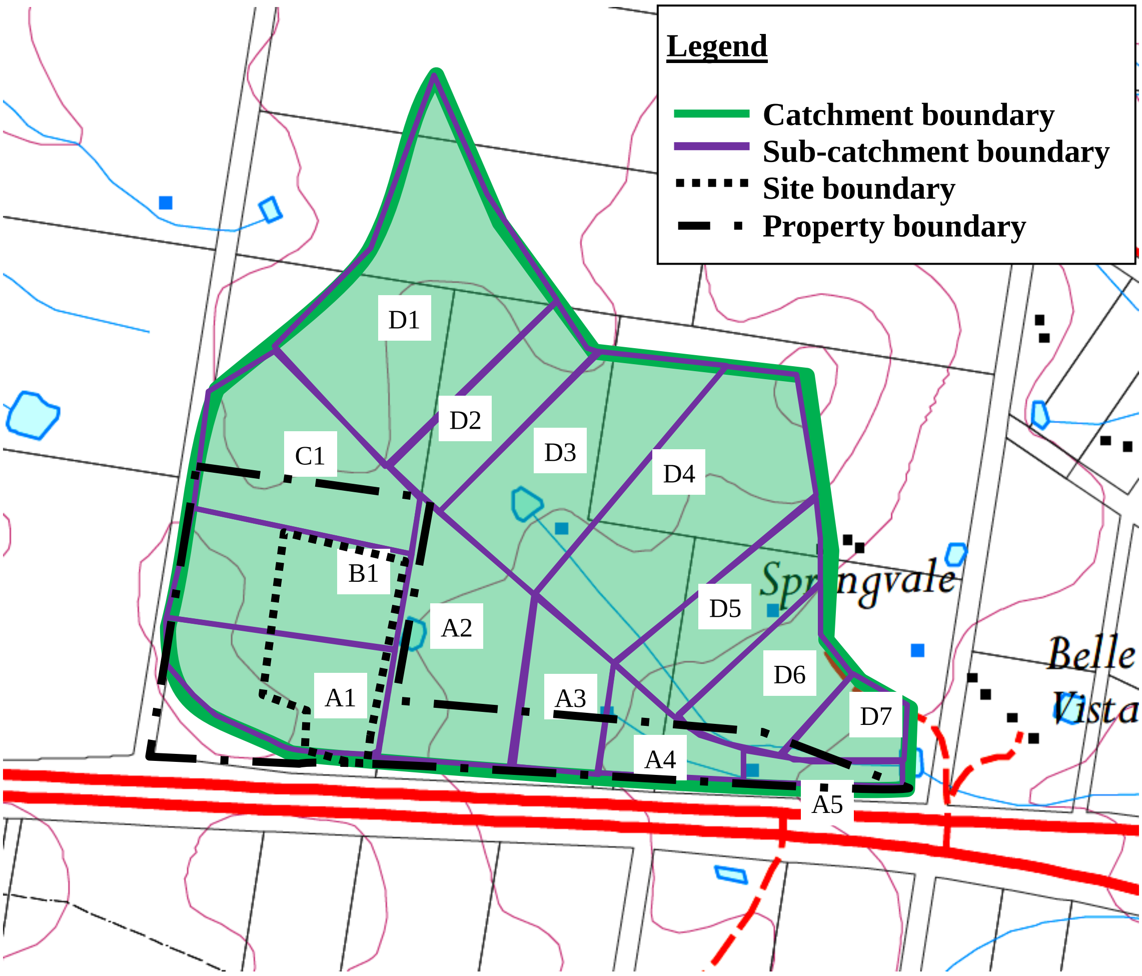



**Figure 2 Sub-Catchment Identification**

## 5.2 Pre-Development Conditions Modelling

A hydraulic model was prepared in DRAINS for the pre-development conditions as shown in Figure 4 which also includes the resulting peak flows.

The results of the model show a peak flow of approximately 3.62$m^3$/s at the outlet farm dam.

## 5.3 Post Development Conditions Modelling

A hydraulic model was prepared in DRAINS for the post development conditions as shown in Figure 5 which also includes the resulting peak flows. The results of the model show a peak flow of approximately 3.78$m^3$/s at the outlet farm dam.

## 5.4 Impact of the Development

The results of the model were assessed and the size of the proposed detention basin adjusted accordingly in order to minimize the increase in peak flows while keeping the detention basin at a reasonable size. The results show a negligible increase in post development peak flows of 0.16$m^3$/s (4.42%).

## 6.0 HYDROLOGIC MODELLING

A hydrologic model of the development was prepared and analyzed in TUFLOW to determine the flood affectation within the catchment of which the site is a part. The catchment was assessed for a 100 year Average Recurrence Interval (ARI) storm event.

### 6.1 Model Detail and Extent

The model is based on a 2m x 2m grid to ensure sufficient detail in the model while maintaining reasonable model runtimes. TUFLOW build 2017-09-AC-iDP-w64 was used in this flood study. The extent of the TUFLOW model is the catchment of the downstream farm dam as shown in Appendix C.

### 6.2 Pre-Development Conditions Modelling

The model was run for the 100 year ARI 90 min storm, which is considered to be the critical storm event for the catchment. The pre-development model results are presented in Appendix C:

The max pre-development flow depth in the whole catchment is roughly 0.5m (ignoring the depths within the farm dams) whereas the max depth within the site boundary pre-development is 0.1m.

The max pre-development flow velocity in the whole catchment is between 1.3 and 1.5m/s whereas the max velocity within the site boundary pre-development is between 0.7 and 0.9m/s.

According to Australian Rainfall and Runoff Book 9, Chapter 5, Section 5.6.2, "The product of depth and velocity (dg.V), with V being the average velocity and dg the depth, should not exceed 0.4 $m^2$/s for safety of pedestrians, 0.6 to 0.7 $m^2$/s for stability of parked vehicles (depending on size), or as directed by the consent authority." Therefore, TUFLOW was used to directly output the depth/velocity product for the catchment pre development. Refer to Appendix C.

The NSW Floodplain Development Manual (NSW FDM 2005) assess flood hazard as a combination of the flow velocity and depth.

NSW FDM describes the hazard categories as follows:

- High Hazard – Possible danger to personnel safety; evacuation by trucks difficult; able-bodies adults would have difficulty in wading to safety; potential for significant structural damage.
- Low Hazard – Should it be necessary, truck could evacuate people and their possession; able-bodied adults would have little difficulty in wading to safety.

TUFLOW was used to directly output the provisional hazard for the catchment pre development. Refer to Appendix C.

## 6.3 Post-Development Conditions Modelling

The proposed ground level of the proposed development was added into the model. The main building within the site was represented in the model by raising the elevation of that part of land by approximately 5m above ground level.

Based on the pre-development modelling conditions, the post-development model was also run for a 100 year ARI 90 minute storm. The post development model results are presented in Appendix C.

The max post-development flow depth in the whole catchment is roughly 0.5m (ignoring the depths within the farm dams) whereas the max depth within the site boundary post-development is 0.1m.

The max post-development flow velocity in the whole catchment is between 1.3 and 1.5m/s whereas the max velocity within the site boundary pre-development is between 0.7 and 0.9m/s.

Similar to pre development conditions modelling, the depth.velocity product and provisional hazard for post development conditions were also output directly from TUFLOW.

## 6.4 Impact of the Development

The impact of the development is determined by finding the difference in the results layers obtained from TUFLOW for the pre and post development conditions. Refer to Appendix C for these layers.

The change in floodwater depths is shown In Figure C10. The proposed HSC development results in a maximum increase in floodwater depths downstream of approximately 0.025m. Figure C10 shows higher depths around the site boundary however this is due to the presence of stormwater cutoff/diversion swales and this is as expected.

The change in the depth.velocity product is shown in Figure C12. The proposed HSC development results in a maximum increase in the depth.velocity product of 0.1m$^2$/s.

The change in floodwater velocities is shown in Figure C11. The proposed HSC development results in a maximum increase in floodwater velocities of 0.3m/s (25%) above the existing velocity of 1.2m/s. (ignoring the higher velocity increase within the cutoff/diversion swales). As shown in Figure 3 below, silt has an approximate erosion velocity of 30-80cm/s (0.3-0.8m/s). We therefore propose lining the farm dam embankments with a geo fabric for scour protection so as to reduce the impact of the proposed HSC.

