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16 November 2021

NL150007

Huntlee Pty Ltd
C/- Swan Project Advisory Pty Ltd
Glen Swan
27 Sandridge Street
Thornton, NSW 2322

Dear Glen,

Re: Huntlee Residential Subdivision (MOD16) - Response to Engeny Peer Review

Northrop Consulting Engineers have prepared the following response to the Engeny Water Management (Engeny) peer review dated the 30 August 2021 and received from DPIE on the 23 September 2021. The following provides additional information requested by Engeny. This letter should be read in conjunction with the following documents:

- Huntlee DAs MOD16 – Stormwater/ Flooding Advice Letter prepared by Engeny Water Management and dated the 30 August 2021, herein referred to as "the Engeny Letter".
- The Huntlee Project Trunk Stormwater and Flooding Assessment – Stage One Project Application Parts 1-4 (Revision E) prepared by Worley Parsons and dated August 2012, herein referred to as "the Worley Study".
- The Huntlee Subdivision – Tributary 1 Stormwater and Flood Management Strategy for Huntlee Pty. Ltd. (Revision B) prepared by Northrop and dated June 2021 and preceding reports and letters, herein referred to as "the Northrop Study".

A list of the requested additional information is summarised in the Engeny Letter under the title *"Advice on Further Information from Applicant".*

This investigation is intended to serve as a response to the requested additional information and, as suggested in the Engeny Letter is an addendum to the Northrop Study. Presented below is a summary of the Engeny request along with a response to each item.

Engeny Item 1.

List and discuss the difference between the modelling parameters used by Worley and Northrop specifically addressing:

Changes to Impervious Percentage:

A comparison between the XP-RAFTS model parameters used in the Northrop Study and those presented in the Worley Study are presented in the below **Table 1**. As shown in **Table 1**, the modelled residential impervious percentage of 65% is consistent for both studies.

Review of Figure 3 and the tables presented in Appendix A of the Worley Study suggests there is a slight difference in the impervious percentage along the eastern side of the Tributary 1 when compared to the Northrop Study. This is due to the Primary School, Mixed Use and Village Centre land uses previously proposed.

		Date
Prepared by	LG	16/11/2021
Checked by	BC	16/11/2021
Admin	BBR	16/11/2021

Table 1 – XP-RAFTS Model Parameters Comparison

Scenario	Parameter	Worley Study	Northrop Study	Comments
Un-Developed Catchments	Initial Loss	15	15	These are consistent.
	Continuing Loss	3.6	3.6	These are consistent.
	Roughness	0.05 - 0.10	0.05 - 0.10	The ranges are generally consistent. The overall average roughness is likely lower in the Northrop Study however, the values used are still within what is considered an acceptable range.
Urban Areas (Proposed Developed Catchments)	Impervious %	65	65	These are consistent.
	Impervious IL	1.5	1.5	These are consistent.
	Impervious CL	0	0	These are consistent.
	Impervious Roughness	0.015	0.012	These are generally consistent with a very negligible change in the results expected. Both values are considered representative of a hardstand surface.
	Pervious IL	10	15	Australian Rainfall and Runoff 1987 guidelines suggests a loss rate between 10-35mm is acceptable across the east coast of NSW. Both modelled initial loss values fall within this range and are therefore considered appropriate.
	Pervious CL	2.5	2.5	These are consistent.
	Pervious Roughness	0.025	0.04	Both values fall within what is considered a reasonable range for a pervious urban area. The Northrop value is based on the XP-RAFTS reference manual and a case study prepared by Willing and Partners. The case study is also presented in the latest Australian Rainfall and Runoff guidelines (2019) - Project 13.

Since the preparation of the Worley Study, the Primary School, Mixed Use and Village Centre facilities have been moved to the Town Centre, located on the western side of Tributary 2, and replaced with residential properties. As a result, the impervious percentage assumed in the Northrop Study is reflective of the currently proposed masterplan.

The Worley study assumed that the School Site would be the same percentage impervious as residential development (65% impervious). Therefore, no change to the stormwater modelling was required in the Northrop model due to the change in landuse as a result of the MOD.

