220923L001

5 October 2022

Ekistics Pty Ltd
3/431 King William Street
Adelaide
South Australia 5000

Attention: Ryan Moyle

PRELIMINARY DRAINAGE ADVICE – LOT 5 HAMPDEN WAY

Ekistics has engaged Tonkin to provide flood and drainage advice for the proposed code amendment at Lot 5 Hampden Way, Strathalbyn. The affected area is bound by Hampden Way, Braemar Drive and Adelaide Road, with the current stage of the lot 4 residential development to the north.

The site generally falls from East to West, on the western side of the site is North Creek, which runs parallel to Hampden Way and crosses the road within the north western section of the project area. The site is currently wholly undeveloped, with well-maintained grass.

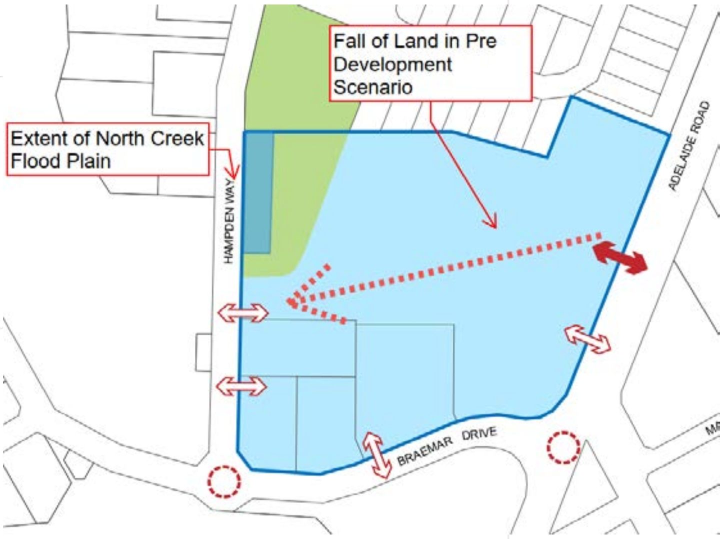


Figure 1 Site Layout

Past this point North creek is directed to the opposite side of Hampden Way via box culverts before eventually joining the Angas River.

North Creek is a tributary of the Angas River and has been modelled previously by Tonkin as a part of the Strathalbyn Proposed Residential Site Lot 4 Stormwater Management Plan (Tonkin ref: 20200687R002)

Catchment Characteristics

The total site area is 3.4 ha and the affected area is envisaged to incorporate a combination of commercial and retail uses, car parking areas and access/loading areas, across an estimated 3 ha area.

Given typical layouts of similar supermarket precincts it is assumed in the post development scenario this space will be 95% impervious, with the remaining area available for major stormwater infrastructure, namely a detention basin to manage the additional site run off.

The current land use proposes to assign 2,500 m^2 to a supermarket, this is likely the largest single building, the next largest being shops and showrooms totalling 1,500 m^2 each in overall floor area.

The northern Lot 4 development has its own stormwater network and manages major flows through a road network and detention basin north west of the Lot 5 site, flows from Lot 4 will not be conveyed through Lot 5 as a result.

The new development sits adjacent North Creek, which has been previously reported as servicing 7 km^2 and conveying an external 1% AEP flow of 10 m^3/s. The flood plain as a result of the 1% annual exceedance probability (AEP) flows from this creek was assessed as part of the previous stormwater management plan for Lot 4 (20200687R002) which determined the flood level in the area around the culverts under Hampden Way is approximately 74.5 m AHD, the approximate extent of the area required for north Creek under these conditions is shown in Figure 1 above.

Modelling and Analysis

Previous reporting identified the flood level as a result of a major storm within North Creek to be 74.5 mAHD. However, this was based on an idealised cross section of the creek and should be considered in further detail as a part of master planning the site.

This is however suitable for an initial assessment of required site levels, outlet inverts and detention basin sizes.