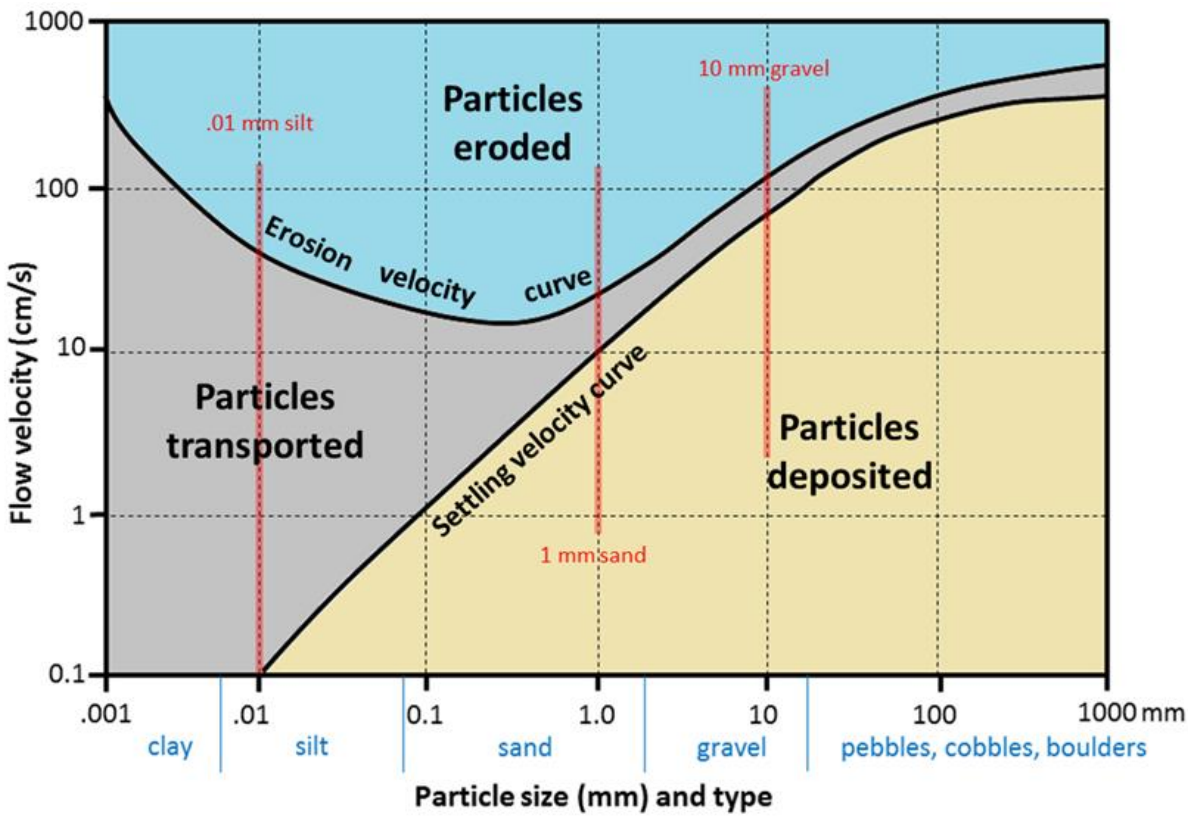


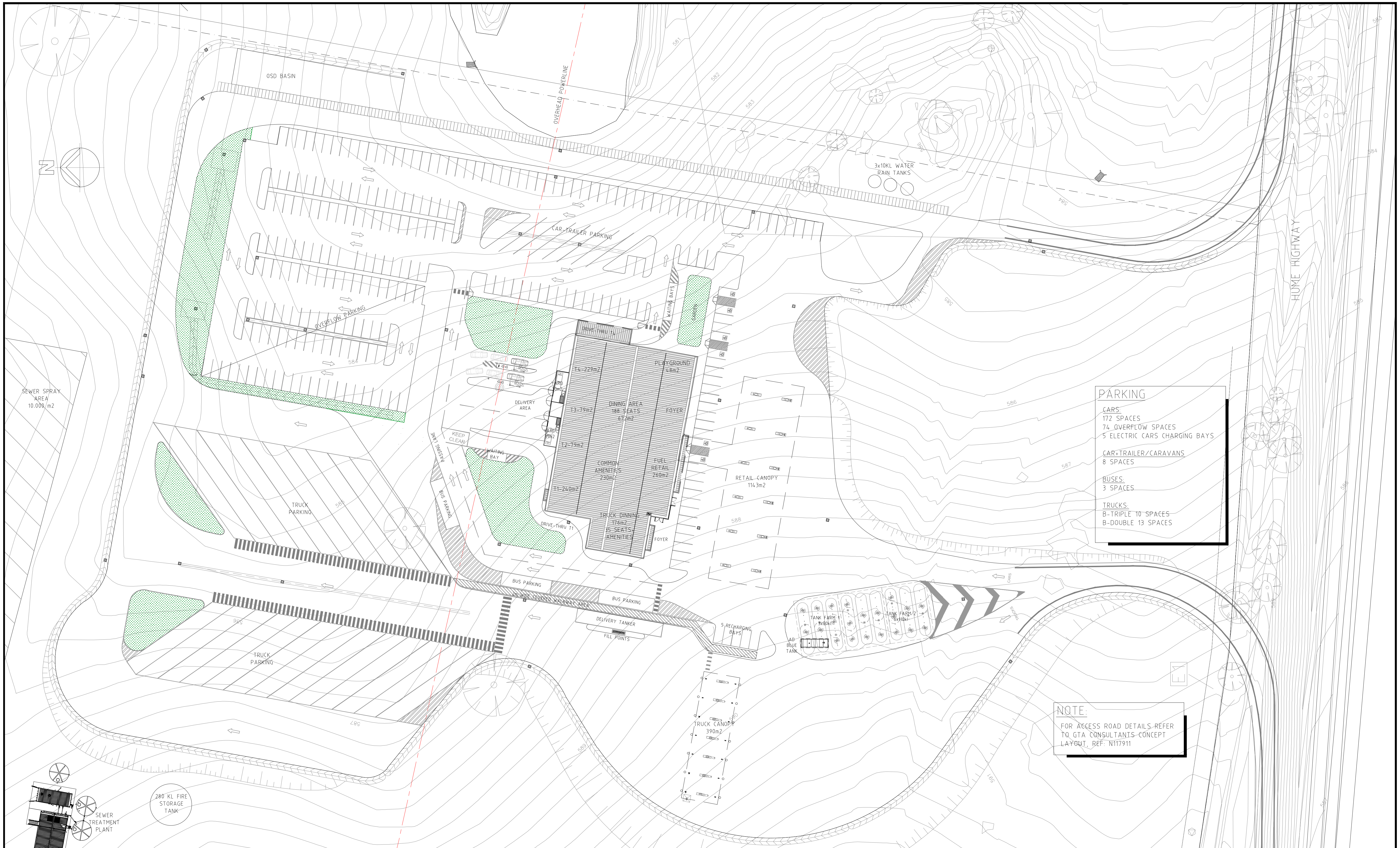

**Figure 3 Hjulström curve**

## 7.0 CONCLUSION

The proposed highway service centre at Lot 1, 27782 Hume Highway, Bowning was assessed for flood impact on surrounding areas by preparing hydraulic and hydrologic models. Both hydraulic and hydrologic modelling has confirmed that the proposed HSC development will have a negligible effect on the existing conditions. We propose a geofabric lining for the farm dam embankments so as to improve on the scour protection from the existing conditions.

In conclusion, we have assessed that the HSC as proposed will not alter the flood levels on adjoining allotments and will provide the required level of flood safety for the development.

**APPENDIX A – Site Plan**




| REV No. | COMMENTS | DATE | INIT. |
|---|---|---|---|
| F | SURVEY ADDED, BUILDING RELOCATED CLEAR FROM POWER LINES | 16.09.16 | DM |
| G | ENTRY LAYOUT REVISED | 17.11.16 | SK |
| H | REVISED SITE PLAN - UPDATED SLIP LANE | 23.01.17 | DM |
| I | REZONING ISSUE | 14.02.17 | DM |
| J | REVISED REZONING ISSUE | 27.03.18 | DM |
| K | REVISED REZONING ISSUE | 25.05.18 | DM |
| L | REVISED REZONING ISSUE | 04.06.18 | DM |
| M | ISSUE FOR REZONING APPROVAL | 10.07.18 | DM |

0 10000 20000 40000 60000
SCALE (mm) 1:1000

REZONING
ISSUE

PROJECT:
HIGHWAY SERVICE CENTRE
BOWNING, NSW

CLIENT:


Richmond + Ross PTY LIMITED
ABN 34 001 485 436
CONSULTING ENGINEERS
38 WILLOUGHBY ROAD,
CROWS NEST, NSW 2065
TEL : (02) 9490 9600
FAX : (02) 9438 1224


# PROPOSED SITE PLAN

DATE: MAY 2016
SCALE: 1:1000 @ A3
JOB No. 160173
DRG.No. A100
REV M


| REV No. | COMMENTS | DATE | INIT. |
|---|---|---|---|
| A | CIRCULATION ISSUE | 16.09.16 | DM |
| B | CIRCULATION ISSUE | 17.11.16 | SK |
| C | REVISED CIRCULATION ISSUE - SLIP LANE REVISED | 23.01.17 | DM |
| D | REZONING ISSUE | 14.02.17 | DM |
| E | REVISED REZONING ISSUE | 27.03.18 | DM |
| F | REVISED REZONING ISSUE | 25.05.18 | DM |
| G | ISSUE FOR REZONING APPROVAL | 10.07.18 | DM |

0 40 80 160 240

SCALE (m) 1:4000

REZONING
ISSUE

PROJECT:
HIGHWAY SERVICE CENTRE
BOWNING, NSW

CLIENT:

**Richmond + Ross** PTY LIMITED
ABN 34 001 485 436

CONSULTING ENGINEERS
38 WILLOUGHBY ROAD,
CROWS NEST, NSW 2065
TEL : (02) 9490 9600
FAX : (02) 9438 1224

# OVERALL SITE PLAN

DATE: SEPT 2016
SCALE: 1:4000 @ A3
JOB No. 160173

DRG.No. A101
REV. G


REZONING ISSUE

| REV No. | COMMENTS | DATE | INIT. |
|---|---|---|---|
| A | ISSUE FOR REZONING APPROVAL | 10.07.18 | DM |

PROJECT:
HIGHWAY SERVICE CENTRE
BOWNING, NSW

CLIENT:
-

Richmond+Ross PTY LIMITED
CONSULTING ENGINEERS
ABN 34 001 485 436
38 WILLOUGHBY ROAD,
CROWS NEST, NSW 2065
TEL : (02) 9490 9600
FAX : (02) 9438 1224

PROPOSED STORMWATER CONCEPT PLAN

| | |
|---|---|
| DATE: | JULY 2018 |
| SCALE: | 1:500 @ A1 |
| JOB No. | 160173 |
| DRG.No. | C100 |
| | REV A |

## STORMWATER NOTES

1. THIS IS A STORMWATER DRAINAGE PLAN ONLY. REFER TO ARCHITECTURAL DRAWINGS FOR ALL SETOUT INFORMATION.

2. ALL DRAINAGE LAYOUTS, LEVELS & DETAILS ARE DIAGRAMMATIC AND INDICATIVE ONLY. NOTE ONLY MAJOR LINES ARE SHOWN.

3. ALL PIPES TO BE 150 DIA UPVC LAID AT 1.0% MIN GRADE. UPVC PIPES TO BE SOLVENT WELDED JOINTS U.N.O.

4. ALL PITS AND COVERS TO PROPRIETARY PRECAST ITEMS, COVER LEVELS TO MATCH SURFACE U.N.O.

5. ALL GRATED DRAINS TO HAVE BASE GRADED 1.0% MIN WITH HEAVY DUTY GRATES.

6. IT IS THE BUILDERS RESPONSIBILITY TO LAY ALL PIPES IN ACCORDANCE WITH ALL RELEVANT AUTHORITY REQUIREMENTS (EG. COUNCIL, EPA, SYDNEY WATER).

7. CONTRACTOR SHALL LOCATE EXISTING SERVICES ON SITE PRIOR TO CONSTRUCTION AND SHALL TAKE EXTREME CAUTION DURING CONSTRUCTION.

## STORMWATER DISPOSAL PHILOSOPHY

1. COLLECT ALL SITE RUNOFF FROM SURFACE GRADES, SUMPS AND UNDERGROUND DRAINS AND DISCHARGE TO EXISTING STORMWATER SYSTEM.

## FLOW CALCULATIONS

USING FORMULA $Q = 0.00028\,CAI$

WHERE Q = DISCHARGE IN LITRES PER SECOND

C = A RUNOFF COEFFICIENT (SEE TABLE)

A = CATCHMENT AREA IN SQ.M.