Worley assumed the Village Centre and Mixed-Use zones would be 80% impervious. This has been changed to 65% impervious in the Northrop modelling to reflect the residential use. As the areas in question are very small significant changes to flows are not expected due to the change in land use.

Loss Rates Applied:

As shown in the above **Table 1**, the pre-developed loss rates and surface roughness assumed for each study is generally consistent.

Some minor differences are observed over the developed catchments. An explanation for each difference is summarised in the Comments column in **Table 1**.

It is noted, the Worley Study also considers “Existing Urban Catchments”. These are located in Tributary 2 and as such, have not been considered in the Northrop Study. This is confirmed from a review of the existing case impervious percentages presented in the Tributary 1 - RAFTS Parameters (Existing State) presented in Appendix A of the Worley Study.

Model Extent:

Attachment 1, shows the difference in model extents between the Worley and Northrop Study Developed Case Catchments. The model extents have only very minor differences, expected to be due to slightly different delineation of hill crests, potentially due to the quality of terrain data available at the time of preparation.

The largest difference is observed in the catchment between the subject site and rail corridor, downstream of the subject site. With pre-to-post modelling originally analysed at the site boundary by the Northrop Study, this additional catchment was not required. This catchment has subsequently been incorporated into the June 2021 issue of the Northrop Study in order to review the peak flows at the rail corridor.

The following **Table 2** presents a comparison between the resultant total catchment extents between the Worley Study and Northrop June 2021 Study.

Table 2 – Catchment Areas Comparison

Study	Worley Study (Appendix A)	Northrop Study (June 2021)	Difference (%)
Existing (ha)	205.0	202.1	-1.4
Developed (ha)	207.8	213.8	2.9
Difference (ha)	+2.8	+11.7	

Table 2 suggests a difference in the total modelled catchment areas of less than 3% between the two studies. This difference is not expected to result in a significant change in the outcome of the investigation.

Table 2 also shows there is a greater difference between the pre and post developed catchments in the Northrop Study when compared to the Worley Study. This is considered conservative, particularly for the purposes of stormwater detention design.

Modelling Methodology:

Both studies have used XP-RAFTS as the hydrological model and for the design of the detention basins and HEC-RAS to define the flood extents. The modelling methodology is therefore consistent.

Selection of Recurrence Intervals and Temporal Patterns:

A summary of the recurrence intervals used for each study is summarised in the below **Table 3**.

Table 3 – Recurrence Interval Comparison

Return Interval (AEP)	Worley Study	Northrop Study
50% (2yr ARI)	Yes	No
20% (4.48yr ARI)	No	Yes
18.1% (5yr ARI)	Yes	No
10% (10yr ARI)	No	Yes
5% (20yr ARI)	Yes	Yes
2% (50yr ARI)	No	Yes
1% (100yr ARI)	Yes	Yes

The comparison presented in the above **Table 3** suggests the Northrop Study analyses more events when compared to the Worley Study. The Northrop Study, however, does not consider the 50% AEP as it assumes incidental detention occurs in the WSUD devices during this frequent event. It is anticipated flows during this frequent event will be captured and detained in the bio-retention basins prior to continuing downstream.

Both studies analyse storm durations ranging from 30 minutes to 720 minutes. It is unclear which temporal patterns are considered in the Worley Study however, the Northrop Study has used "Zone 1 – South-East Coast Division" as recommended in the Australian Rainfall and Runoff 1987 guidelines.

Discuss the differences in the assessment outcomes between the Northrop and Worley assessments:

The following **Table 4**, ***Table 5*** and **Table 6** present a comparison between the modelled peak flow between the Worley and Northrop studies at the rail corridor for the existing case, developed case without detention and developed case with detention scenarios respectively.

