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Our Ref: DJL: L.T2450.002.docx

28 June 2024
Ku-ring-gai Council
Locked Bag 1006
Gordon NSW 2072

Attention: Sophia Findlay

Dear Sophia

RE: FLOOD MODELLING OF NORMAN GRIFFITHS OVAL

Background

Torrent Consulting was engaged by Ku-ring-gai Council (Council) to undertake flood modelling of proposed flood detention infrastructure at Norman Griffiths Oval, 30 Lofberg Road, West Pymble. The proposed redevelopment of the oval incorporates the replacement of the grassed surface with a synthetic turf on top of an underground detention (provided by means of StormTech chambers and coarse aggregate with a water retaining capacity of 2.4ML).

Previous modelling of the local catchment (Quarry Creek) and earlier oval redevelopment options has been undertaken, including most recently in *Norman Griffiths Oval - Flood Risk Investigation* (BMT, 2020) using DRAINS software hydrology inputs and TUFLOW 2D hydraulic model software. The BMT (2020) study built upon the earlier model development by Jacobs (2018).

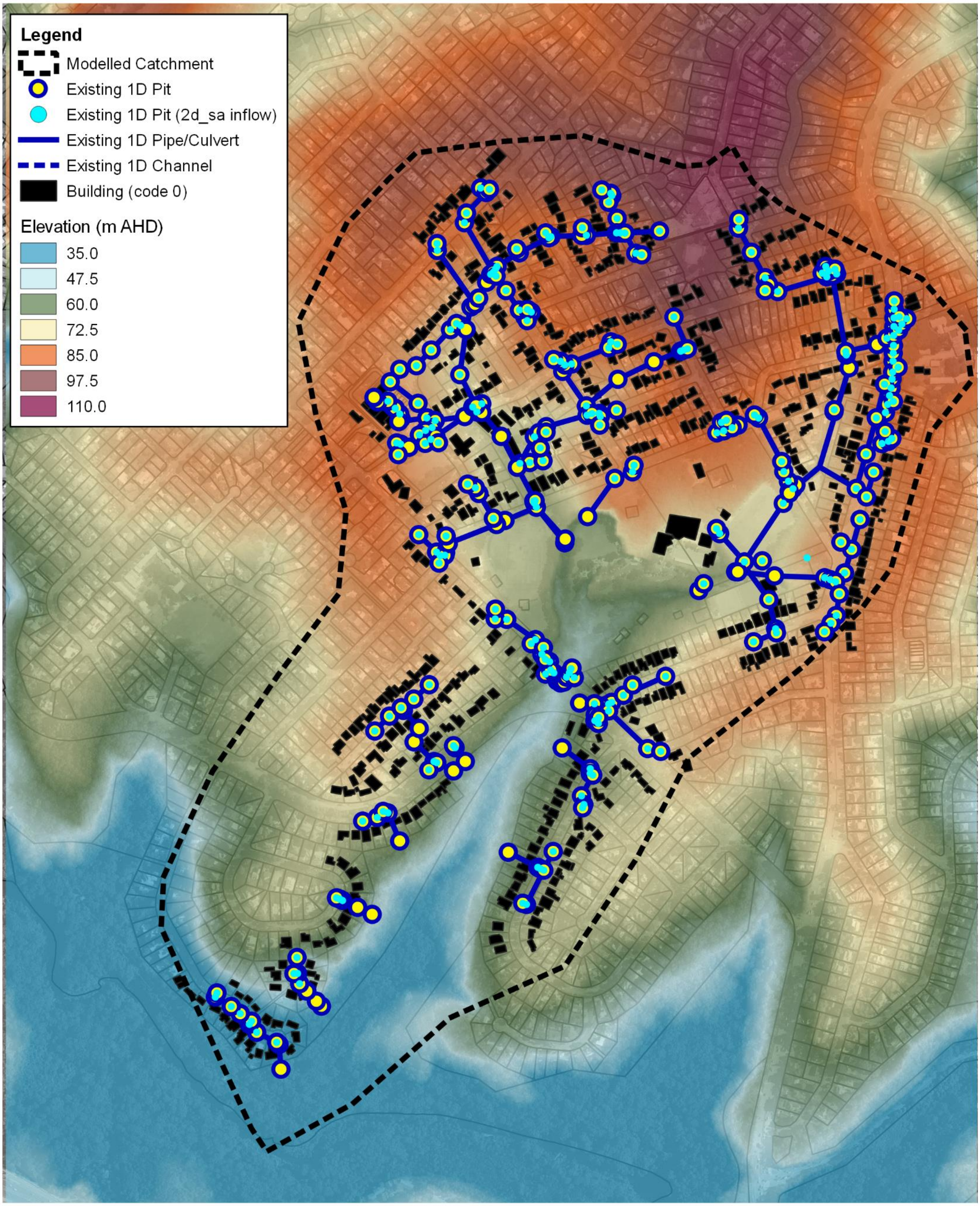
Subsequent to this modelling, the design configuration of the proposed oval redevelopment and flood detention infrastructure has progressed. Accordingly, Council sought to update the flood modelling and assess potential impacts of the redevelopment on existing design flood conditions. Further, the release of Australian Rainfall and Runoff 2019 guidelines (ARR2019) supersedes the hydrological modelling approaches adopted in the previous DRAINS model.

The objective of the current assessment is to update existing modelling to represent proposed modified configurations of the stormwater detention infrastructure and assess potential impacts relevant to ARR2019 design hydrology.

Existing Model Configuration

The TUFLOW model from BMT (2020) for the baseline scenario (pre-development conditions) was utilised as the base for the current model development. A detailed review of the model has not been undertaken, however, as Council's adopted model it is assumed fit for purpose. The existing model extent and key schematisation features is shown in Figure 1 with a summary of the general model configuration is provided hereunder:

- Model Domain and Topography – the model domain covers the full catchment of Quarry Creek extending to the confluence with Lane Cover River. The adopted TUFLOW model resolution is 2m with the underlying model topography based on LiDAR data.



Title:

TUFLOW Model Configuration (BMT, 2020)

0 200 400 m

approx. scale

Figure: 1

Revision: A

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- Building representation – buildings footprints potentially within overland flow paths were removed from the model domain via a zero code in the 2d_code layer.
- Stormwater Drainage Network – extensive network of stormwater pits and pipes, open channels and cross drainage structures incorporated in relevant one-dimensional model layers.
- Hydraulic Roughness – Mannings' 'n' representation of hydraulic roughness defined by land use categories comprising roads, grassed surface, urban blocks, waterways, dense vegetation, hardstand areas and buildings.
- Inflow Boundaries – design flow hydrographs derived from the DRAINS model applied as source area (2d_sa) boundaries directly to surface or modelled pits/pit groups as per Figure 1.
- Downstream Boundary - The downstream boundary of the model extends well downstream of Norman Griffiths Oval towards the confluence with Lane Cover River adopting a model derived stage-discharge relationship based on the local topography and nominal hydraulic slope.

Model Configuration Changes

The main objectives of the model updates are to redefine existing flood conditions based on ARR2019 hydrological methods and represent the proposed Norman Griffiths Oval redevelopment works, in particular the stormwater drainage and detention infrastructure.

Model Approach

The base model was modified to simulate rainfall-runoff response via the direct rainfall (rainfall on grid) functionality. Surface flows are generated directly within the hydraulic model without the requirement for a separate hydrological model (e.g. DRAINS model previously used). The direct rainfall approach for the catchment is considered to improve on the predefined inflow distribution to the stormwater drainage network (as adopted from the DRAINS model) with a better representation of the overland flow distribution throughout the catchment.

The model has also been run in HPC (Heavily Parallelised Compute) simulation mode providing advantages in simulation times and model stability for the whole of catchment direct rainfall modelling.

ARR2019 design rainfall inputs

The release of the ARR2019 guidelines provides updated procedures for design flood estimation. This includes updated intensity-frequency-duration (IFD) rainfall estimates and application of a suite of revised temporal patterns for establishing critical design flood conditions.

The design rainfall depths were sourced from the BoM IFD portal and are summarised in Table 1 for various design event magnitudes and storm durations. Note that only the 1% AEP event has been simulated for the assessment, with other design rainfalls provided for reference.