I = RAINFALL INTENSITY IN MILLIMETRES PER HOUR

$^{100}I_5$ = 196mm/HR FOR 100 YEAR RETURN PERIOD 5 MINUTE DURATION STORM

## FLOW CALCULATION SCHEDULE

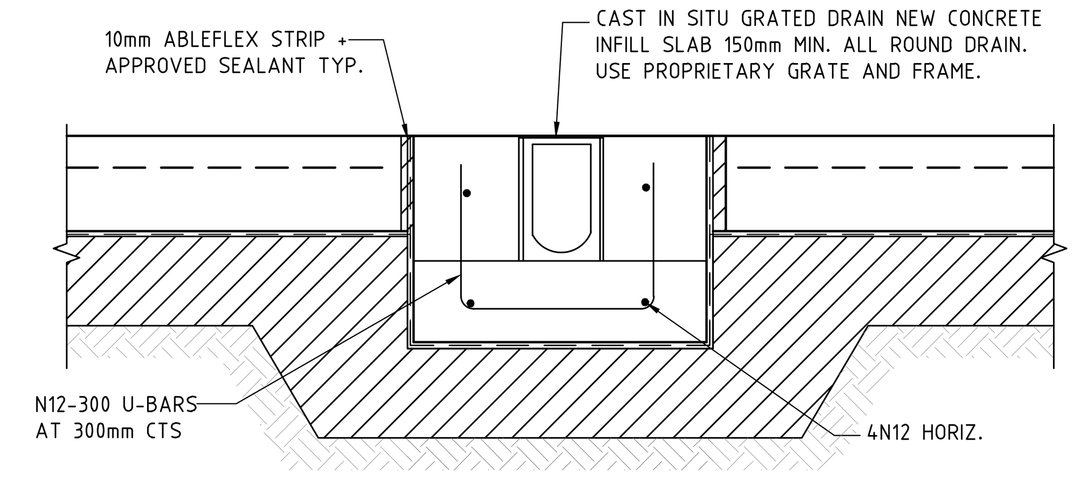
| LINE | CATCHMENT AREA (SQM) (OVERLAND FLOWS) | | | FLOW INTO LINE FROM CATCHMENT (L/S) | | | TOTAL FLOW (L/S) | MINIMUM PIPE REQUIREMENT | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ROOF | PAVE'T | L'SCAPE | ROOF C=1.00 | PAVEMENT C=0.95 | LANDSCAPE C=0.65 | | SIZE (mm) | GRADE (MIN) | CAPACITY (L/S) |
| 1 | | 3000 | | | 155.29 | | 155.29 | 375 | 1:93 | 207.54 |
| 2 | | 1935 | | | 100.16 | | 100.16 | 300 | 1:98 | 112.22 |
| 3 | | 2341 | | | 121.18 | | 376.63 | 525 | 1:86 | 523.27 |
| 4 | | 852 | | | 44.10 | | 44.10 | 225 | 1:79 | 58.51 |
| 5 | | 353 | | | 18.27 | | 62.38 | 300 | 1:86 | 119.87 |
| 6 | | | | | | | 439.01 | 525 | 1:66 | 597.83 |
| 7 | | 1090 | | | 56.42 | | 56.42 | 300 | 1:178 | 82.97 |
| 8 | 3180 | 1486 | | 173.27 | 76.92 | | 745.62 | 675 | 1:148 | 770.26 |
| 9 | | 528 | | | 27.33 | | 27.33 | 225 | 1:77 | 59.27 |
| 10 | | 381 | | | 19.72 | | 47.05 | 225 | 1:51 | 72.98 |
| 11 | | 920 | | | 47.62 | | 47.62 | 225 | 1:70 | 62.20 |
| 12 | | 2130 | 140 | | 110.26 | 4.96 | 955.51 | 750 | 1:103 | 1218.80 |
| 13 | | 501 | | | 25.93 | | 25.93 | 225 | 1:114 | 48.60 |
| 14 | | 260 | | | 13.46 | | 13.46 | 150 | 1:100 | 17.73 |
| 15 | | 2288 | | | 118.44 | | 118.44 | 450 | 1:66 | 398.64 |
| 16 | | 435 | 150 | | 22.52 | 5.31 | 185.66 | 450 | 1:66 | 398.64 |
| 17 | | 1615 | 570 | | 83.60 | 20.19 | 289.44 | 525 | 1:81 | 539.29 |
| 18 | | 452 | | | 23.40 | | 23.40 | 150 | 1:52 | 24.69 |
| 19 | | 515 | | | 26.66 | | 50.06 | 225 | 1:95 | 53.30 |
| 20 | | 1124 | | | 58.18 | | 397.68 | 600 | 1:136 | 589.97 |
| 21 | | 1765 | | | 91.36 | | 91.36 | 300 | 1:88 | 118.49 |
| 22 | | 2265 | | | 117.24 | | 208.61 | 375 | 1:61 | 256.69 |
| 23 | | 1731 | 440 | | 89.60 | 15.58 | 105.19 | 300 | 1:54 | 151.58 |
| 24 | | 4105 | 200 | | 212.49 | 7.08 | 533.37 | 600 | 1:70 | 824.20 |
| 25 | | | 650 | | | 23.02 | 954.07 | 750 | 1:102 | 1224.79 |
| 26 | | 1215 | | | 62.89 | | 62.89 | 225 | 1:61 | 66.68 |
| 27 | | 2785 | | | 144.16 | | 2116.64 | 1200 | 1:240 | 2727.11 |
| 28 | | | | | | | 139.00 | 375 | 1:87 | 214.64 |
| 29 | | | | | | | 298.00 | 450 | 1:61 | 414.76 |
| 30 | | | | | | | 497.00 | 525 | 1:82 | 535.97 |
| 31 | | | | | | | 696.00 | 600 | 1:72 | 812.60 |
| 32 | | | | | | | 2812.64 | 900 | 1:56 | 2669.30 |
| 33 | | | | | | | 123.00 | 375 | 1:103 | 197.12 |
| 34 | | | | | | | 253.00 | 525 | 1:175 | 365.75 |

## LINE SCHEDULE

| TAG | UPSTREAM INVERT | SIZE Ø (mm) | MATERIAL | LENGTH (m) | GRADE (ACTUAL) | DOWN-STREAM INVERT |
|---|---|---|---|---|---|---|
| 1 | 585.66 | 375 | CONCRETE | 45.60 | 1:93 | 585.17 |
| 2 | 585.47 | 300 | UPVC | 29.40 | 1:98 | 585.17 |
| 3 | 585.02 | 525 | CONCRETE | 62.00 | 1:86 | 584.30 |
| 4 | 585.37 | 225 | UPVC | 37.20 | 1:79 | 584.90 |
| 5 | 584.70 | 300 | CONCRETE | 34.40 | 1:86 | 584.30 |
| 6 | 584.05 | 525 | CONCRETE | 29.50 | 1:66 | 583.60 |
| 7 | 583.75 | 300 | CONCRETE | 80.00 | 1:178 | 583.30 |
| 8 | 583.30 | 675 | CONCRETE | 57.70 | 1:148 | 582.91 |
| 9 | 584.20 | 225 | UPVC | 14.70 | 1:77 | 584.01 |
| 10 | 583.71 | 225 | UPVC | 20.80 | 1:51 | 583.30 |
| 11 | 583.20 | 225 | UPVC | 7.70 | 1:70 | 583.09 |
| 12 | 582.91 | 750 | CONCRETE | 83.50 | 1:103 | 582.10 |
| 13 | 585.72 | 225 | UPVC | 38.60 | 1:114 | 585.38 |
| 14 | 585.59 | 150 | UPVC | 20.90 | 1:100 | 585.38 |
| 15 | 585.75 | 450 | CONCRETE | 24.40 | 1:66 | 585.38 |
| 16 | 585.38 | 450 | CONCRETE | 63.20 | 1:66 | 584.42 |
| 17 | 584.42 | 525 | CONCRETE | 58.80 | 1:81 | 583.69 |
| 18 | 584.20 | 150 | UPVC | 16.70 | 1:52 | 583.88 |
| 19 | 583.88 | 225 | UPVC | 18.00 | 1:95 | 583.69 |
| 20 | 583.69 | 600 | CONCRETE | 15.00 | 1:136 | 583.58 |
| 21 | 585.38 | 300 | UPVC | 30.00 | 1:88 | 585.04 |
| 22 | 585.04 | 375 | CONCRETE | 57.00 | 1:61 | 584.10 |
| 23 | 583.80 | 300 | UPVC | 24.20 | 1:54 | 583.35 |
| 24 | 583.20 | 600 | CONCRETE | 45.80 | 1:70 | 582.55 |
| 25 | 582.47 | 750 | CONCRETE | 12.30 | 1:102 | 582.35 |
| 26 | 582.62 | 225 | UPVC | 16.50 | 1:61 | 582.35 |
| 27 | 582.10 | 1200 | CONCRETE | 24.00 | 1:240 | 582.00 |
| 28 | 586.16 | 375 | CONCRETE | 125.80 | 1:87 | 584.72 |
| 29 | 584.72 | 450 | CONCRETE | 65.70 | 1:61 | 583.65 |
| 30 | 583.65 | 600 | CONCRETE | 78.20 | 1:82 | 582.70 |
| 31 | 582.40 | 525 | CONCRETE | 35.80 | 1:72 | 581.90 |
| 32 | 581.90 | 900 | CONCRETE | 50.00 | 1:56 | 581.00 |
| 33 | 585.10 | 375 | CONCRETE | 118.30 | 1:103 | 583.95 |
| 34 | 583.95 | 525 | CONCRETE | 35.00 | 1:175 | 583.75 |