Table 4 – Existing Case Peak Flow Comparison at Rail Corridor

Return Interval (AEP)	Worley Study (Table 5-3)	Northrop Study (June 2021 – Table 7)	Difference (m^3/s)
18.1% / 20%	9.9	9.9	0.0
5%	13.9	15.9	2.0
1%	20	24.4	4.4

Table 5 - Developed Case Without Controls Peak Flow Comparison at Rail Corridor

Return Interval (AEP)	Worley Study (Table 5-3)	Northrop Study (June 2021)	Difference (m^3/s)
18.1% / 20%	16.3	17.9	+1.6
5%	22.5	24.2	+1.7
1%	29.6	31.2	+1.6

Table 6 – Developed Case Peak Flow Comparison at Rail Corridor with Mitigation (Detention)

Return Interval (AEP)	Worley Study (Table 5-3)	Northrop Study (June 2021 – Table 7)	Difference (m^3/s)
18.1% / 20%	9.9	8.9	-1.0
5%	13.9	14.7	0.8
1%	18.8	23.3	4.5

The results presented in **Table 4** show a similar peak flow is observed for the frequent 18.1 / 20% AEP design storm events however, an increasing difference for less frequent events with up to 4.4m^3/s during the 1% AEP. A commensurate increase in peak flow is also observed in the developed case scenario with detention, with a higher peak flow of up to 4.5m^3/s presented in **Table 6** during the 1% AEP design storm event.

During the developed case scenario without detention, **Table 5** suggests there is an increase in peak flow in the Northrop Study of up to 1.7m^3/s for all design storm events. With a higher peak flow estimated in the Northrop Study, the sizing of infrastructure such as the culvert crossings the definition of the Flood Planning Levels can be considered conservative.

The difference in peak flow may be due to a number of factors including, slightly different total catchment areas, calculated link lag times, timing of flows through different sub-catchments, digitised catchment shapes, surface roughness, rainfall losses etc.

Although there is a difference in peak flow, the detention strategy remains unchanged whereby, both studies aim to limit developed case peak flows to pre-developed rates. The peak flow is considered relative for the purposes of the pre-to-post investigation with both the Worley and Northrop Studies maintaining the estimated existing case flow rates.

To review the effectiveness of the detention strategy for each study, the below ***Table 7*** presents a comparison between the developed without detention minus the developed with detention scenarios. This has been reviewed in an attempt to assess the detention capacity of each strategy.

Table 7 - Comparison of the Effectiveness of Detention

Return Interval (AEP)	Worley Study (Table 5-3)	Northrop Study (June 2021)	Difference (m^3/s)
18.1% / 20%	6.4	9.0	+2.6
5%	8.6	9.5	+0.9
1%	10.8	7.9	-2.9

The above ***Table 7*** shows the Northrop Study provides a greater reduction in peak flows during more frequent events when compared to the Worley Study. This can be considered beneficial with greater capacity for detention during events that are expected to occur more often.

During less frequent events, (i.e. the 1% AEP), ***Table 7*** suggests the Worley Study has a greater detention capacity. Although the Worley Study is expected to provide a greater reduction in peak flow during less frequent events, a comparison of the pre to post peak flows suggests the strategy also over-detains flows by up to $1.2m^3/s$ during the 1% AEP (i.e. reduces flows from $20m^3/s$ to $18.8m^3/s$). Subtracting this from the total reduces the difference to approximately $1.7m^3/s$, approximately 6% of the total Developed case without controls peak flow.

Additional incidental detention is also expected at the culvert crossings upstream of the detention basin as well as in the bio-retention basins. This infrastructure has not been included in the XP-RAFTS detention modelling, to remain conservative however, is expected to contribute additional detention capacity throughout the catchment, further reducing the difference observed during less frequent events.

It is also important to recognise, the models prepared for each study are a representation of a theoretical case and are based on assumed conditions. In reality, conditions across the catchment and hydrology will vary, and will depend on a number of antecedent factors including, but not limited to, climate conditions, vegetation growth, irrigation and impervious percentages. Even with accurate calibration data, stormwater modelling is not a perfectly precise practice. These imperfections are managed through the application of freeboard which in this case, exceeds the requirements set out by Council's Local Environmental Plan and Development Control Plan (as discussed below).

Consider impacts of updating the assessment from ARR1987 to ARR2016:

As discussed above the changes to the modelling caused by the MOD16 were extremely small on the flood and stormwater modelling and did not warrant updating from ARR1987 to ARR2016.