The minimum floor level for Lot 5 for all buildings will need to be set above 74.8 mAHD to provide minimum 300 mm freeboard from the creek floodplain. However, given the need to drain the site to a single basin which is expected to be located in the north west corner of the site, site levels are likely to be driven by required cover to services rather than the flood height itself.

To determine the required site levels, a theoretical length of pipe with an outlet invert level within the basin (IL) of 74.5 m AHD was considered. The expected trunk main length was assumed to be 190 m, and a typical grade of 0.5%, which resulted in the highest invert level on site of 75.5mAHD. For a 300 mm pipe, appropriate cover would set the required surface level in the south east corner of the site as 76.4 m AHD.

It is not likely the 100 year flood level itself will drive the requirements for site filling. An appropriate minimum floor level of 76.5 mAHD in the south east corner of the site, and 76.1 mAHD in the north west corner (discussed further below) would provide ample protection during flood events and allow for suitable cover for stormwater infrastructure. These levels should be reviewed in more detail once a layout is confirmed during master planning.

From a filling perspective, this would imply no filling is required in the south east corner, and approximately 1.6 m of fill will be required in the north west corner. Once a concept is developed the volume and height of fill required should be reviewed in more detail. Of particular note the exist5ing level in the north east corner is 79.2 mAHD (2.7 m higher than minimum required floor level) which indicates there is an opportunity to gain some volume during bulk earthworks.

A DRAINS model was produced to indicate the required size of a detention basin and trunk mains for Lot 5. The 1% AEP North Creek flood level was used as the minimum IL to mitigate any potential tailwater effects on the internal drainage system.

An Initial Loss – Continuous Loss hydrological model was used, with data obtained from Australian Rainfall and Runoff 2019 (Table 1) to determine the pre development flows as a part of detention basin sizing.

Table 1: Initial loss - continuing loss parameters

	Pervious	Impervious
Initial loss (mm)	26	0
Continuing Loss (mm/hr)	4.4	4.4

For the purposes of modelling a 10 minute time of concentration was used for the area assigned to the supermarket, with the rest of the area divided equally across the site, each assigned 5 minute time of concentrations for the impervious area.

Given there is currently no development in the area the predevelopment area was assumed to be 100% pervious, with a 30 min time of concentration determined from the kinematic wave equation.

The results of the DRAINS analysis is summarised in the table below.

Table 2: Drainage Modelling Results

Storm Event	Pre Development Flow (L/s)	Post Development Basin Inflow (L/s)	Required Detention (m^3)	Peak Flow out of Basin (L/s)	Required Surface Area (m^2)(assuming 1 m depth and 1 in 4 batters)	Required Outlet Size (mm)
10% AEP	124	700	600	118	1200	300
1%AEP	391	1108	1100	340	2000	450

Given the significant detention requirements in the minor and major storm, during future detailed design of the basin, an outlet structure will need to be included to ensure discharge can be restricted suitably in both storm events.

In order to detain stormwater to a different extent in a minor and major storm event an outlet structure will be required. One option is outlined in the image below.