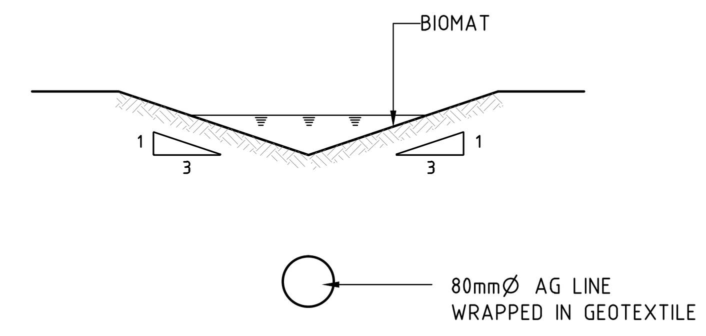
## PIT SCHEDULE

| TAG | TYPE | SIZE | RL TOP | IL | COVER | NOTES |
|---|---|---|---|---|---|---|
| A | INLET | 900X900 | 586.50 | 585.66 | CLASS D GRATE | |
| B | INLET | 600x900 | 586.66 | 585.47 | CLASS D GRATE | |
| C | INLET | 600x900 | 586.00 | 585.02 | CLASS D GRATE | BACKDROP PIT |
| D | INLET | 600x600 | 586.25 | 585.37 | CLASS D GRATE | |
| E | INLET | 900x900 | 586.25 | 584.70 | CLASS D GRATE | BACKDROP PIT |
| F | JUNCTION PIT | 900x900 | 585.93 | 584.05 | CLASS D SEALED LID | BACKDROP PIT |
| G | INLET | 600x600 | 584.50 | 583.75 | CLASS D GRATE | |
| H | INLET | 900x900 | 585.30 | 583.30 | CLASS D GRATE | BACKDROP PIT |
| J | INLET | 900x900 | 585.42 | 584.20 | CLASS D GRATE | |
| K | INLET | 900x900 | 585.25 | 583.71 | CLASS D GRATE | BACKDROP PIT |
| L | INLET | 600x900 | 584.25 | 583.20 | CLASS D GRATE | |
| M | INLET | 900x900 | 584.42 | 582.91 | CLASS D GRATE | BACKDROP PIT |
| N | INLET | 600x600 | 586.40 | 585.72 | CLASS D GRATE | |
| P | INLET | 600x600 | 586.40 | 585.59 | CLASS D GRATE | |
| Q | INLET | 600x600 | 586.65 | 585.75 | CLASS D GRATE | |
| R | INLET | 600x900 | 586.35 | 585.38 | CLASS D GRATE | |
| S | INLET | 600x900 | 585.50 | 584.42 | CLASS D GRATE | |
| T | INLET | 600x600 | 585.00 | 584.20 | CLASS D GRATE | |
| U | INLET | 600x900 | 584.84 | 583.88 | CLASS D GRATE | |
| V | INLET | 600x600 | 584.59 | 583.69 | CLASS D GRATE | BACKDROP PIT |
| W | HEADWALL | Enter RL | | 583.58 | | |
| Y | INLET | 600x600 | 586.13 | 585.38 | CLASS D GRATE | |
| Z | INLET | 600x600 | 585.87 | 585.04 | CLASS D GRATE | |
| AA | HEADWALL | Enter RL | | 584.10 | | |
| AB | INLET | 900x900 | 585.00 | 583.80 | CLASS D GRATE | |
| AC | INLET | 600x600 | 584.10 | 583.20 | CLASS D GRATE | BACKDROP PIT |
| AD | INLET | 600x900 | 583.62 | 582.47 | CLASS D GRATE | BACKDROP PIT |
| AE | INLET | 900x900 | 583.99 | 582.62 | CLASS D GRATE | |
| AF | INLET | 900x900 | 584.19 | 582.00 | CLASS D GRATE | |
| AG | INLET | 600x600 | 587.00 | 586.16 | CLASS D GRATE | |
| AH | INLET | 600x600 | 585.55 | 584.72 | CLASS D GRATE | |
| AJ | INLET | 600x600 | 584.55 | 583.65 | CLASS D GRATE | |
| AK | INLET | 900x900 | 583.70 | 582.40 | CLASS D GRATE | BACKDROP PIT |
| AL | INLET | 600x900 | 583.00 | 581.90 | CLASS D GRATE | |
| AM | HEADWALL | Enter RL | | 581.00 | | |
| AN | INLET | 900x900 | 586.60 | 585.10 | CLASS D GRATE | |
| AP | INLET | 450x450 | 584.30 | 583.95 | CLASS D GRATE | |
| AQ | HEADWALL | Enter RL | | 583.75 | | |



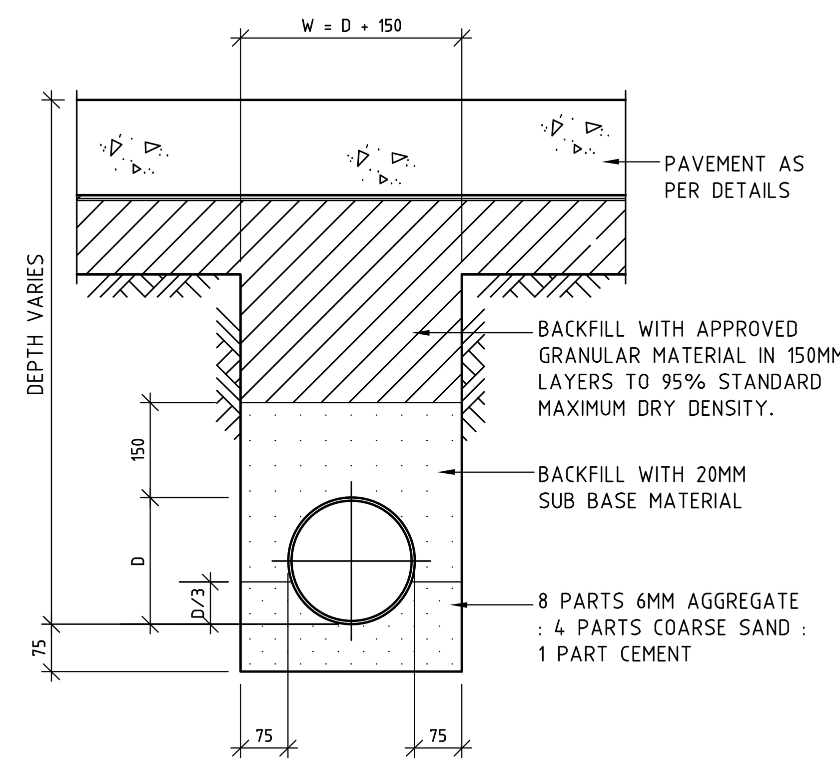

## TYPICAL GRATED DRAIN DETAIL

GRATINGS TO BE HEELGUARD D.I. ADJACENT TO CANOPIES AND WALKWAYS & EXTRA HEAVY DUTY SLOTTED D.I.TO ROAD RESERVE CROSSOVER. PROVIDE LOCK DOWNS AS SPECIFIED BY MANUFACTURER. ALONG WITH RUBBER GASKETS TO GRATES.



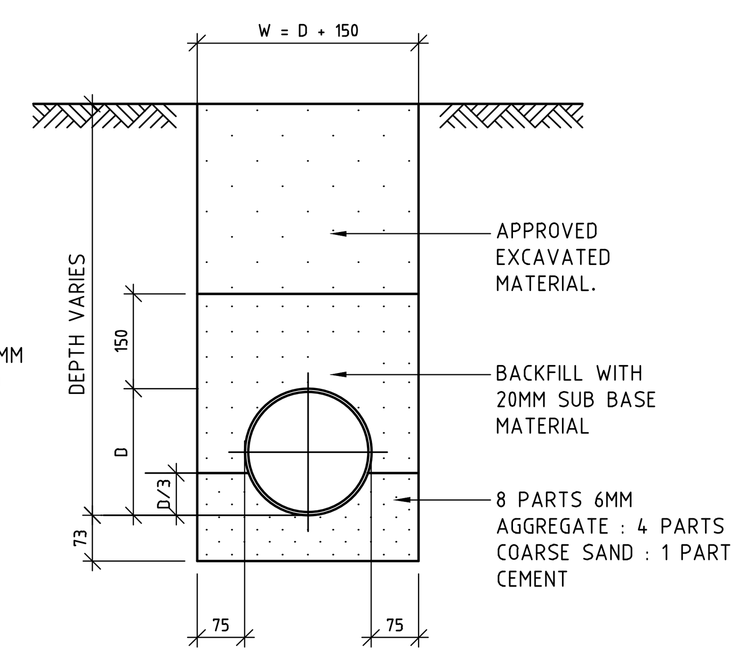

## SWALE/AG DRAIN

MIN GRADE 1%
SCALE 1:10



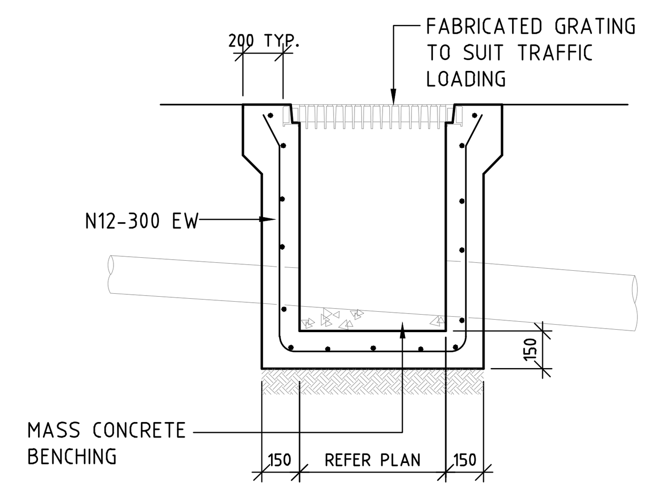

## STORMWATER PIPE BEDDING DETAIL

SCALE 1:10




## STORMWATER PIPE BEDDING DETAIL UNDER GROUND

SCALE 1:10




## TYPICAL CONCRETE STORMWATER DRAINAGE PIT

SCALE 1:25

REZONING ISSUE

| REV No. | COMMENTS | DATE | INIT. |
|---|---|---|---|
| A | ISSUE FOR REZONING APPROVAL | 10.07.18 | DM |

PROJECT:
HIGHWAY SERVICE CENTRE
BOWNING, NSW

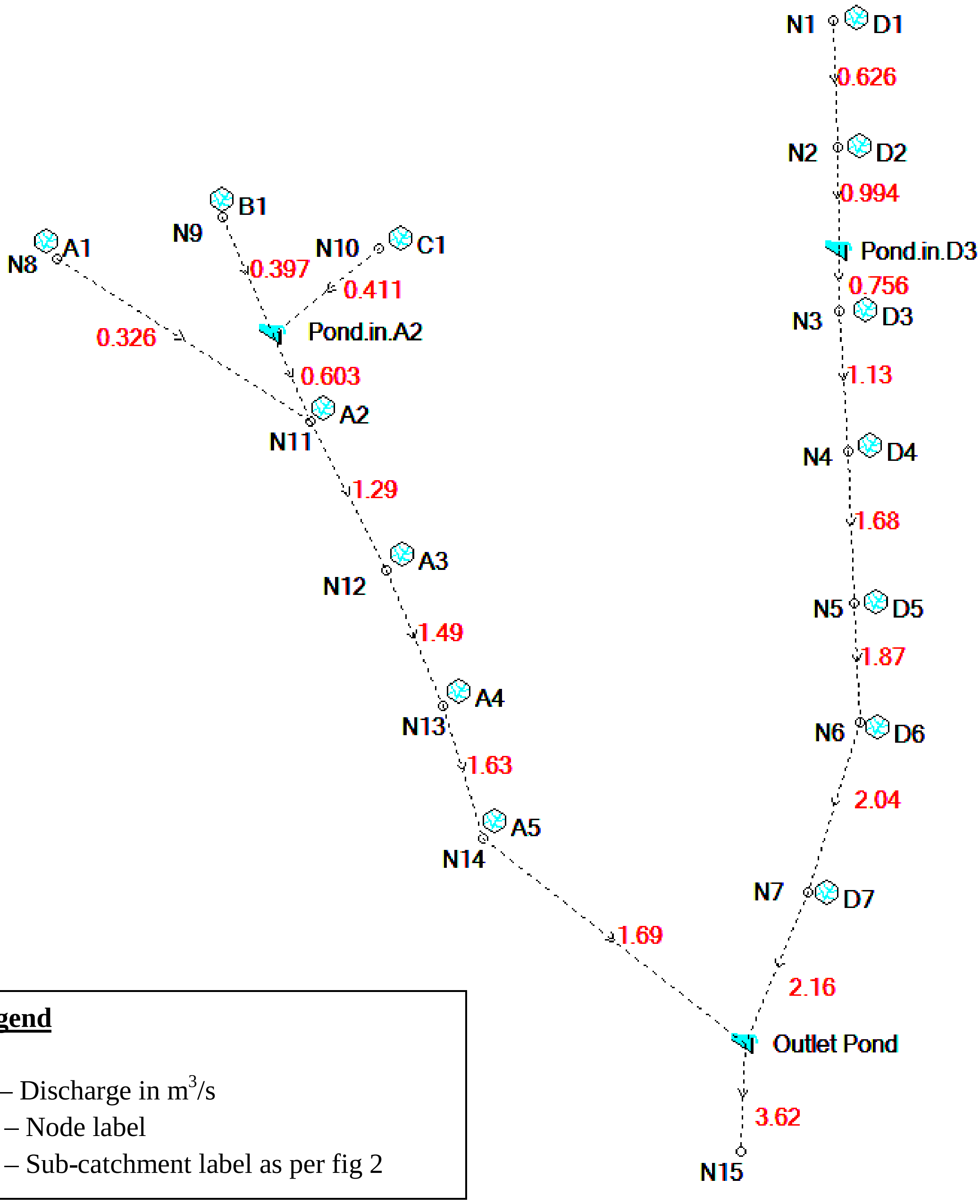
CLIENT:
-


Richmond+Ross PTY LIMITED
CONSULTING ENGINEERS
ABN 34 001 485 436
38 WILLOUGHBY ROAD, CROWS NEST, NSW 2065
TEL : (02) 9490 9600
FAX : (02) 9438 1224