Notwithstanding the recent NSW-specific guidance on initial loss and a continuing loss for undeveloped catchment, the majority of the catchment is urbanised. There are some differences in the rainfall loss models within the DRAINS and TUFLOW models, however, some consistency was maintained. Losses for road corridors and hardstand areas were adopted as 1 mm initial loss and 0 mm/h continuing loss. For developed urban areas these losses were modified to account for ~50% impervious area providing an initial loss of 2 mm (depending on storm event) and a continuing loss of 1 mm/h. Grasses and vegetated areas adopted 5 mm initial loss and 2 mm/h continuing loss

Table 1 – Design IFD Rainfall

Duration (mins)	10% AEP	5% AEP	2% AEP	1% AEP	0.5% AEP
10	22.5	25.9	30.5	34.2	36.8
15	28.1	32.5	38.3	42.8	46.1
20	32.2	37.2	43.8	49.1	52.9
25	35.4	40.9	48.2	54	58.2
30	38	43.9	51.7	58	62.6
45	43.9	50.6	59.8	67.2	72.7
60	48.3	55.7	65.9	74.2	80.4
90	55.2	63.7	75.6	85.3	92.3
120	60.9	70.4	83.7	94.6	102.7
180	70.8	82	97.9	110.7	119.7
270	83.7	97.3	116.8	131.7	141.7
360	95.2	110.9	132.8	150.8	161.7

Direct Rainfall

A number of model changes were made to facilitate the direct rainfall modelling approach. All DRAINS model inflow hydrographs were removed and replaced with a single catchment-wide rainfall layer referencing the appropriate design ARR2019 rainfall and temporal pattern. All building polygons previously removed from the model domain via the code layer were reinstated to include the roof area runoff with the direct rainfall approach.

Existing Design Flood Conditions

The TUFLOW model was simulated (using the HPC solver) for the 1% AEP design rainfall event for storm durations ranging from ten minutes to 360 minutes. The ARR 2019 guidelines ensemble method to design flood hydrology involves the simulation of ten rainfall temporal patterns for each design event magnitude and duration, with the average condition of the ten being adopted for design purposes. The point rainfall temporal patterns provided for the East Coast South temporal rainfall region were adopted for the ensemble method accordingly.

The TUFLOW model simulations were analysed downstream of Norman Griffiths Oval to identify the critical duration, i.e., that which produces the peak flood flows for the 1% AEP design event magnitude. This is undertaken by calculating the average peak flood flow and the peak flood flow variance of the ten simulated hydrographs for each design event duration and magnitude.

The box-plot shown in Figure 2 illustrates the variation of the discharge predicted by the ensemble patterns across the simulated durations. The 25-minute duration was identified as being critical for the 1% AEP event, providing for the highest mean flow of 9.9 m^3/s downstream of Norman Griffiths Oval (PO line reference 94). The design temporal pattern ID 4458 (TP03) was selected as producing hydrographs most representative of the mean design condition from the results of the ensemble method with corresponding peak flow of 10.0 m^3/s.

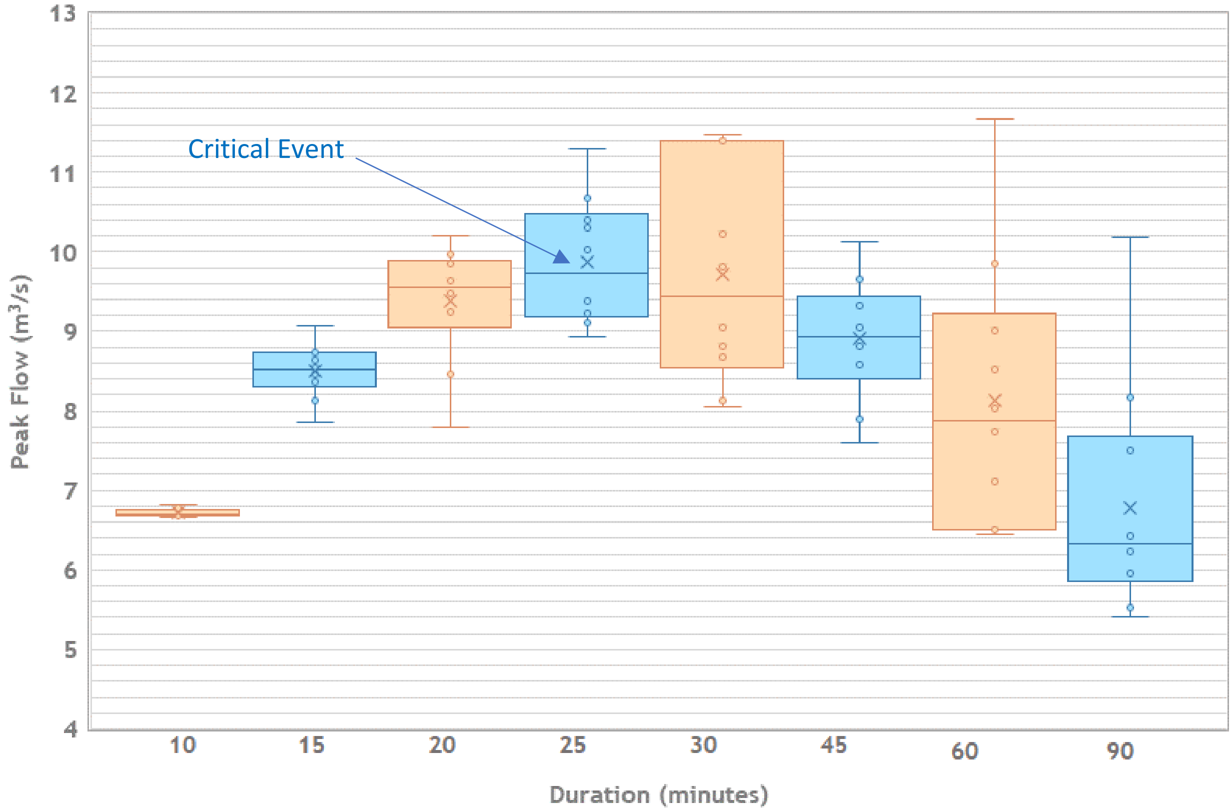


Figure 1 Critical Duration Analysis for Downstream of NGO (Plot Output line 94)

A comparison of the simulated peak design flows in the current model and BMT (2020) model is shown in in Table 2 for downstream of Norman Griffiths Oval. Similar peak design flows for the 1% AEP event are simulated despite the different hydrological inputs and modelling approaches.

Table 2 – Modelled 1% AEP Peak Design Flows (m^3/s)

Location	Current Model	BMT (2020)
D/S Norman Griffiths Oval	10.0	9.6

Further comparison of the simulated design flow hydrographs downstream of Norman Griffiths Oval for the current model and BMT (2020) model is shown in Figure 3. The timing differences is representative of the adopted critical duration and temporal patterns based on the ARR2019 and ARR1987 hydrology inputs, being the 25-minute and 60-minute durations respectively.

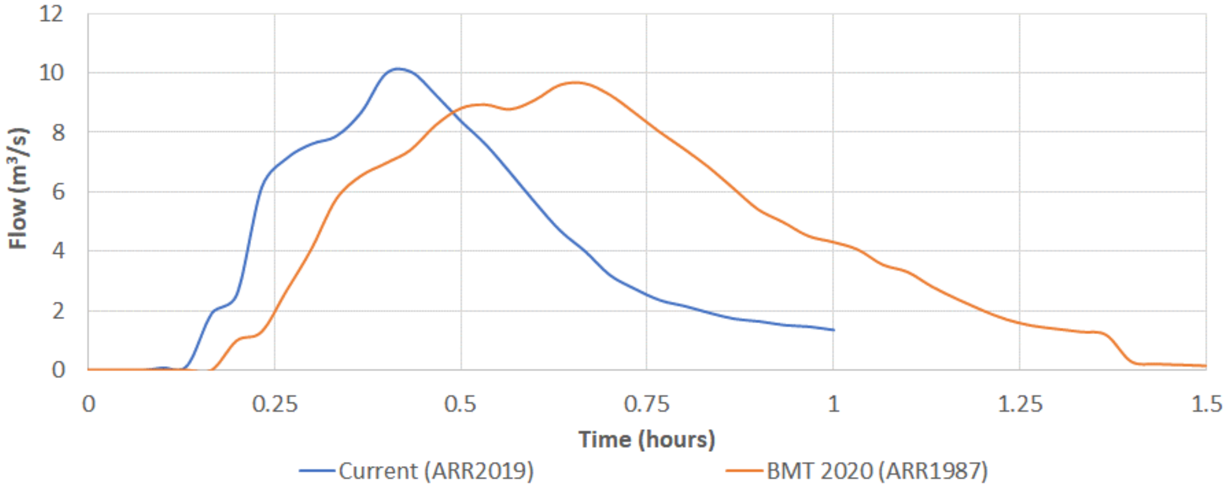


Figure 3 Simulated Hydrographs for Downstream of NGO (Plot Output line 94)

The larger total rainfall depth for the 60-minute hydrograph provides for an overall higher flood volume. However, the relative shorter duration intensities embedded in the temporal pattern provide for similar peak flows. This is evident in the input rainfall hyetographs for the respective events as shown in Figure 4, with peak 5-minute rainfall burst of 19.4mm for the ARR2019 25-minute (TP03) event compared with 17.9mm for the ARR1987 60-minute event.