However, in the event where increased flows occur due to a change in the hydrological data and methodology (i.e. from ARR87 to ARR2019) or climate change, the following is noted:

- Minimal impacts to access are expected at the proposed and existing culvert crossings with more than 2.5m freeboard to the 1% AEP at the Nord Grove Culvert Crossing and 1.5m freeboard at the existing Triton Boulevard culvert crossing.
- Impacts to lots due to increases in Flood Planning Levels (i.e. the 1% AEP + 500mm) are also expected to be minor with the majority of lots already located above the worst case PMF event. Lots affected by the PMF are in excess of 1m above the 1% AEP design storm event (i.e. there is still additional freeboard available beyond the FPL).

Engeny Item 2.

Details the area of riparian zones with non-riparian corridor works within them, and a plan showing where these will be offset.

Attachment 2 illustrates Tributary 1, the extreme flood lines, the riparian buffers and subdivision footprint. The subdivision footprint is shown to be clear of the riparian buffers, expect for the watercourse crossings. The watercourse crossings are required for access and do not generally need to be offset within riparian buffers.

A Vegetation Management Plan (VMP) for Tributary 1 has been prepared and accepted by NRAR. Once subdivision works are complete the VMP will be implemented to restore the riparian corridor.

The only known works that may impede into riparian corridors are stormwater outlets and rec tracks which will ultimately be positioned around vegetation. Both of these items are permissible within riparian corridors and do not require specific offset areas.

Engeny Item 3.

What the inundation depths are at the edge of the building envelopes for Stage 11 lots within the modelled PMF inundation extent, including consideration of the evacuation requirements for the lot in the north-east of Stage 11.

A maximum PMF flood level of approximately 47.13m AHD has been modelled in the existing detention basin. Minimum terrain levels in Tooze Circuit, adjacent to Stage 11, and the affected lots is approximately 46.95m AHD. This corresponds to a maximum flood depth of 180mm in Tooze Circuit with very minor flooding expected in the adjacent lots. Similarly, flow velocities in the area are expected to be low as flows will be arrested and detained by the downstream basin embankment.

The following Figure 1 presents the latest Australian Rainfall and Runoff 2019 hazard categories. With a flood depth less than 300mm and low flow velocities expected, H1 hazard conditions are expected in Tooze Circuit and within a small portion of the adjacent residential lots during the PMF. This flow behaviour is safe for both vehicles and pedestrians and as such, evacuation from the affected lots is still available.