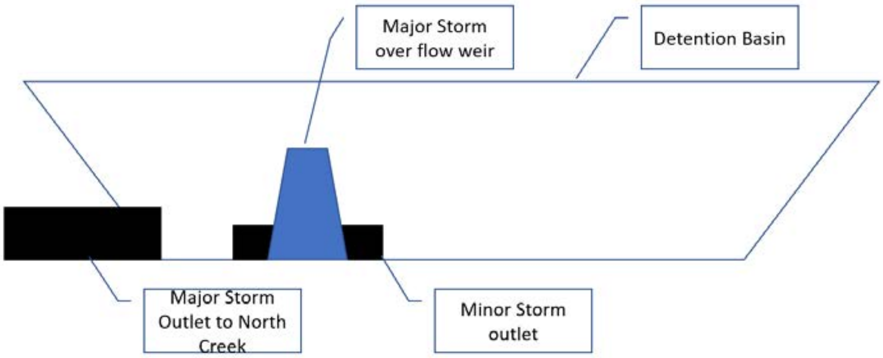


Figure 2 Diagrammatic weir outlet structure

By using a pipe and weir arrangement, the larger major storm water pipe will not be utilised to its full capacity until the weir is also engaged, thus limiting the flow rate in the minor storm event. The risk to this option is the weir itself will need to be built to the full width of the basin with minimum 1 in 4 batters and will hence require space that could otherwise be used for stormwater detention. This space is allowed for in the 2000 m^2 number in the table above.

If the shape of the basin or the land take of a weir structure is considered too extreme a weir pit could also be constructed adjacent the basin to control these outflows, however this would require a custom design and construct.

The major storm outlet would be able to discharge either directly to North creek adjacent the basin, or under Hampden Way depending on the final basin orientation.

The water level within the modelled basin was also reviewed to compare to the required floor levels discussed previously, the following graph summarises these results.

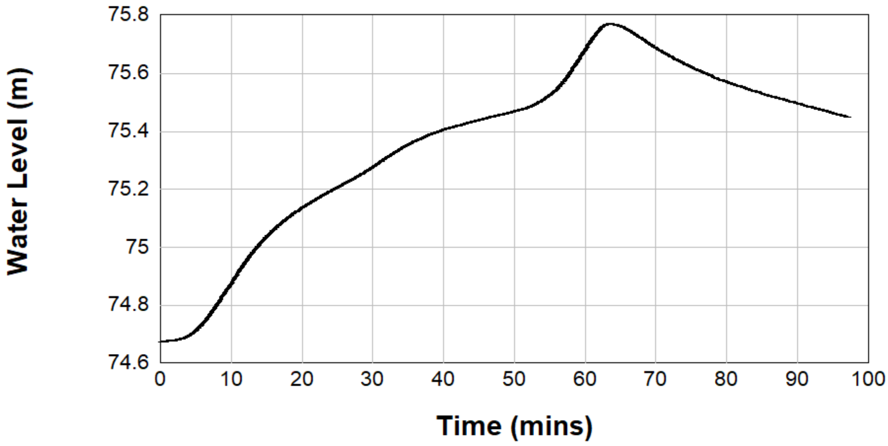


Figure 3 Detention Basin 100 year Water Level

The worst case water level in the basin was 75.8mAHD, allowing for 300 mm freeboard, both the top of basin and future building floor levels in the north west corner of the site should be a minimum of 76.1 mAHD this will allow for some fall from the south east corner level of 76.5 mAHD, however future road design, may dictate adjustments to this south eastern level.

Results and Future Investigations

As a part of the local activity centre, site levels will need to be designed and constructed to suitably protect the future buildings from stormwater inundation in a 1% AEP storm event.

In order to maintain the existing functionality of North creek, no construction should occur within the flood plain adjacent the creek to ensure there is no worsening of flooding to anyone downstream of the site.

If the minimum floor level and top of the basin is set to 76.1 m AHD near North creek, this will allow the local activity centre to be outside and above the 1% AEP storm event flooding extents. The minimum floor level should be reviewed in further detail during future applications within the affected area.

In order to manage additional flows resulting from the increased development, a 1100 m^3 basin will be required. For an average 1 m deep basin, this is expected to require between 2000 - 2300 m^2 of space depending on batter slops being 1:4 – 1:6 and having an allowance of 20% for shaping. In addition to this area, an additional; 1200 m^2 will be required to build up the western wall of the basin from the edge of North creek. The approximate land requirement of a basin with 1:4 sides, the undeveloped area for north creek, and the required area for the western basin wall is outlined in the figure below.