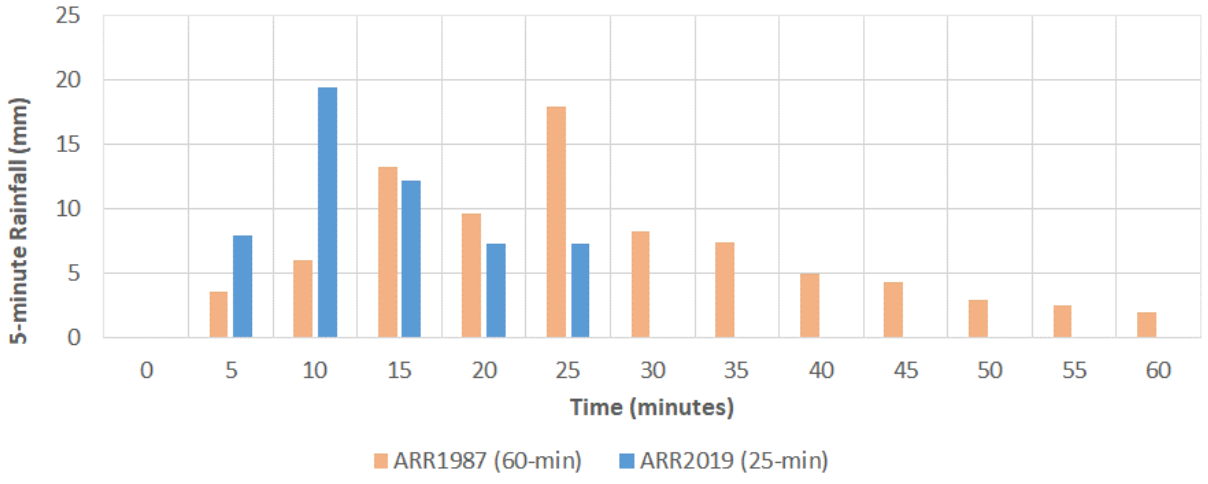
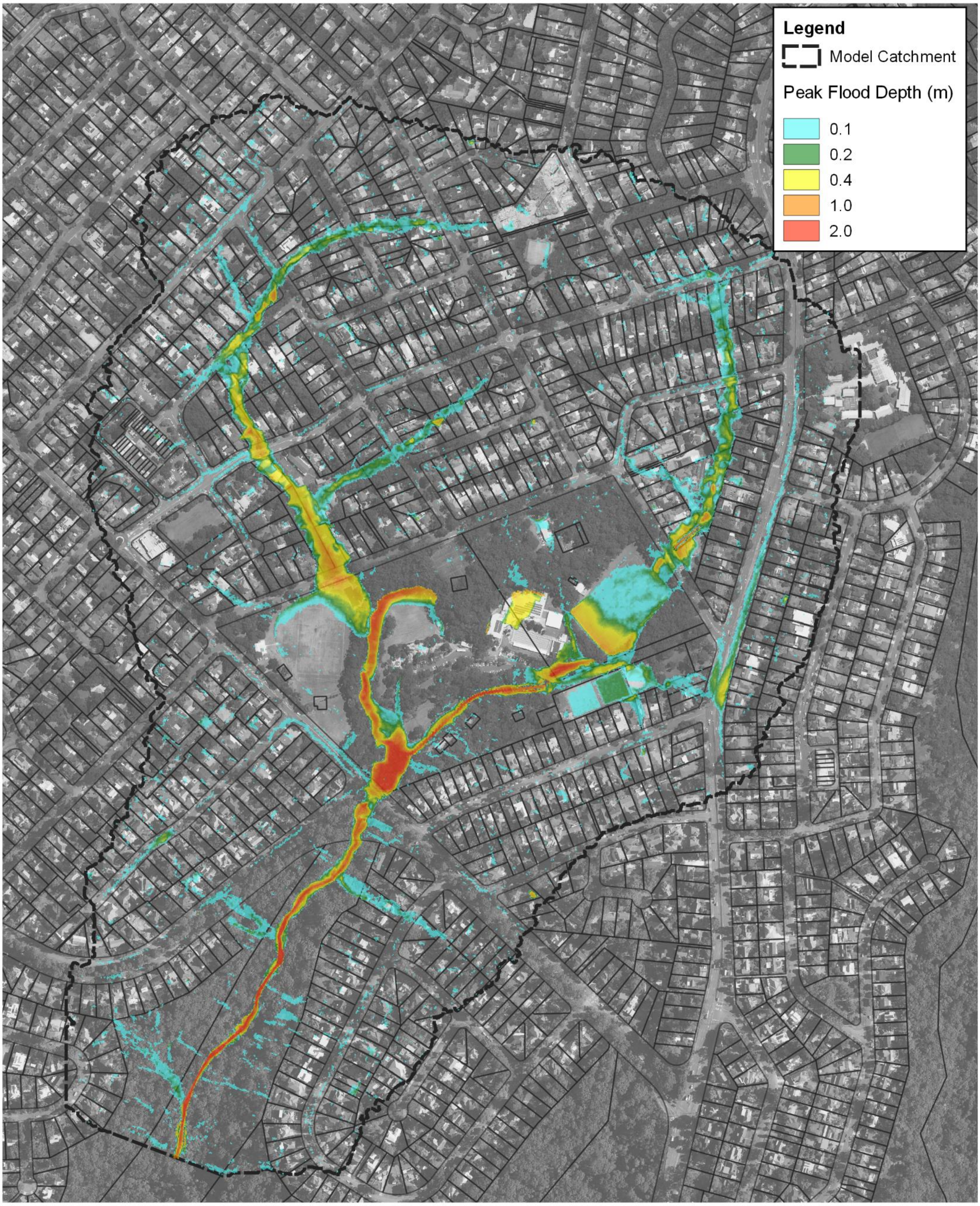


Figure 4 Design Rainfall Hyetographs

The simulated peak 1% AEP flood inundation extents and flood depth distribution for existing conditions is shown in Figure 5 corresponding to the adopted critical event (25-minute TP03). The simulated flooding conditions are similar to those mapped previously in BMT (2020), with additional resolution of the overland flow paths as noted.



Title:

Simulated 1% AEP Flood Depth
Existing Conditions

Figure: **5**

Revision: **A**

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Norman Griffiths Oval Drainage Works

The proposed works as described in the Review of Environmental Factors (WillowTree Planning, 2023) involves capture, detention and quality treatment of stormwater run-off associated with the new synthetic playing field and upper catchment flows. Key components of the proposed stormwater treatment and detention system are as follows:

- CDS Unit to filter upper catchment flows from the northeast. The proposed CDS Unit will be located along the north-eastern boundary of the site and requires partial demolition of the existing box culvert and pit to connect to proposed diversion chamber. The CDS filters rubbish, debris, sediment, and hydrocarbons from upper catchment stormwater runoff before directing flows into under-field detention basin.
- Inlet pipes along the sides of the field to capture upper catchment flows from the northwest and southeast. Inlet pipes along the sides of the field will allow upper-catchment stormwater flows from the northwest and southeast to permeate into the under-field detention basin.
- Under-field detention with 2.4 megalitre capacity within sub-surface aggregate layer. The under-field detention basin has sufficient capacity to accommodate stormwater flows from the subject site and upper-catchment areas up to a 1% AEP storm event.
- Two (2) under-field Stormtech SC-740 Chambers. The Stormtech Chambers will attenuate stormwater flows and convey flows to the southwest of the site.
- Bio-Retention Basin 226m^2. The proposed Bio-Retention Basin will be located along the southwestern edge of the field and will provide quality treatment for stormwater prior to discharging to a pit system which connects to the existing 1050mm dia underground stormwater pipe.
- Retention of existing 1050mm dia under field stormwater pipe for integration into proposed system, when flows exceed the capacity of the CDS unit overflow, the CDS weir and be conveyed to the southwest through the existing 1050mm dia underground stormwater pipe

The general layout is shown in Figure 6 with plans of key infrastructure included in Appendix A.