PROPOSED STORMWATER DETAILS AND SCHEDULES

DATE: JULY 2018
SCALE: AS SHOWN @ A1
JOB No. 160173
DRG.No. C101
REV A

## APPENDIX B – DRAINS Model Results




**Legend**

10 – Discharge in $m^3/s$
N5 – Node label
A5 – Sub-catchment label as per fig 2

**Figure 4 Pre-Development DRAINS Model and Output**

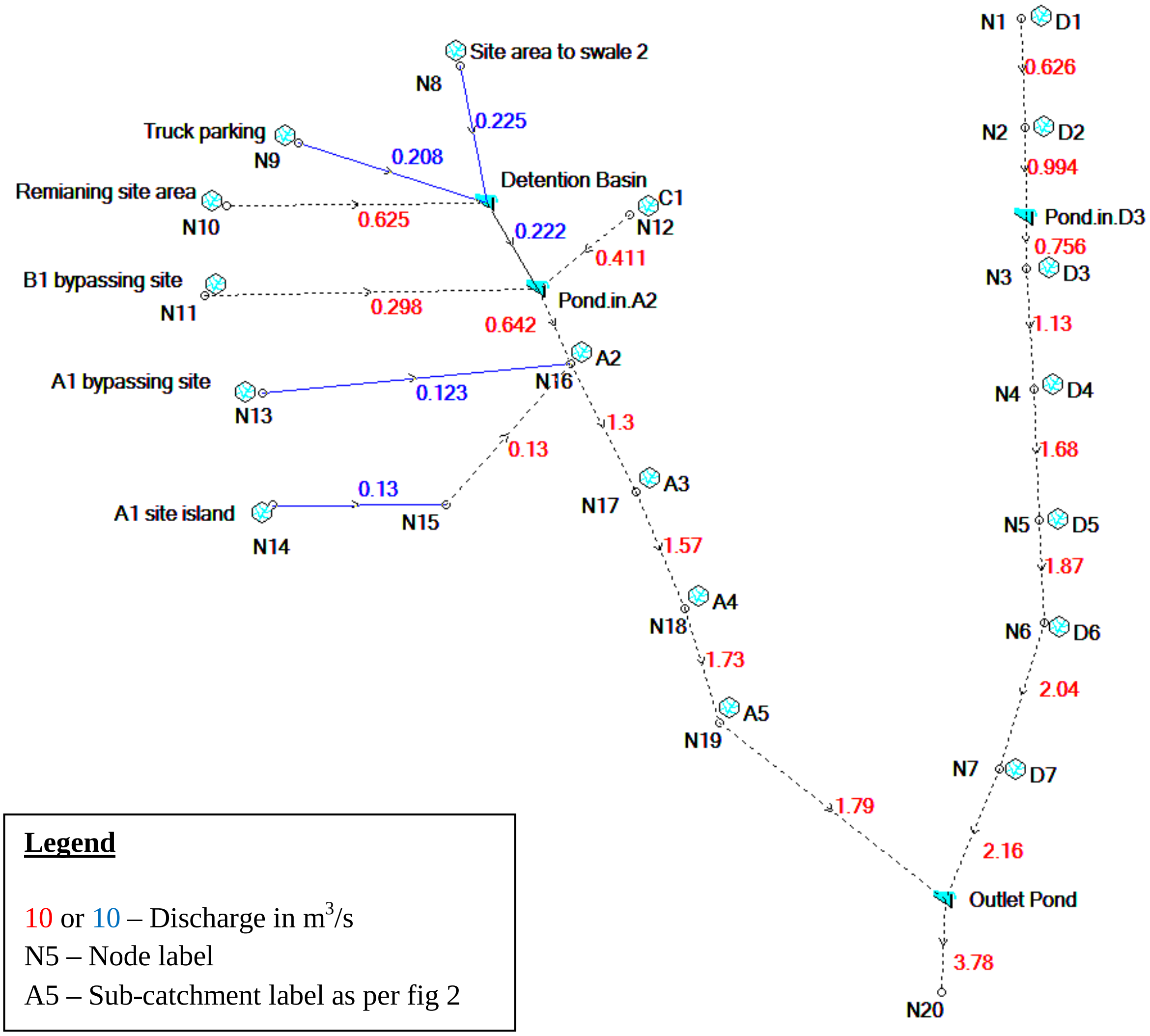



**Figure 5 Post-Development DRAINS Model and Output**

## APPENDIX C – TUFLOW Model Results

**Legend**

TUFLOW Model Extent

Site Boundary

**Figure C1:**
**TUFLOW Model Extent**

N

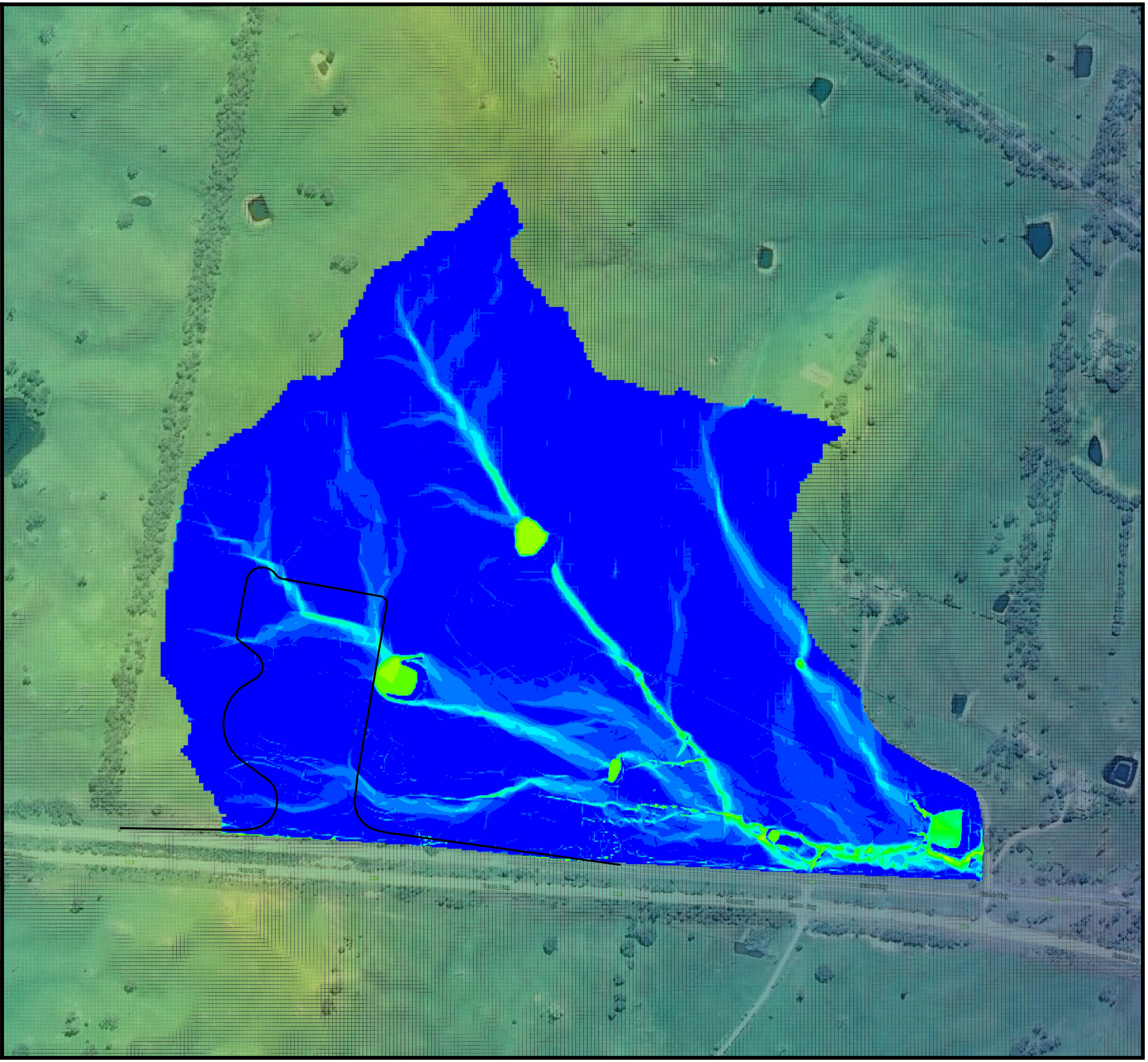
Scale 1:5000 @ A3

0 100 200 300 400 m

Prepared By:

Richmond + Ross PTY LIMITED
ABN 34 001 485 436
CONSULTING ENGINEERS AND PROJECT LEADERS

38 WILLOUGHBY ROAD,
CROWS NEST, NSW, 2065,
TEL: (02) 9490 9600



## Legend

Site Boundary

Pre Dev 1% AEP Floodwater Depths

- <=0.01
- 0.01-0.02
- 0.02-0.04
- 0.04-0.06
- 0.06-0.08
- 0.08-0.1
- 0.1-0.125
- 0.125-0.15
- 0.15-0.175
- 0.175-0.2
- 0.2-0.3
- 0.3-0.4
- 0.4-0.5
- 0.5-0.6
- 0.6-0.7
- 0.7-0.8
- 0.8-0.9
- 0.9-1.0