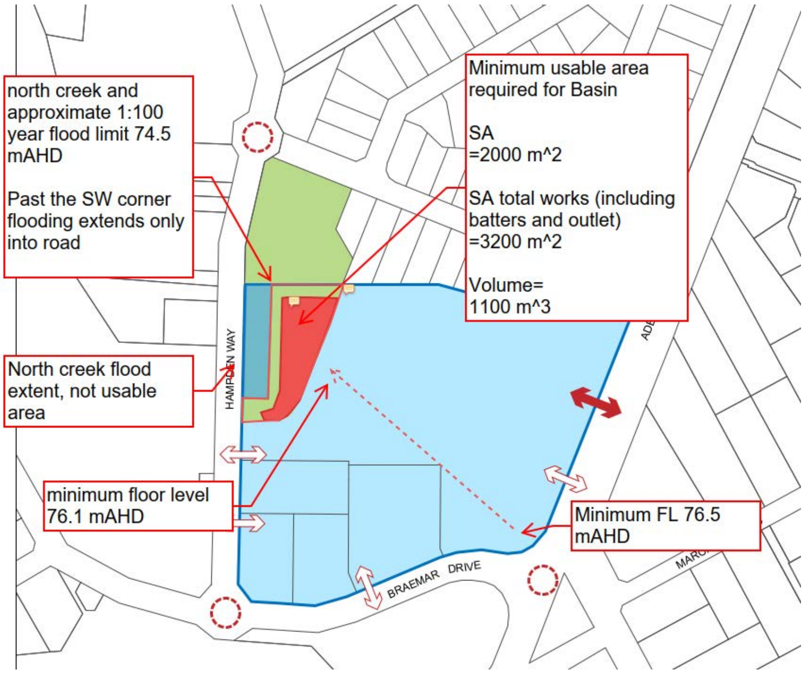


Figure 4 Detention Space Requirement

There are significant detention requirements in both the minor and major storm events, this will need to be managed by an outlet structure which should be considered in further detail during master planning. This is proposed to be achieved either through weir within the basin, or a custom weir pit adjacent the basin, depending on space requirements.

A survey and analysis of north creek further downstream should be undertaken to refine the floodplain assumptions made as a part of this review.

The existing HEC-RAS model should be updated with the improved cross section and increased extent to confirm the expected 1% AEP flood level in North Creek adjacent the site.

As a part of master planning a concept design should be undertaken to identify potential options for the basin outlet structure, basin size, and site levels to accommodate serviceability.

If you have any queries about the above, please contact Corey Pontifex or the undersigned on 8273 3100.

Yours sincerely,

Pontifex

Corey Pontifex

Senior Engineer

Tonkin

enc 20200687R002A Strathalbyn Proposed Residential Site Lot 4 Stormwater Management Plan

Strathalbyn Proposed Residential Site Lot 4 (D125134)

Stormwater Management Plan

Strath Hub Pty Ltd

7 September 2021
Ref: 20200687R002

Building exceptional outcomes together

Document History and Status

Rev	Description	Author	Reviewed	Approved	Date
1	First Issue	KSS		KSS	13/05/2020
2	Updated SMP	BT	KSS	KSS	17/09/2021

Contents

Project: Strathalbyn Proposed Residential Site Lot 4 (D125134) | Stormwater Management Plan
Client: Strath Hub Pty Ltd
Ref: 20200687R002

Figures

Appendices

1 Introduction

1.1 Background

Tonkin has previously prepared a stormwater management plan (SMP) for a proposed retirement village on approximately 7.1 ha of land situated between Adelaide Road and Hampden Way at Strathalbyn (Tonkin ref: 20200678R001A). The developer has since advised that the proposed development will now contain residential allotments instead of retirement village allotments. As a result, the SMP must be updated to reflect these changes. Figure 1 below shows the location of the site.

Figure 1: Site location

The land is currently undeveloped. The land has a general fall from east to west, with North Creek running in a channel along the western boundary of the site adjacent to Hampden Way.