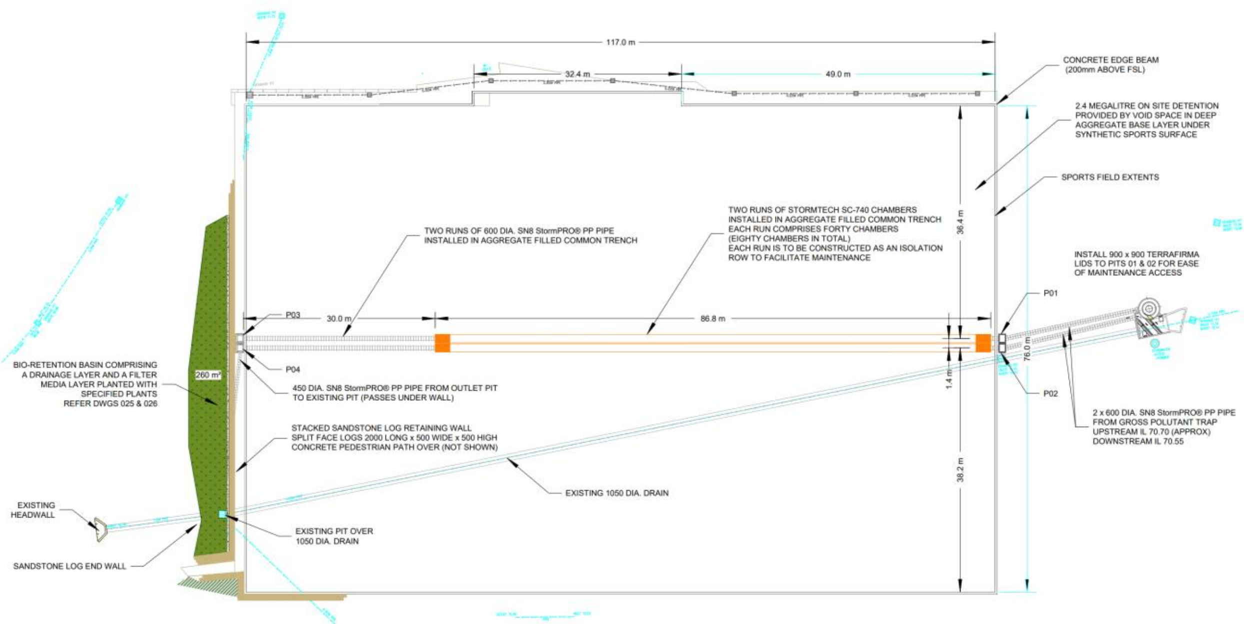


Figure 6 Proposed Stormwater Drainage System

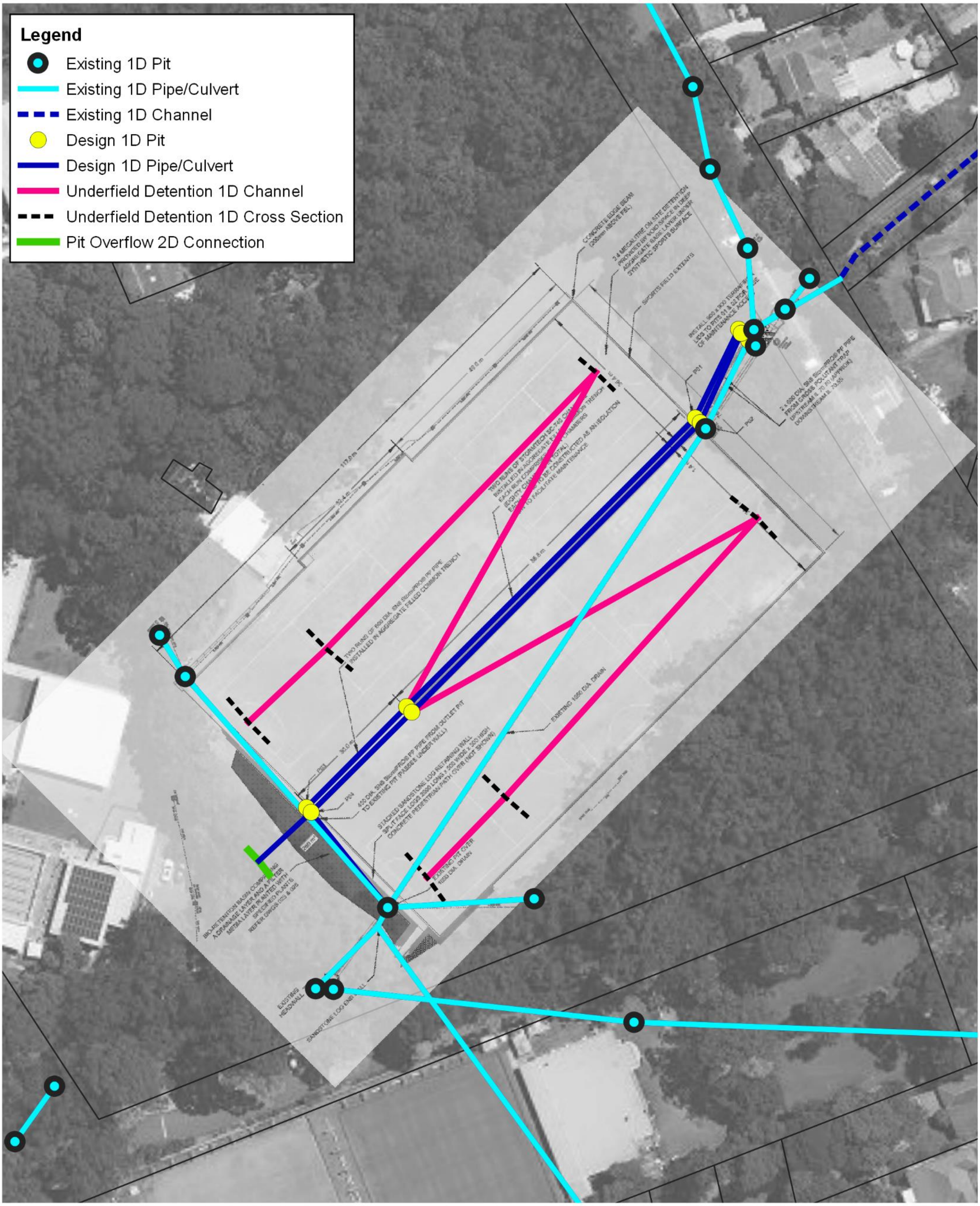
The key elements of the proposed works have been represented in the TUFLOW model as summarised below:

- Diversion Chamber / CDS Unit – the existing stormwater pit was modified to represent the hydraulic controls forming the diversion chamber configuration including:
    - CDS Unit inlet – represented as rectangular culvert control section 0.45m x 0.45m for CDS flow discharging to first 600mm dia inlet pipe to Stormtech chamber.
    - Weir 1 – control weir directing CDS inlet flow with overtopping bypass flow to Weir 2 control. Modelled as rectangular broad crested weir of 1.8m width at crest level 71.65m AHD.
    - Weir 2 – control weir directing CDS bypass flow to second 600mm dia inlet pipe to Stormtech chamber with overtopping to existing 1050mm dia stormwater pipe under field. Modelled as rectangular broad crested weir of 1.95m width at crest level 71.65m AHD.
- Inlet pipes – pipe connection from CDS unit and Weir 1 (low flow and bypass) to Stormtech chambers. Comprises two lines of 600mm dia pipe.
- Stormtech chambers – under field Stormtech chambers represented as two parallel lines (86.8m in length) of rectangular culvert 1.2m x 0.5m (representative cross section area).
- Under-field detention - subsurface storage (derived via aggregate layer void) represented in the model as open channel section on each side of Stormech chambers. Cross sections are defined as per the subgrade layer sections in Turf One dwg 023 REV H (refer to Appendix A). Channel length modified by void ratio to provide the appropriate volumetric storage (nominally 2.4 megalitres).
- StormPRO pipes – under field pipes connecting Stormtech chambers to pit outlet structure at downstream end of field. Represented as two runs of 600mm dia pipe.
- Downstream Pit outlet – pit structure receiving Stormpro pipes and discharging to 450mm outlet pipe. Pit overflow represented by 2 x 2.1m x 0.15m rectangular section at control level of 71.5m AHD discharging to surface at downstream bioretention.
- Outlet pipe – 450mm dia pipe from field outlet pit connecting to existing 1050mm dia stormwater pipe downstream of the field.

A schematic of the model representation of the proposed works and integration with the existing modelled drainage infrastructure is shown in Figure 7. Invert levels of pit/pipe infrastructure adopted as per the detailed plans in Appendix A. Adopted Manning's 'n' of 0.013 for all new pipes and culverts as per Optimal (2023).

It is understood the playing field is to be designed to be flood free (no surface flow) at the 1% AEP flood magnitude. Under existing conditions, once the stormwater system capacity is exceeded overland flows downstream of Lofberg Road sheet across the field. It is expected the field design would provide for appropriate perimeter bunding and/or swale design to direct excess flow around the field. The model representation has adopted a filed surface elevation to remain flood free and represent diversion of excess overland flow around the field perimeter.

The simulated peak 1% AEP flood inundation extents and flood depth distribution for the proposed design conditions is shown in Figure 8 corresponding to the adopted critical event (25-minute TP03).