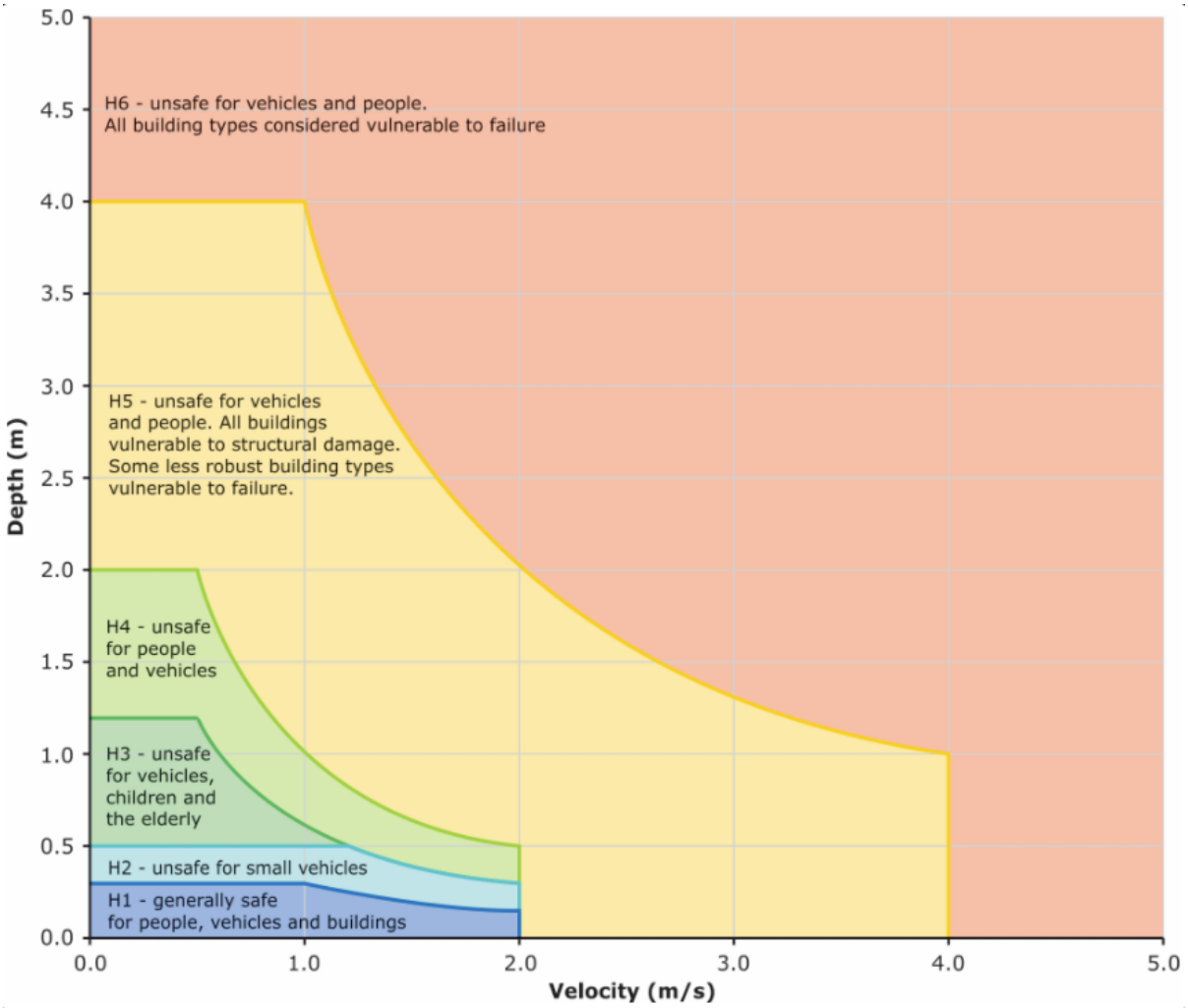


Figure 1 - Australian Rainfall and Runoff 2019 Hazard Categories

Engeny Item 4.

Specific reference to the relevant sections of the Cessnock City Council guidelines adhered to with stormwater treatment basins and how these are to be met.

The Cessnock City Council Development Control Plan – Part E17 – Huntlee has been reviewed with respect to water quality. The following **Table 8** presents a review of Section 3.2 of the DCP and a demonstrates how the proposed development responds to the controls.

Table 8 – Cessnock City Council Development Control Plan – Part E17 – Section 3.2 Controls and Response