**Figure C2:**
**Pre Dev**
**1% AEP Floodwater Depths**

N

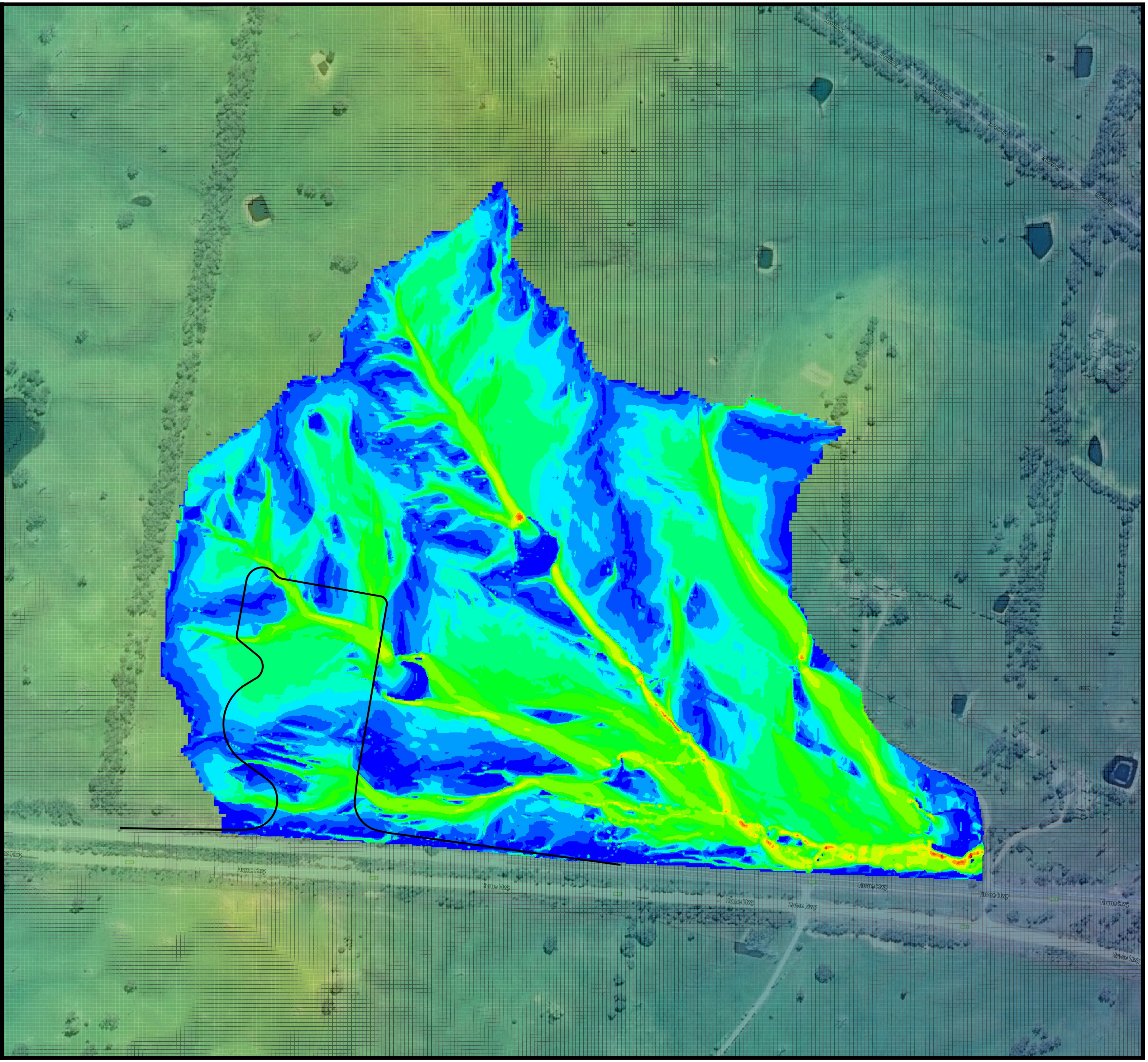
Scale 1:5000 @ A3

0 100 200 300 400 m

Prepared By:

Richmond+Ross PTY LIMITED
ABN 34 001 485 436
CONSULTING ENGINEERS AND PROJECT LEADERS

38 WILLOUGHBY ROAD,
CROWS NEST, NSW, 2065,
TEL: (02) 9490 9600



**Legend**

Site Boundary

Pre Dev 1% AEP Floodwater Velocities

- <=0.02
- 0.02-0.04
- 0.04-0.06
- 0.06-0.08
- 0.08-0.1
- 0.1-0.15
- 0.15-0.2
- 0.2-0.3
- 0.3-0.5
- 0.5-0.7
- 0.7-0.9
- 0.9-1.1
- 1.1-1.3
- 1.3-1.5

**Figure C3:**
**Pre Dev**
**1% AEP Floodwater Velocities**

N

Scale 1:5000 @ A3

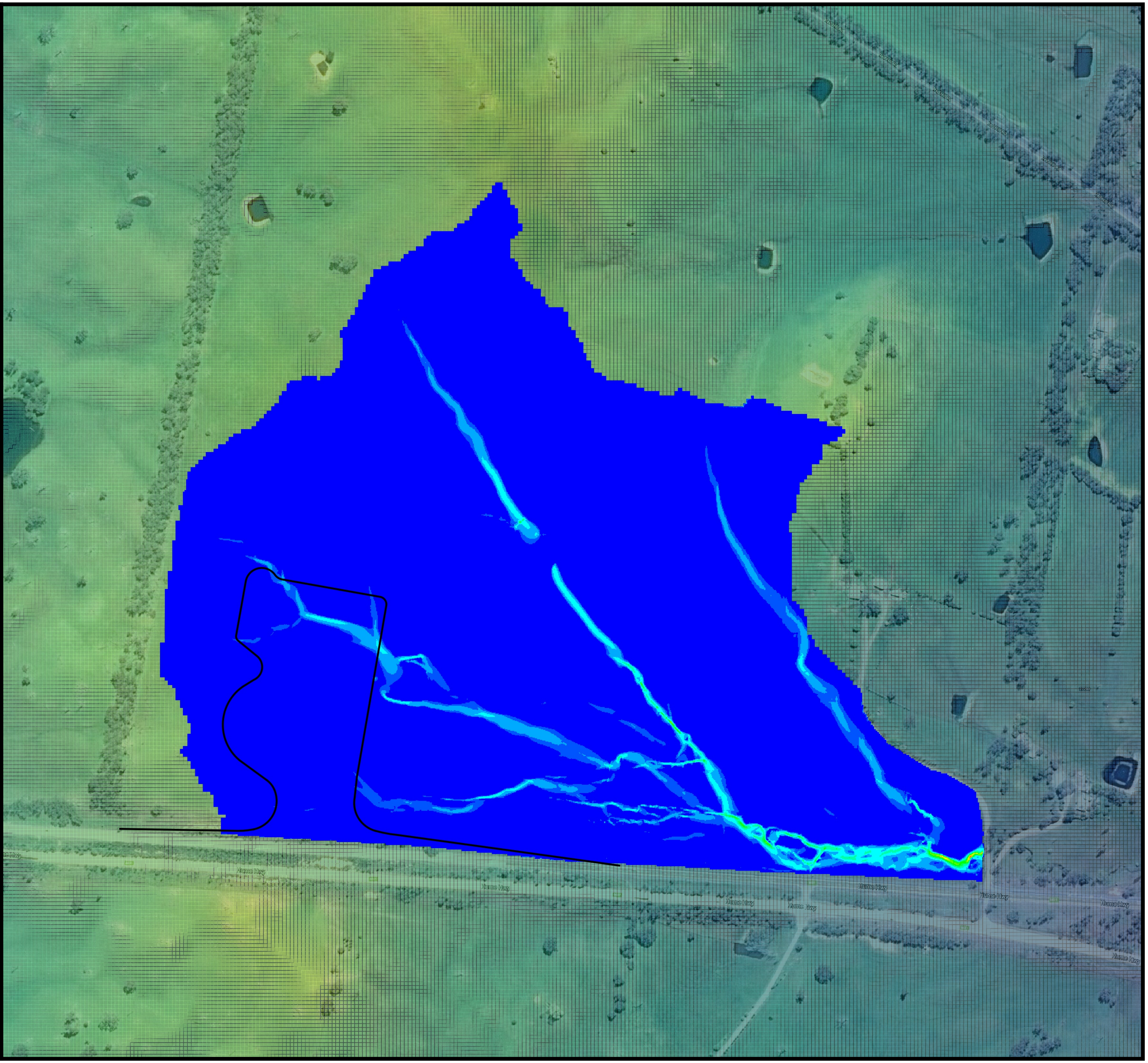
0 100 200 300 400 m


Prepared By:

Richmond+Ross PTY LIMITED
ABN 34 001 485 436

CONSULTING ENGINEERS AND PROJECT LEADERS

38 WILLOUGHBY ROAD,
CROWS NEST, NSW, 2065,
TEL: (02) 9490 9600



**Legend**

Site Boundary

Pre Dev 1% AEP Depth.Velocity Product

- 0.01
- 0.02
- 0.05
- 0.1
- 0.15
- 0.2
- 0.25
- 0.3
- 0.35
- 0.4
- 0.45
- 0.5
- 0.6

**Figure C4:**
**Pre Dev**
**1% AEP Depth.Velocity Product**

N

Scale 1:5000 @ A3

0 100 200 300 400 m

Prepared By:

Richmond + Ross PTY LIMITED
ABN 34 001 485 436
CONSULTING ENGINEERS AND PROJECT LEADERS

38 WILLOUGHBY ROAD,
CROWS NEST, NSW, 2065,
TEL: (02) 9490 9600

**Legend**

Site Boundary

Pre Dev 1% AEP Provisional Flood Hazard

Low

Medium

High

**Figure C5:**
**Pre Dev**
**1% AEP Provisional Hazard**

N

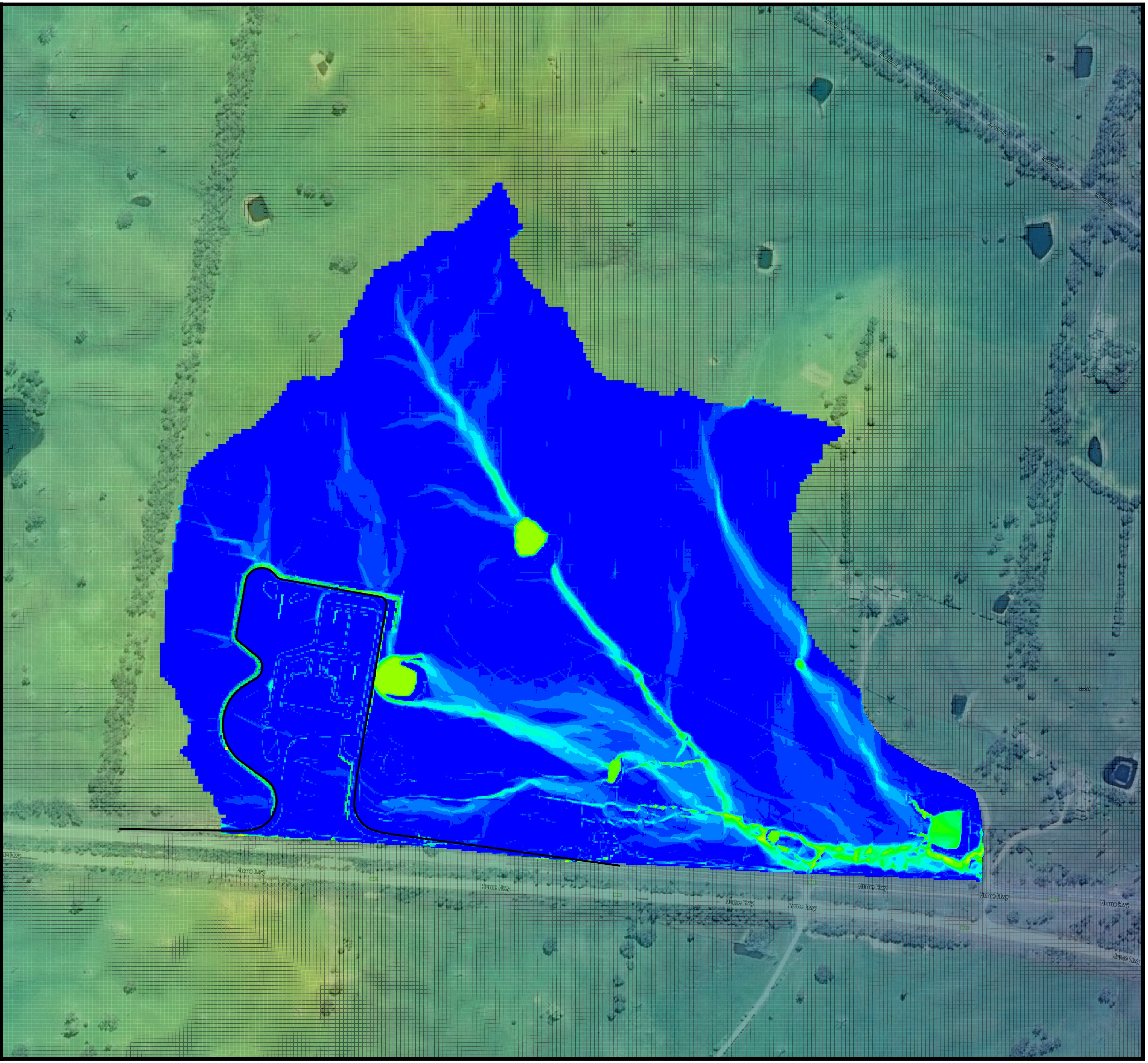
Scale 1:5000 @ A3

0 100 200 300 400 m

Notes:
Provisional flood hazard categories based on the Australian NSW Floodplain Development Manual (NSWG, 2005).