Title:

TUFLOW Model Configuration of Proposed Works

0 30 60 m

approx. scale

Figure: **7**

Revision: **A**

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Flood Impact

Comparison of the simulated design flow hydrographs downstream of Norman Griffiths Oval for the existing conditions and proposed conditions is shown in Figure 8. The peak flows and hydrographs shapes remain quite similar between the existing and proposed conditions. The simulations indicate the proposed works to be effective in providing a similar flood conveyance and detention function to the existing conditions. The proposed design condition peak flow of 9.3m^3/s at this location is a small reduction in the corresponding existing condition peak flow of 10.0m^3/s.

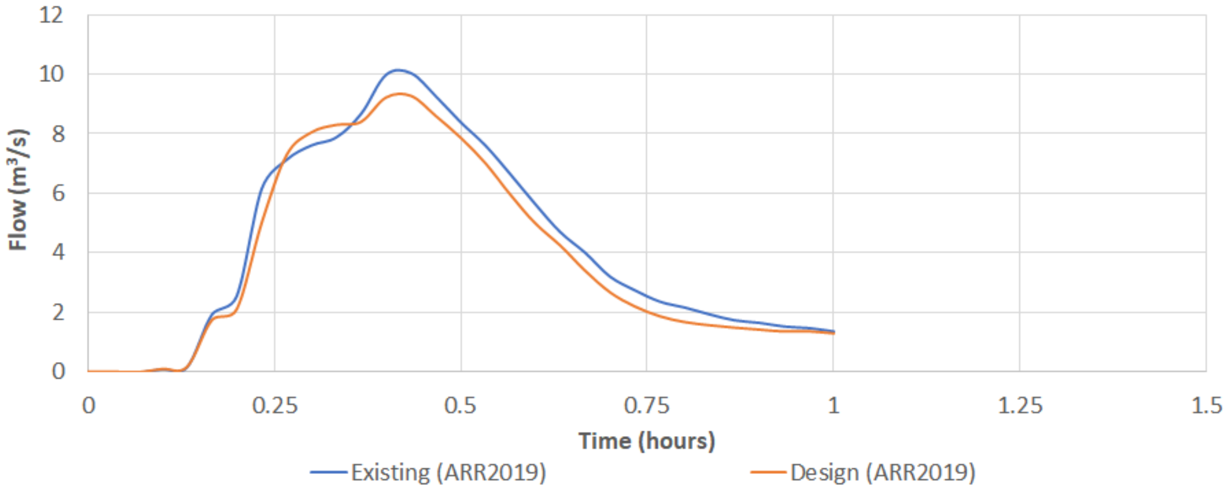
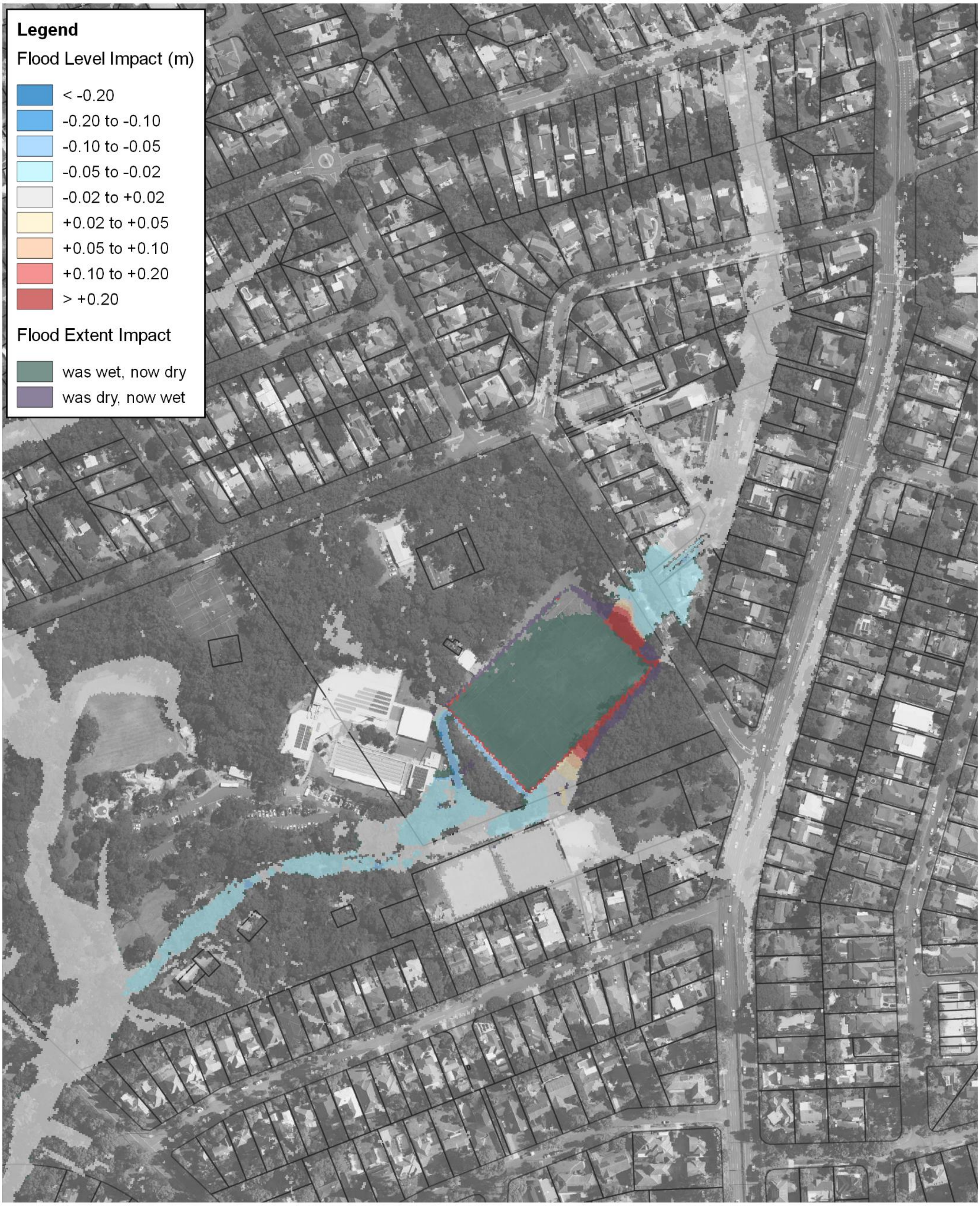


Figure 8 Simulated Hydrographs for Downstream of NGO (Plot Output line 94)

The relative impact of the proposed development has been considered in terms of potential changes to existing flood behaviour. The impact of the proposed development on existing design flood conditions can be better understood in a spatial context through comparison of the change in modelled peak flood levels. The simulated change in peak flood inundation extents and levels is presented in Figure 9 for the 1% AEP event.

Figure 9 shows the exclusion of inundation of the proposed field and the subsequent change in peak flood level upstream and downstream of the works. A minor reduction in peak flood level (<0.05m) is shown in the upstream area around Lofberg Road. This likely a function of the improved drainage capacity provided by the proposed stormwater infrastructure. Similar reductions in peak flood level are shown downstream of Norman Griffiths Oval which would correspond to the minor reductions in peak flow as demonstrated in Figure 8.

Increases in peak flood level are shown around the northern and eastern perimeter of the field. This is associated with the diversion of overland flow exceeding the stormwater drainage system capacity, with the proposed playing field to remain free of surface inundation. The simulated impact does not extend beyond the general oval area and does not impact neighbouring property.



Title:

Simulated 1% AEP Flood Level Impact

0 90 180 m

approx. scale

Figure: 9

Revision: A

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Conclusion

Torrent Consulting was engaged by Ku-ring-gai Council to undertake flood modelling of proposed flood detention infrastructure at Norman Griffiths Oval. The proposed redevelopment of the oval incorporates the replacement of the grassed surface with a synthetic turf on top of an underground detention (provided by means of StormTech chambers and coarse aggregate with a water retaining capacity of 2.4ML).

This assessment has included modification of existing models developed for the Quarry Creek catchment (BMT, 2020). The modifications include:

- Conversion of existing TUFLOW model to direct rainfall (rainfall on grid) simulation of rainfall runoff process replacing existing DRAINS model hydrological inputs.
- Update of hydrological inputs to ARR2019 approaches, specifically incorporating changes to design rainfall and ensemble temporal patterns.
- Incorporation of proposed stormwater and detention infrastructure in hydraulic model

The modified model provides for updated baseline (existing) design flood conditions for the simulated 1% AEP design event. Peak design flows in the vicinity of Norman Griffiths Oval were found to be relatively similar to the previous adopted Council conditions.