This document has been prepared at the request of Strath Hub Pty Ltd and provides a Stormwater Management Plan for the proposed development. The Plan considers the site in the context of the surrounding catchments and addresses flooding and management of stormwater runoff from the proposed development.

2 External Catchments

2.1 North Creek

North Creek runs along the eastern boundary of the site in a man-made channel. The channel is trapezoidal in shape with a base width of approximately 0.5 m and 1 in 3 side slopes. Within the boundaries of the site the creek is vegetated with reeds and grasses. A number of small trees are located outside the channel on the eastern bank.

The hydrology of North Creek was assessed as a part of investigations carried out by Connell Wagner (Connell, 2004). As a part of that investigation, peak flows from North Creek, which has a catchment area of approximately 7 km^2 upstream of the development, were estimated using the Rational Method. The calculations determined the 1% AEP (100-year average recurrence interval) peak flow to be 18 m^3/s.

As a part of the development of the SMP developed previously by Tonkin, a review of the North Creek hydrological assessment was undertaken by determining peak flows from the catchment using the following regional flood estimation methods:

- Euseff Regional Flood Estimation Relationships
- Regional Flood Frequency (RFF) Tool (Australian Rainfall and Runoff 2016)

2.1.1 Euseff Relationships

Euseff (1995) developed a series of relationships between catchment area and peak flow for the Mount Lofty Ranges. For the higher annual rainfall areas within the ranges, the relationship he developed for a 1% AEP event was:

$Q_{100} = 3.8\ A^{0.73}$, where A is the catchment area in km^2.

Using this relationship, the peak 1% AEP flow for the North Creek catchment was calculated to be 15.7 m^3/s.

For lower annual rainfall areas within the ranges, the same relationship was:

$Q_{100} = 1.09\ A^{0.87}$

Using this relationship, the peak 1% AEP flow for the catchment was calculated to be 5.9 m^3/s.

Strathalbyn, with an annual rainfall of 490 mm, lies in an area that would best be characterised as being more representative of the lower rainfall areas within the ranges. The peak flow produced by the second of the above equations is therefore more likely to be representative of peak flows from the North Creek catchment.

2.1.2 Regional Flood Frequency Tool

As part of the revision of Australian Rainfall and Runoff, a tool for estimation of peak flows from catchments in various areas of Australia has been developed. This tool was used to estimate peak flows from the North Creek catchment.

Output from the tool, showing peak 1% AEP flows for a range of gauged catchments within the Mount Lofty Ranges, is shown in Figure 2. The plot indicates a trend with a peak flow of 8 - 10 m^3/s for a catchment area of 7 km^2.

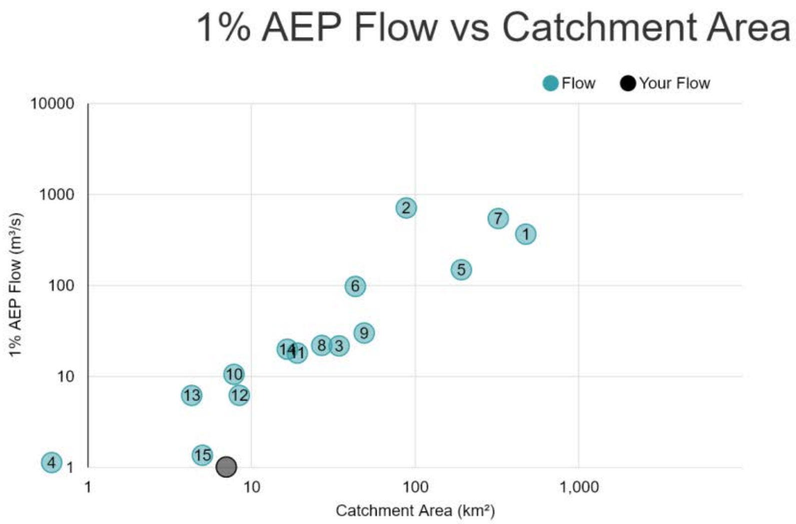


Figure 2: Output from RFF Tool for North Creek Catchment

2.1.3 Adopted North Creek Peak Flow

Based on the above assessment, we have conservatively adopted a peak 1% AEP flow of 10 m^3/s for assessment of the floodplain of North Creek through the proposed development.