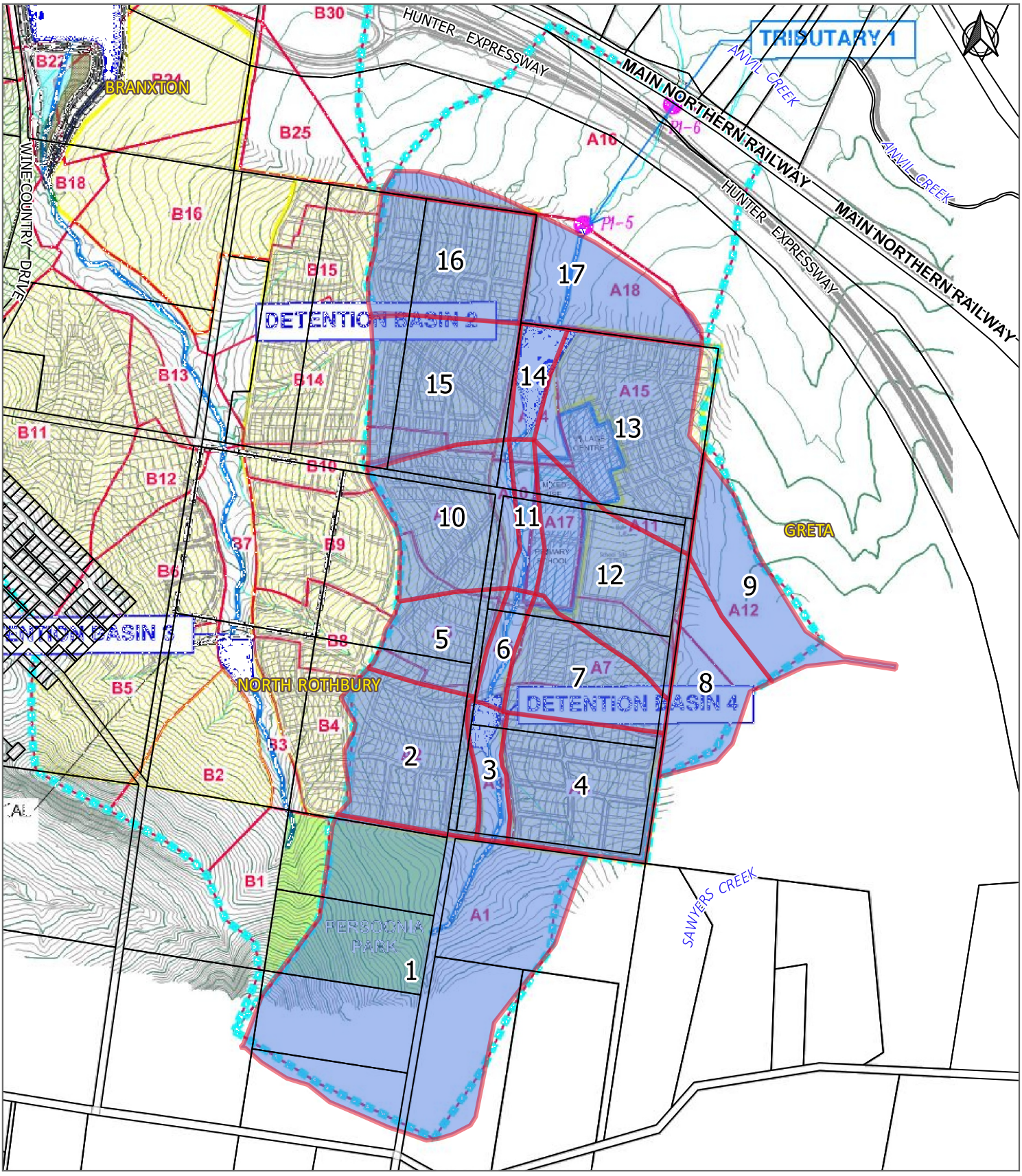
Section 3.2 Item	Control	Response
(7a)	An identification of water management and other relevant objectives (relating, for example, to salinity hazard, mosquito risk)	This has been identified throughout the design development phase of the project.
(7b)	An identification and assessment of relevant site characteristics and constraints	This has been identified throughout the design development phase of the project and has been / will be further reviewed at detailed design phase.
(7c)	An identification of potentially feasible (storm) water management strategies, which may comprise stormwater reuse options, best planning practices, stormwater treatment measures (in both public and private domain) and indicative maintenance requirements;	This has been identified throughout the design development phase of the project has been / will be further refined and reviewed at detailed design phase.
(7d)	An assessment of the potential strategies, including the nature, basis and outcomes of stormwater modelling used to assess alternative solutions. This assessment of alternative strategies should address compliance with management objectives, life cycle costs, ongoing operations and maintenance requirements, land take requirements, expected reliability, likely level of community acceptance and future management responsibilities;	This has been prepared throughout the design development phase of the project and has been / will be further refined and reviewed at detailed design phase.
(7e)	A suitably detailed description of the preferred WSUD strategy and elements therein, in the form of documents, plans and conceptual diagrams (as appropriate)	This has been prepared throughout the design development phase of the project and further refined and reviewed at detailed design phase. Detailed drawings have been / will be prepared that are suitable for construction purposes.
(8)	The WSUD Strategy shall demonstrate how the stormwater quality targets set in Table 1 will be achieved. TSS = 85% TP = 45% TN = 45%	The water quality targets will be / have been met for each Stage of the development. These have been achieved through GPTs and Bio-Retention basins.