The simulation of the proposed stormwater drainage works associated with the oval redevelopment indicates the stormwater drainage system capacity and detention function to perform similarly to the existing system in managing potential flood impact to the downstream environment.

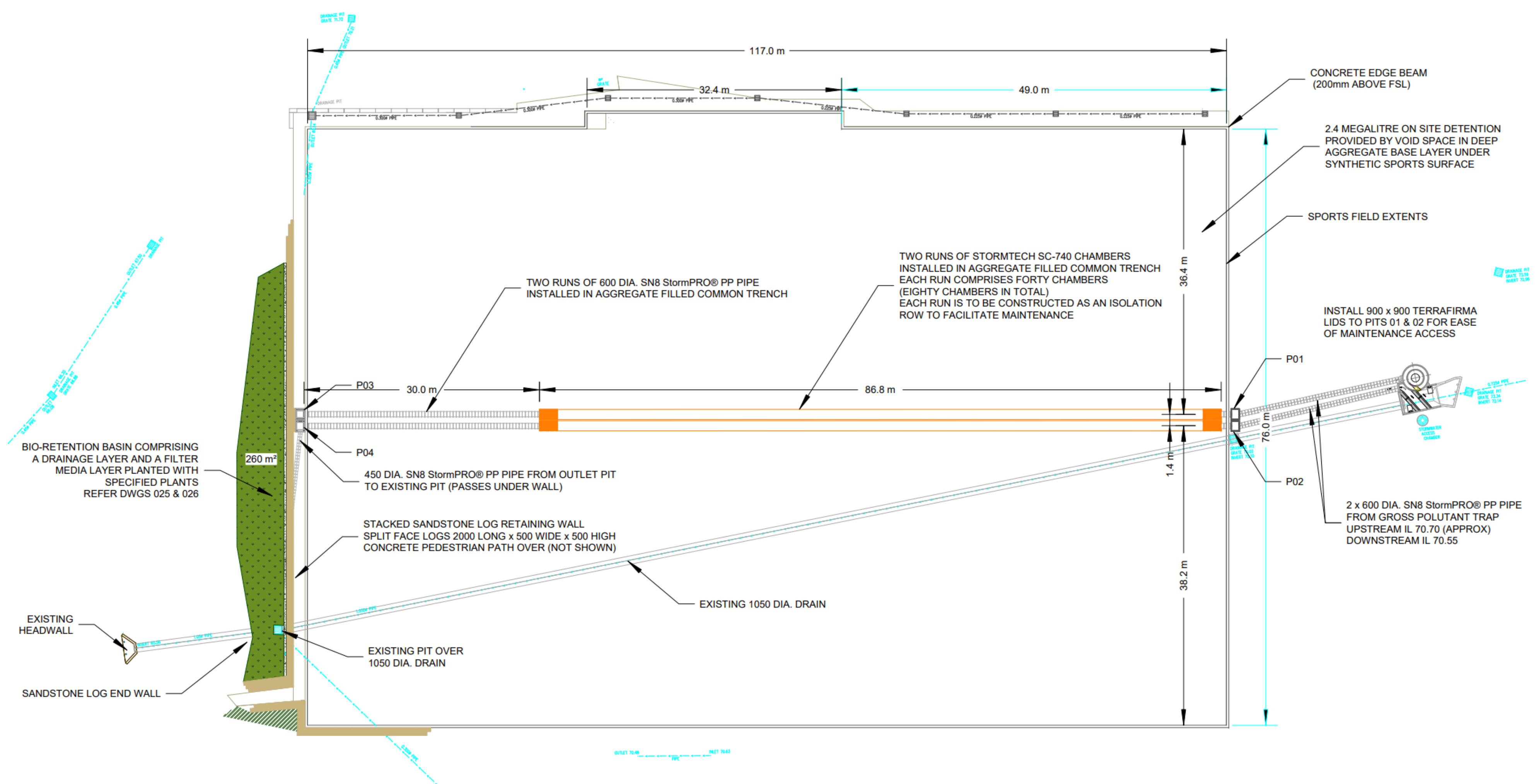
We trust that this report meets your requirements. For further information or clarification please contact the undersigned.

Yours faithfully

Torrent Consulting

Darren Lyons
Principal Water Resources Engineer
CPEng MIEAust

APPENDIX A – Design Details



PLAN VIEW

SCALE 1:500 @ A3

PIT	PIT TYPE	LENGTH	WIDTH	DEPTH	INVERT RL	COVER RL	EASTING	NORTHING	COVER	CLASS
01	JUNCTION PIT INLET	1200	900	1550	70.50	72.05			TERRA FIRMA GRP	B
02	JUNCTION PIT INLET	1200	900	1550	70.50	72.05			TERRA FIRMA GRP	B
03	JUNCTION PIT OUTLET	1200	900	1870	70.24	72.11			CONCRETE	B
04	JUNCTION PIT OUTLET	1200	900	1870	70.24	72.11			CONCRETE	B

TurfOne
A BildGroup Company

PROJECT
KU-RING-GAI COUNCIL RFT9-2021
STORMWATER MITIGATION AND SYNTHETIC SPORTS FIELD
NORMAN GRIFFITHS OVAL DESIGN AND CONSTRUCT

DRAWING TITLE
SPORTS FIELD BASE PROFILE ON-SITE DETENTION SCHEMATIC LAYOUT

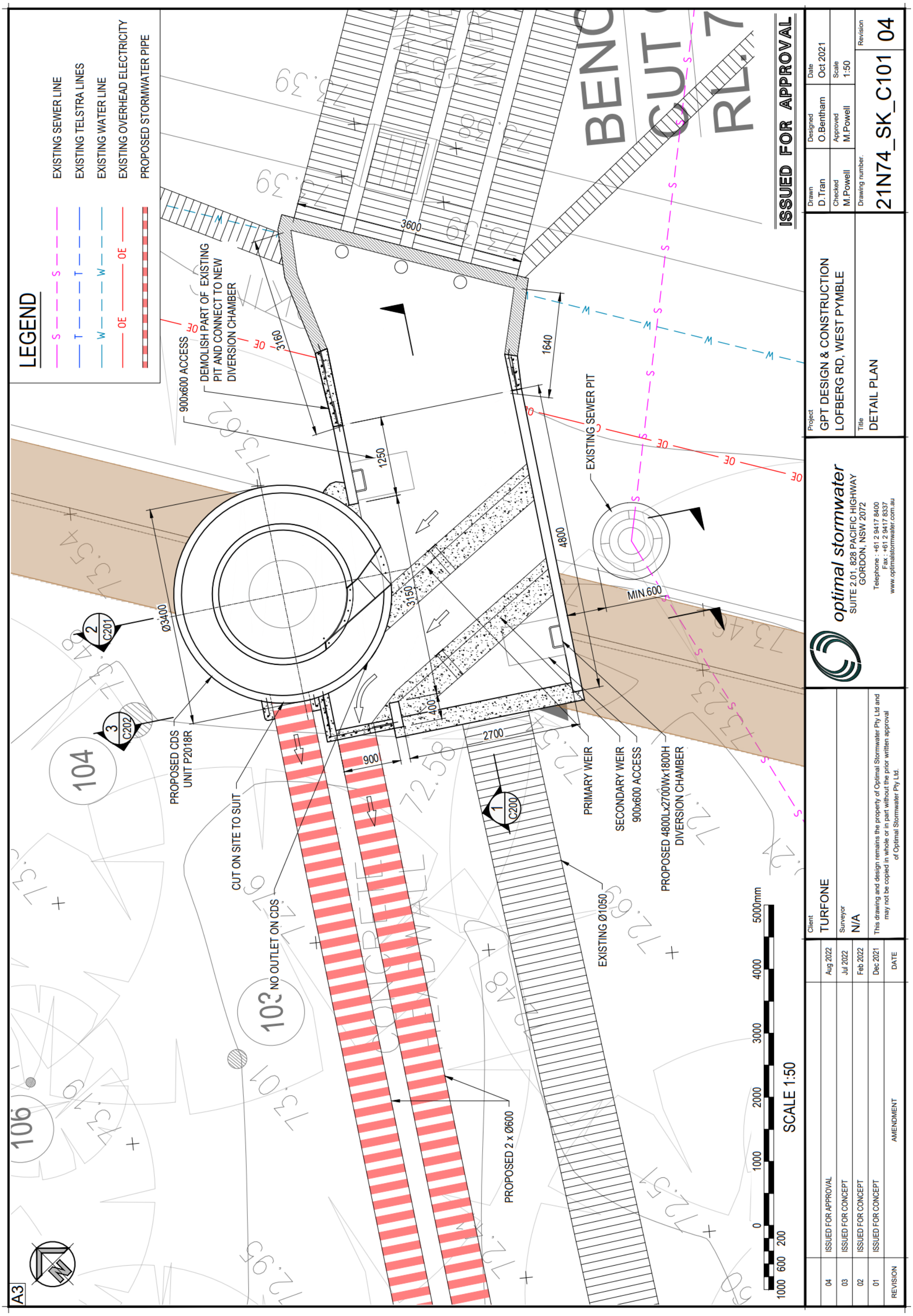
NOTES
THE CENTERLINE OF THE STORMTECH TRENCH IS SET 0.9m TO THE NORTH OF THE CENTERLINE OF THE FIELD TO AVOID CONFLICT IN THE POSITIONING OF PIT 02 AND THE EXISTING PIT OVER THE BARREL DRAIN AT THE LOFTBERG ROAD END OF THE FIELD.