2.1.4 Flood Level Assessment

A HEC-RAS model was prepared for the section of North Creek running parallel to Hampden Way as part of the previous SMP developed by Tonkin. Data for preparation of the model was taken from design drawings of Hampden Way and the North Creek realignment works prepared by Connell Wagner in 2005.

A Manning's roughness (n) value of 0.05 was adopted for modelling the channel based on a visual inspection of the current creek condition.

The downstream boundary condition for modelling flood levels was governed by the twin 675 diameter culverts under Hampden Way. Due to the limited capacity of the culverts relative to the magnitude of flows from the upstream catchment, floodwaters will overtop Hampden Way. The design road profile at the culvert was modelled in HEC-RAS as a weir to determine the overtopping level in a 1% AEP event.

Outputs from the HEC-RAS model are contained in Appendix A. The flood levels determined by HECRAS were used to plot the 1% AEP flood extent onto the land, which is shown in Figure 3 below. The plotted floodplain shows that only a small portion of the land along the western boundary is affected by flooding in a 1% AEP event. Lower lying land in the north western corner of the site would be inundated to a shallow depth in this event.

The 1% AEP flood level at the upstream boundary of the site was determined to be 77.4 mAHD. At the downstream boundary, this flood was determined to have a level of 74.8 mAHD.

2.2 Land to the North

Tonkin was previously engaged to undertake the detailed design works for a 51-lot subdivision located in Allotment 1 in DP 122085, which is to the immediate north of the site area. As part of the detailed design works, a stormwater management report was prepared for the site (Tonkin ref: 20200469R002RevA). The site is understood to be currently in construction.

Based on the report, it is determined that a detention basin sized for the 1% AEP event is located adjacent to the north western boundary of the proposed site area. Further review of the DRAINS model developed for the 51-lot subdivision shows a peak water level in the basin of 77.64 mAHD for the 1% AEP event.

When comparing the 1% AEP peak water level of the basin with the available site survey (Andrew & Associates, 2021), the surrounding ground elevation is determined to be lower by approximately 800 mm.