Prepared By:

Richmond+Ross PTY LIMITED
ABN 34 001 485 436
CONSULTING ENGINEERS AND PROJECT LEADERS
38 WILLOUGHBY ROAD, CROWS NEST, NSW, 2065,
TEL: (02) 9490 9600



## Legend

Site Boundary

Post Dev 1% AEP Floodwater Depths

- <=0.01
- 0.01-0.02
- 0.02-0.04
- 0.04-0.06
- 0.06-0.08
- 0.08-0.1
- 0.1-0.125
- 0.125-0.15
- 0.15-0.175
- 0.175-0.2
- 0.2-0.3
- 0.3-0.4
- 0.4-0.5
- 0.5-0.6
- 0.6-0.7
- 0.7-0.8
- 0.8-0.9
- 0.9-1.0

**Figure C6:**
**Post Dev**
**1% AEP Floodwater Depths**

N

Scale 1:5000 @ A3

0 100 200 300 400 m

Prepared By:

Richmond + Ross PTY LIMITED
ABN 34 001 485 436

CONSULTING ENGINEERS AND PROJECT LEADERS

38 WILLOUGHBY ROAD,
CROWS NEST, NSW, 2065,
TEL: (02) 9490 9600

## Legend

Site Boundary

Post Dev 1% AEP Floodwater Velocities

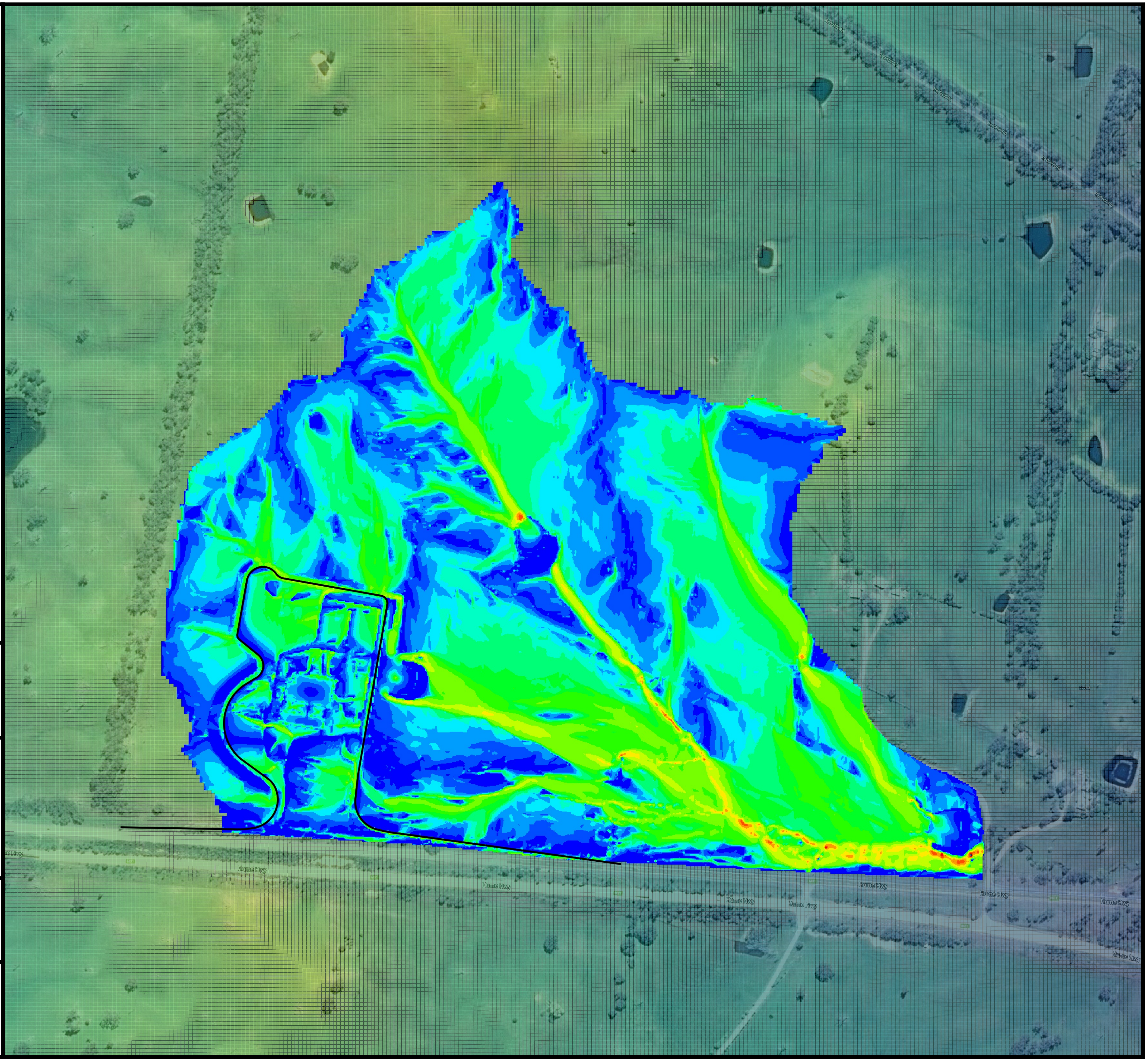
- <=0.02
- 0.02-0.04
- 0.04-0.06
- 0.06-0.08
- 0.08-0.1
- 0.1-0.15
- 0.15-0.2
- 0.2-0.3
- 0.3-0.5
- 0.5-0.7
- 0.7-0.9
- 0.9-1.1
- 1.1-1.3
- 1.3-1.5

**Figure C7:**
**Post Dev**
**1% AEP Floodwater Velocities**

N

Scale 1:5000 @ A3

0 100 200 300 400 m



Prepared By:

Richmond+Ross PTY LIMITED
ABN 34 001 485 436

CONSULTING ENGINEERS AND PROJECT LEADERS

38 WILLOUGHBY ROAD,
CROWS NEST, NSW, 2065,
TEL: (02) 9490 9600

**Legend**

Site Boundary

Post Dev 1% AEP Depth.Velocity Product

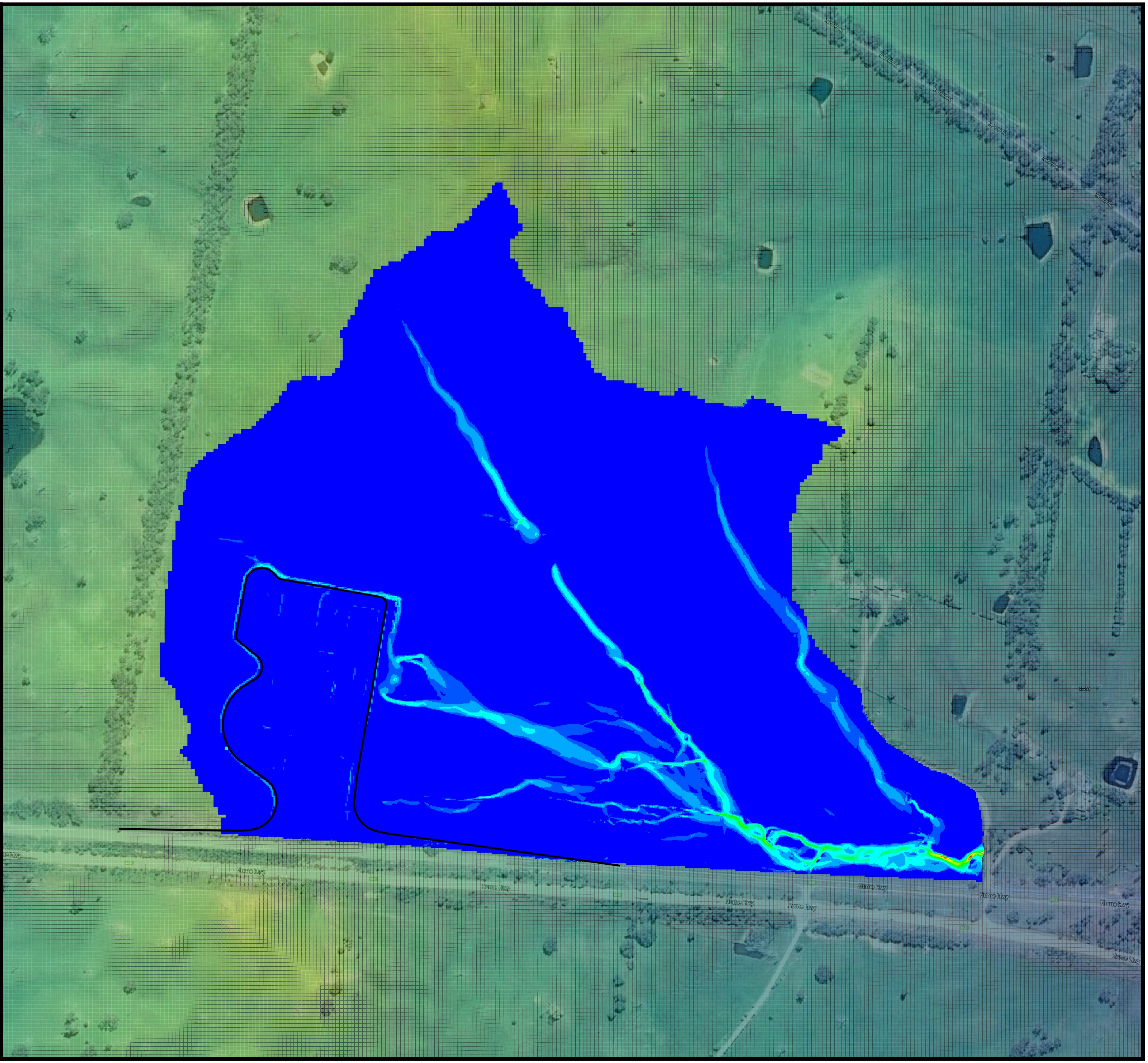
- 0.01
- 0.02
- 0.05
- 0.1
- 0.15
- 0.2
- 0.25
- 0.3
- 0.35
- 0.4
- 0.45
- 0.5
- 0.6

**Figure C8:**
**Post Dev**
**1% AEP Depth.Velocity Product**

N

Scale 1:5000 @ A3

0 100 200 300 400 m



Prepared By:

Richmond+Ross PTY LIMITED
ABN 34 001 485 436

CONSULTING ENGINEERS AND PROJECT LEADERS

38 WILLOUGHBY ROAD,
CROWS NEST, NSW, 2065,
TEL: (02) 9490 9600

**Legend**

Site Boundary

Post Dev 1% AEP Provisional Hazard

- Low
- Medium
- High

**Figure C9:**
**Post Dev**
**1% AEP Provisional Hazard**

N

Scale 1:5000 @ A3

0 100 200 300 400 m

Notes:
Provisional flood hazard categories based on the Australian NSW Floodplain Development Manual (NSWG, 2005).