Ku-ring-gai Council

REVISIONS

REV	DATE	DESCRIPTION	CHECK
K	1/02/23	CONSTRUCTION	DOV

DRAWN Donald Vary	DATE 1/02/2023
VERIFIED Geethaka Kumbalatara	DATE 1/02/2023
APPROVED	DATE
PROJECT No.	TO-0003
DRAWING No.	020 REV K


LEGEND
EXISTING SEWER LINE
EXISTING TELSTRA LINES
EXISTING WATER LINE
EXISTING OVERHEAD ELECTRICITY
PROPOSED STORMWATER PIPE
900x600 ACCESS
DEMOLISH PART OF EXISTING PIT AND CONNECT TO NEW DIVERSION CHAMBER
EXISTING SEWER PIT
MIN.600
PROPOSED CDS UNIT P2018R
CUT ON SITE TO SUIT
NO OUTLET ON CDS
PRIMARY WEIR
SECONDARY WEIR 900x600 ACCESS
PROPOSED 4800Lx2700Wx1800H DIVERSION CHAMBER
EXISTING Ø1050
PROPOSED 2 x Ø600
Ø3400
3600
3160
1640
1250
4800
3150
400
2700
900
104
103
106
SCALE 1:50
0 1000 2000 3000 4000 5000mm
ISSUED FOR APPROVAL
Project
GPT DESIGN & CONSTRUCTION
LOFBERG RD, WEST PYMBLE
Title
DETAIL PLAN
Drawn D.Tran
Checked M.Powell
Designed O.Bentham
Approved M.Powell
Date Oct 2021
Scale 1:50
Drawing number 21N74_SK_C101
Revision 04
optimal stormwater
SUITE 2.01, 828 PACIFIC HIGHWAY
GORDON, NSW 2072
Telephone : +61 2 9417 8400
Fax : +61 2 9417 8337
www.optimalstormwater.com.au
Client TURFONE
Surveyor N/A
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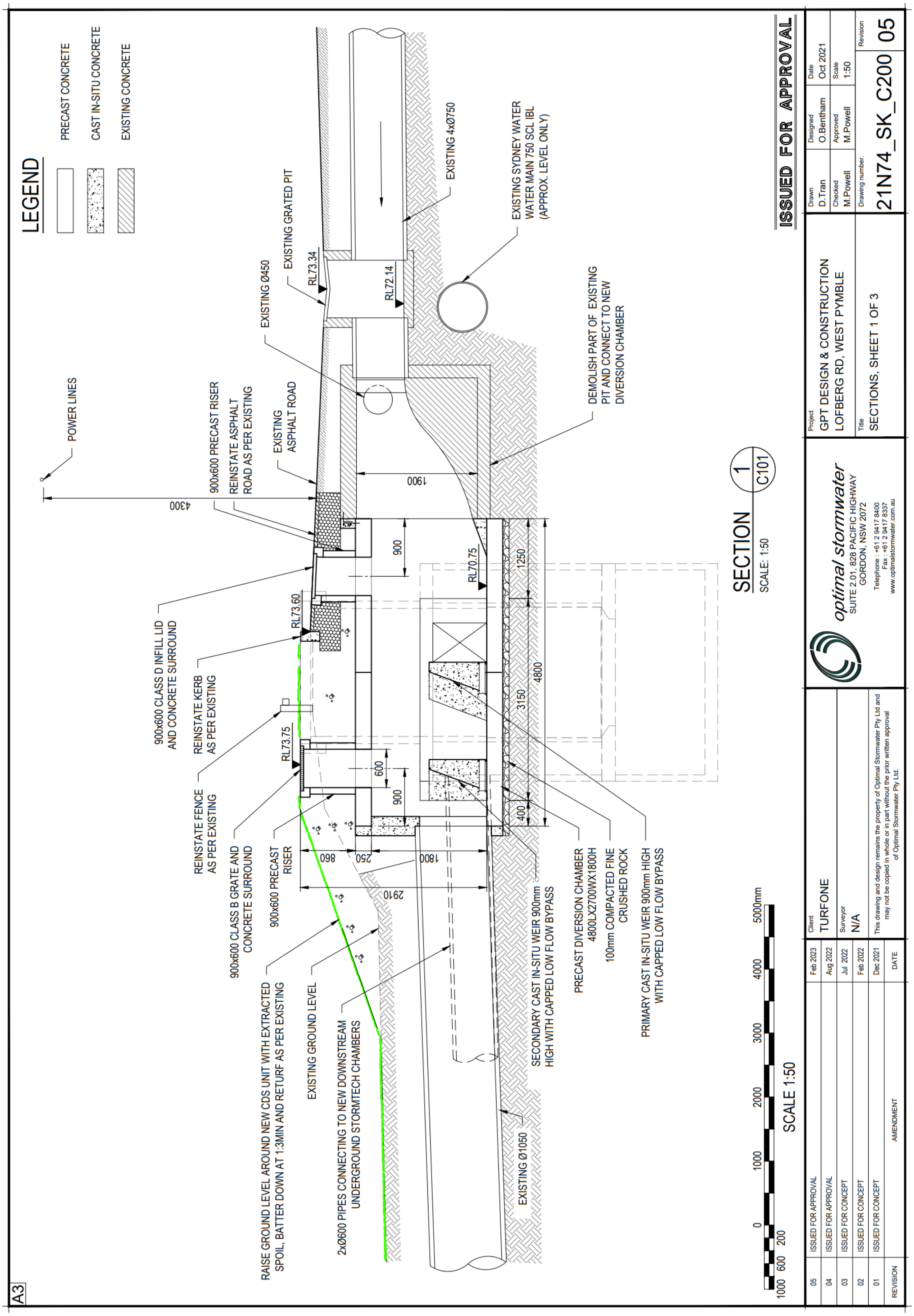
04 ISSUED FOR APPROVAL Aug 2022
03 ISSUED FOR CONCEPT Jul 2022
02 ISSUED FOR CONCEPT Feb 2022
01 ISSUED FOR CONCEPT Dec 2021
REVISION AMENDMENT DATE
A3