Section 3.2 Item	Control	Response
(9)	Compliance with the targets at Table 1 is to be determined through stormwater quality (MUSIC) modelling.	MUSIC modelling has been/ will be prepared for each Stage to ensure the Percentage Reduction Targets outlined in the DCP (and in the above item) are met.
(10)	The WSUD strategy is to take into account riparian zone and creek management and include the following measures	WSUD devices have been placed in accordance with NRAR's Guidelines for Controlled Activities on Waterfront Land.
(10a)	The ephemeral hydrology of creeks is to be maintained or restored, where possible, by diverting excess flow via intercepting stormwater pipes to downstream storages for reuse	Stormwater detention has been designed to limit post development runoff from the subject site to pre-developed rates. With the absence of rainwater tanks across the Huntlee Precinct, no loss in the volume of runoff is expected and as such the ephemeral nature of re-stocking downstream pools and riffles is expected to remain unchanged.
(10b)	Flow attenuation and/or diversion via the intercepting stormwater pipes will be required to meet the stream erosion index objectives within the 'Water Sensitive Urban Design – Book 2 – Planning and Management' guidelines produced by Landcom (2009).	Stormwater detention has been designed to limit post development runoff from the subject site to pre-developed rates. The Stream Erosion Index objectives have not been considered as reuse tanks are not proposed as part of the development and a precinct wide wastewater reticulation strategy introduced as an alternative.
(10c)	Flow in excess of the 5 year ARI peak flow may flow into the creek and be conveyed to detention basins that form part of the major drainage system.	Splitter pits have been/ will be installed upstream of WSUD devices to ensure high flows are directed into the main watercourse/ major drainage system.
(10d)	Erosion control and bank stabilisation measures shall be incorporated within the waterway where required.	Scour protection and bank stabilisation measures has been/ will be considered during detailed design phase.

We trust this is what you require. If you have any queries, please feel free to contact the undersigned on (02) 4943 1777 to discuss.

Laurence Gitzel
Civil & Flood Engineer

Attachment 1



Legend

Northrop Catchments

Worley Study - Figure 3

0 300 600 900 Metres

1:13,000

Figure 1

Model Extent Comparison

NL150007

Huntlee Subdivision - MOD16

NORTHROP

Data Source: Background - Worley Study (Figure 3), Cadastre - NSW LPI 2020

28/10/2021 \\ne-nclfp1\job_files1\YEAR 2015 Jobs\NL150007\G - Design\XPRAFTS\Tributray 1\210611 - Rail Corridor

Attachment 2

STAGE 7
STAGE 8
STAGE 14A
STAGE 23A
STAGE 14B
STAGE 23
STAGE 22
STAGE 21
STAGE 18
STAGE 16
STAGE 13
STAGE 11
STAGE 12
PROPOSED NORD GROVE CULVERT CROSSING.
EXISTING TRITON BOULEVARD CULVERT CROSSING.
STAGE 19
STAGE 20
STAGE 17A
STAGE 17
STAGE 17B

LEGEND

- EXISTING LOT BOUNDARY
- FUTURE LOT BOUNDARY
- TRIBUTARY 1
- EXISTING WATER QUALITY BIOFILTRATION BASIN
- FUTURE WATER QUALITY BIOFILTRATION BASIN
- EXISTING DETENTION BASIN
- FUTURE DETENTION BASIN
- EXISTING/FUTURE ROAD NETWORK
- POST DEVELOPMENT 1% AEP FLOOD INUNDATION LEVEL.
- POST DEVELOPMENT PMF INUNDATION LEVEL.
- TRIBUTARY 1
- RIPARIAN CORRIDOR

NL150007 - KATHERINE'S LANDING HUNTLEE SUBDIVISION
TRIBUTARY 1 FLOOD INUNDATION EXTENTS
MOD 16 BOUNDARY EXTENTS - 01.11.21

SCALE 1:2000@A1

0 20 40 60 80 100m

Limitation Statement

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Document Register

Rev	Status	Prepared	Reviewed	Admin	Date
1	Draft	LG	BC	BBR	02/11/2021
A	Approval	LG	BC	BBR	16/11/2021