Prepared By:
Richmond + Ross PTY LIMITED
ABN 34 001 485 436
CONSULTING ENGINEERS AND PROJECT LEADERS
38 WILLOUGHBY ROAD,
CROWS NEST, NSW, 2065,
TEL: (02) 9490 9600

**Legend**

Site Boundary

Change in Floodwater Depths Post Development (m)

- -0.1
- -0.075
- -0.05
- -0.025
- 0
- 0.025
- 0.05
- 0.075
- 0.1
- 0.125
- 0.15
- 0.175
- 0.2
- 0.225
- 0.25
- 0.275
- 0.3

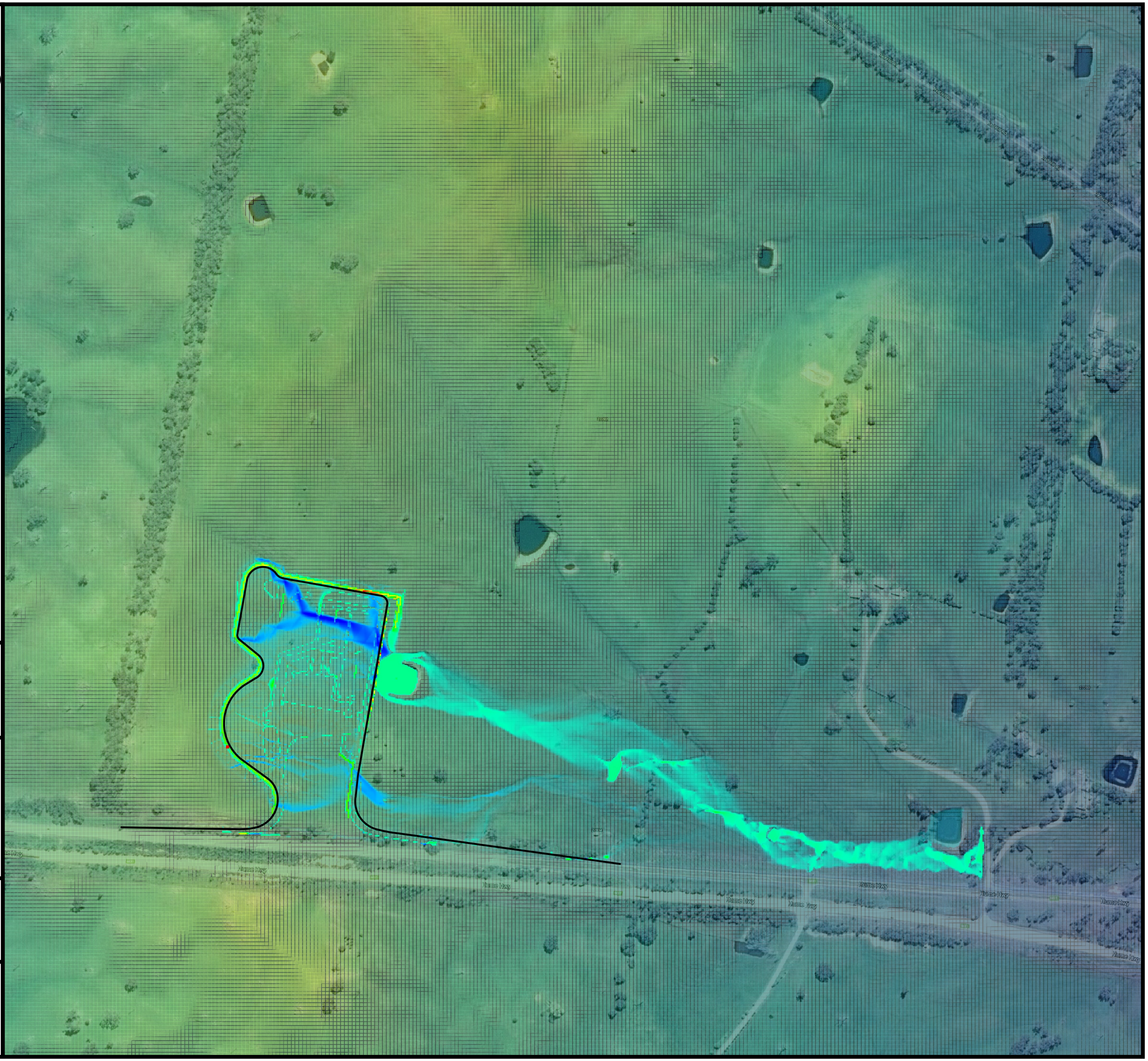


**Figure C10:**
**Change in 1% AEP Floodwater Depths Post Dev**

N

Scale 1:5000 @ A3

0 100 200 300 400 m


Prepared By:

Richmond+Ross PTY LIMITED ABN 34 001 485 436

CONSULTING ENGINEERS AND PROJECT LEADERS

38 WILLOUGHBY ROAD, CROWS NEST, NSW, 2065, TEL: (02) 9490 9600

## Legend

Site Boundary

Change in Floodwater Velocities Post Development

- -0.5
- -0.4
- -0.3
- -0.2
- -0.1
- 0
- +0.1
- +0.2
- +0.3
- +0.4
- +0.5
- +0.6

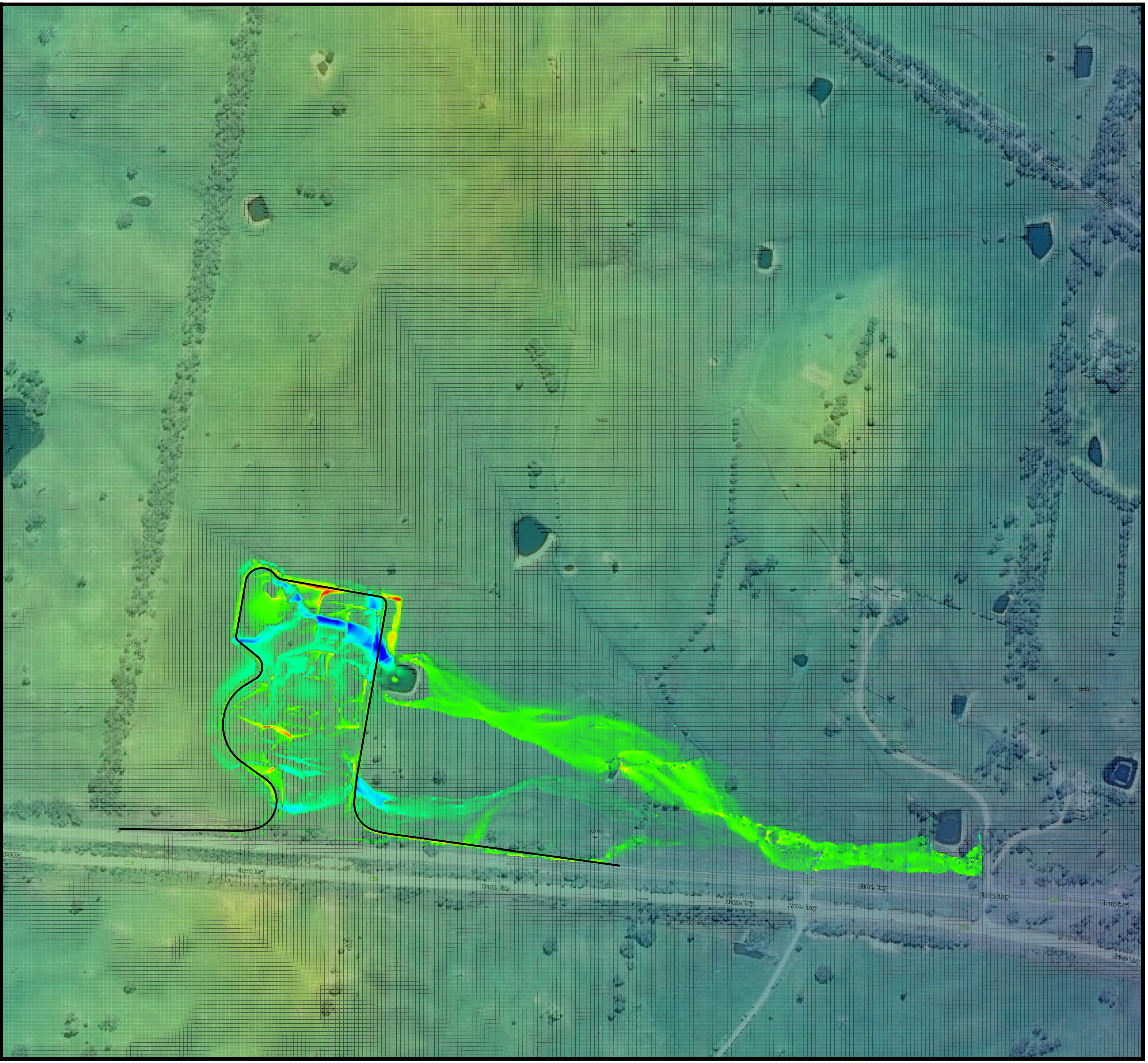


**Figure C11:**
**Change in 1% AEP Floodwater Velocities**
**Post Dev**

N

Scale 1:5000 @ A3

0 100 200 300 400 m


Prepared By:

Richmond+Ross PTY LIMITED
ABN 34 001 485 436

CONSULTING ENGINEERS AND PROJECT LEADERS

38 WILLOUGHBY ROAD,
CROWS NEST, NSW, 2065,
TEL: (02) 9490 9600

**Legend**

Site Boundary

Change in Depth.Velocity Product Post Development

- -0.05
- -0.04
- -0.03
- -0.02
- -0.01
- 0
- +0.01
- +0.02
- +0.03
- +0.04
- +0.05
- +0.06
- +0.07
- +0.08
- +0.09
- +0.1

**Figure C12:**
**Change in 1% AEP Depth.Velocity Product**
**Post Dev**

N

Scale 1:5000 @ A3

0 100 200 300 400 m

Prepared By:

Richmond+Ross PTY LIMITED
ABN 34 001 485 436
CONSULTING ENGINEERS AND PROJECT LEADERS

38 WILLOUGHBY ROAD,
CROWS NEST, NSW, 2065,
TEL: (02) 9490 9600