LEGEND
PRECAST CONCRETE
CAST IN-SITU CONCRETE
EXISTING CONCRETE
POWER LINES
4300
EXISTING ASPHALT ROAD
900x600 PRECAST RISER
REINSTATE ASPHALT ROAD AS PER EXISTING
EXISTING Ø450
EXISTING GRATED PIT
RL73.34
RL72.14
EXISTING 4xØ750
EXISTING SYDNEY WATER WATER MAIN 750 SCL IBL (APPROX. LEVEL ONLY)
DEMOLISH PART OF EXISTING PIT AND CONNECT TO NEW DIVERSION CHAMBER
1900
900
1250
RL70.75
RL73.60
900x600 CLASS D INFILL LID AND CONCRETE SURROUND
REINSTATE KERB AS PER EXISTING
3150
4800
RL73.75
600
900
400
REINSTATE FENCE AS PER EXISTING
900x600 CLASS B GRATE AND CONCRETE SURROUND
900x600 PRECAST RISER
860
250
1800
2910
PRECAST DIVERSION CHAMBER 4800LX2700WX1800H
100mm COMPACTED FINE CRUSHED ROCK
PRIMARY CAST IN-SITU WEIR 900mm HIGH WITH CAPPED LOW FLOW BYPASS
SECONDARY CAST IN-SITU WEIR 900mm HIGH WITH CAPPED LOW FLOW BYPASS
RAISE GROUND LEVEL AROUND NEW CDS UNIT WITH EXTRACTED SPOIL, BATTER DOWN AT 1:3MIN AND RETURF AS PER EXISTING
EXISTING GROUND LEVEL
2xØ600 PIPES CONNECTING TO NEW DOWNSTREAM UNDERGROUND STORMTECH CHAMBERS
EXISTING Ø1050
SECTION 1 C101
SCALE: 1:50
SCALE 1:50
1000 600 200 0 1000 2000 3000 4000 5000mm
ISSUED FOR APPROVAL
A3
optimal stormwater
SUITE 2.01, 828 PACIFIC HIGHWAY GORDON, NSW 2072
Telephone : +61 2 9417 8400
Fax : +61 2 9417 8337
www.optimalstormwater.com.au
Project GPT DESIGN & CONSTRUCTION LOFBERG RD, WEST PYMBLE
Title SECTIONS, SHEET 1 OF 3
Drawn D.Tran
Designed O.Bentham
Date Oct 2021
Checked M.Powell
Approved M.Powell
Scale 1:50
Drawing number. 21N74_SK_C200
Revision 05
Client TURFONE
Surveyor N/A
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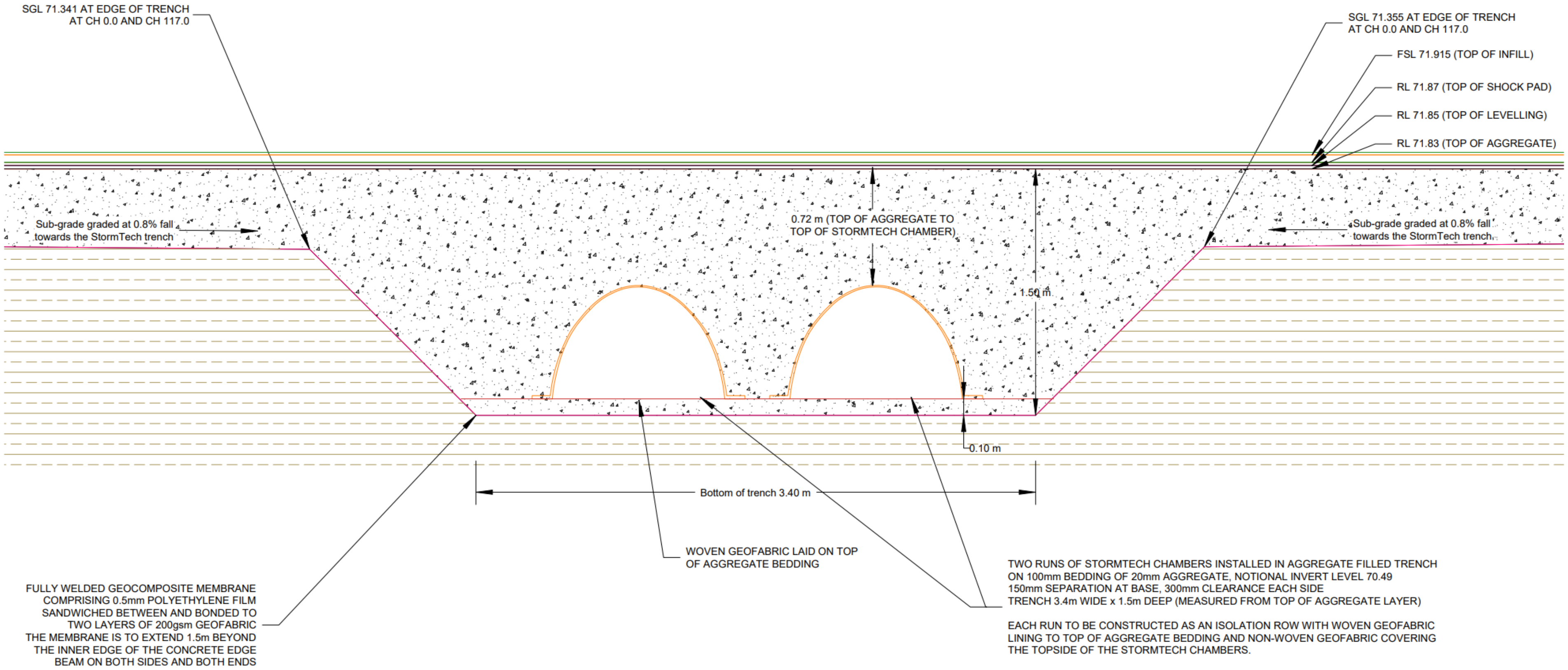
03 ISSUED FOR CONCEPT Jul 2022
02 ISSUED FOR CONCEPT Feb 2022
01 ISSUED FOR CONCEPT Dec 2021
REVISION AMENDMENT DATE

SECTIONAL VIEW OF STORMTECH TRENCH AT CH 0.0 AND CH 117.0

SCALE 1:25 @ A3



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PROJECT
KU-RING-GAI COUNCIL RFT9-2021
STORMWATER MITIGATION AND SYNTHETIC SPORTS FIELD
NORMAN GRIFFITHS OVAL DESIGN AND CONSTRUCT

DRAWING TITLE
SPORTS FIELD BASE PROFILE ON-SITE DETENTION SECTION

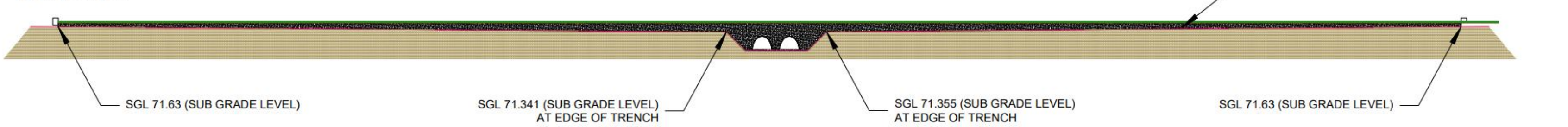
Ku-ring-gai Council

REVISIONS

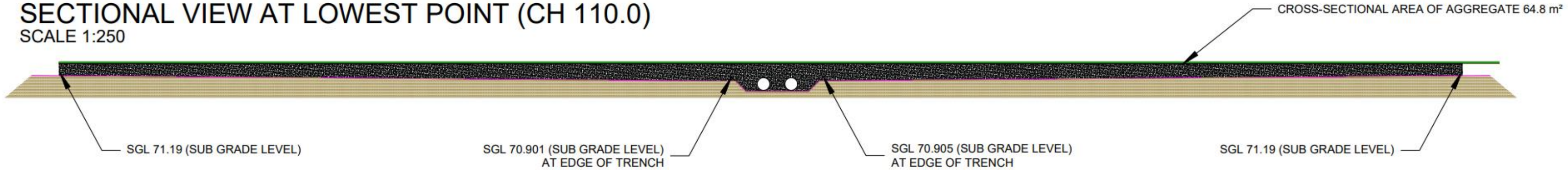
REV	DATE	DESCRIPTION	CHECK
G	20/09/22	CONSTRUCTION	DOV

DRAWN Donald Vary	DATE 20/09/2022
VERIFIED Geethaka Kumbalatara	DATE 20/09/2022
APPROVED	DATE
PROJECT No.	TO-003
DRAWING No.	022 REV G

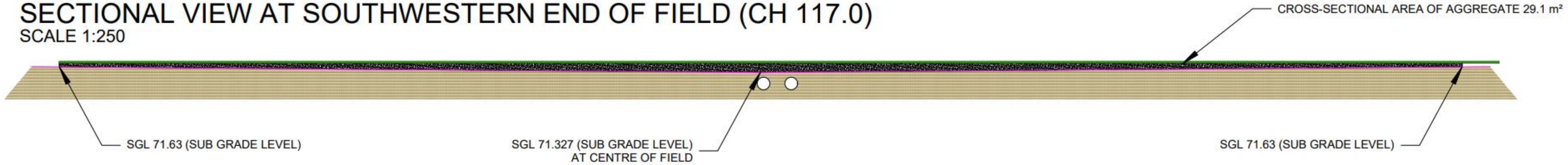
SECTIONAL VIEW AT NORTHEASTERN END OF FIELD (CH 0.0)
SCALE 1:250



SECTIONAL VIEW AT LOWEST POINT (CH 110.0)
SCALE 1:250



SECTIONAL VIEW AT SOUTHWESTERN END OF FIELD (CH 117.0)
SCALE 1:250



VOLUMETRIC CALCULATION FOR ON-SITE DETENTION

Cross-sectional area of aggregate:
CH 0.0 33.5 m²
CH 110.0 64.8 m²
CH 117.0 29.1 m²
Volume of aggregate CH 0.0 to CH 110 = 110 x (33.5 + 64.8) / 2 = 5,406 m³
Volume of aggregate CH 110.0 to CH 117.0 = 7 x (64.8 + 29.1) / 2 = 328 m³
Therefore total volume of aggregate = 5,734 m³
Void space in aggregate layer = 0.4 x 5,734 = 2,293 m³
Void space in StormTech chambers = 80 x 1.30 = 104 m³
Void space in 600 dia. StormPro pipes = 62.4m x 0.28 = 17.5 m³
Therefore total void space measured to underside of blinding layer = 2,414 m³
Capacity of on-site detention = 2.4 megalitres

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