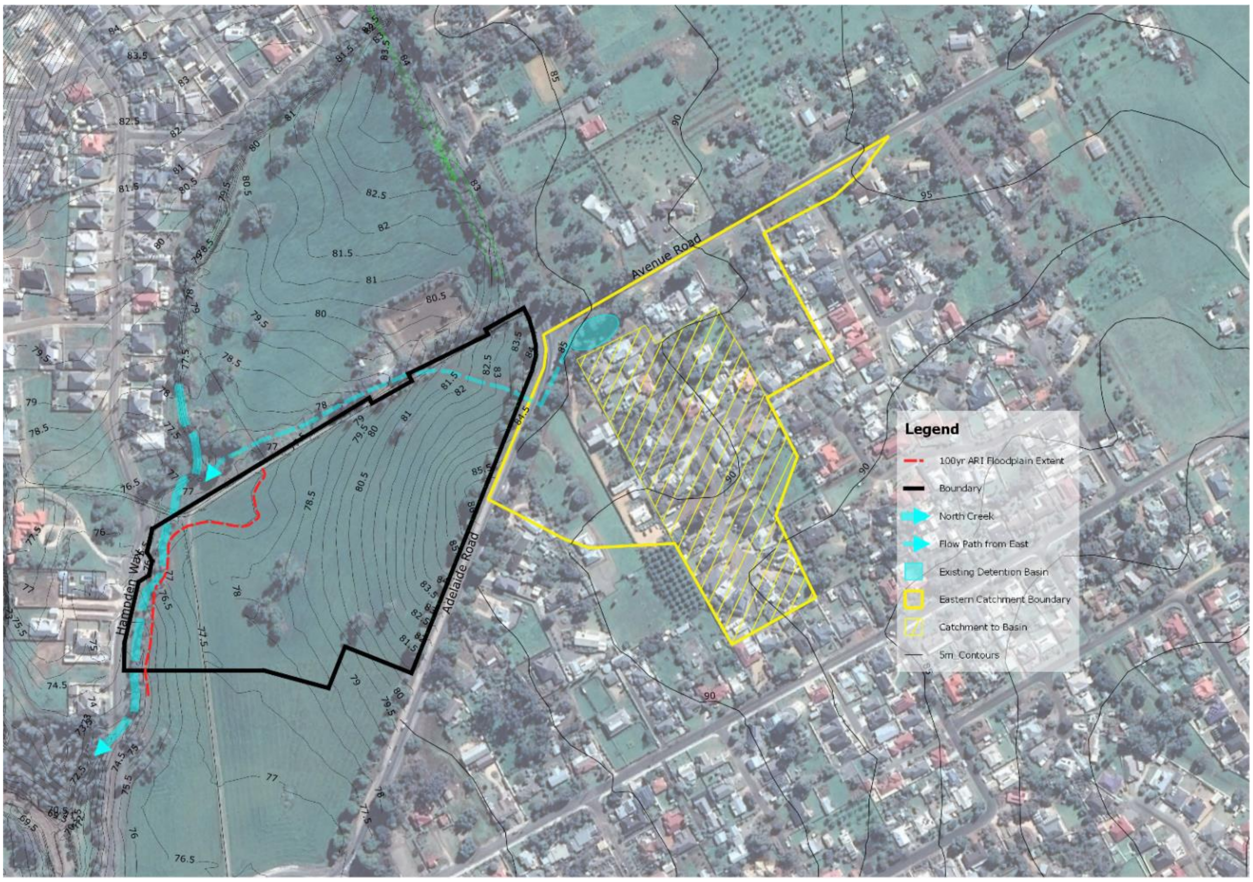
2.3 Land to the East

There is an existing culvert under Adelaide Road just south of its intersection with Avenue Road.

The catchment draining to this culvert is shown in Figure 3 and includes residential areas lying to the east of the subject land. Runoff from a large portion of this catchment is intercepted by a detention basin on the south eastern corner of the intersection of Adelaide Road and Avenue Road. It is understood that this basin was designed to cater for the 1% AEP peak flow from its contributing catchment and reduce this flow to pre-development levels.

Flows from the Adelaide Road culvert will currently run across the north eastern corner of the land towards a shallow depression that lies on land to the north of the site. This depression discharges into North Creek near the north western corner of the site.

Figure 3: External Catchment Influences on Subject Land



3 Proposed Development

3.1 Layout

The proposal is for a residential development comprising approximately 64 dwellings. The proposed layout of the development is shown in Figure 4. The development site includes 1.28 ha of reserves.

For the purposes of this assessment, we have assumed that outside of the reserves which are 100% pervious and roads which are 100% impervious, the development will result in allotments having directly connected, indirectly connected, and pervious area percentages consistent with that shown in DIT Design Standard RD-DK-D2. Given that the majority of the residential allotments have areas between 600 m^2 and 1600 m^2, the following percentages shown in Table 1 are used.

Table 1 Directly connected impervious, indirectly connected impervious, and pervious percentages of allotment areas (adopted from Table RD-DK-D2 7-1)

Allotment Size	% Directly connected impervious	% Indirectly connected impervious	% Pervious
500 – 700 m^2	60%	15%	25%
700 – 1000 m^2	40%	15%	45%
1000 – 2000 m^2	30%	15%	55%

Based on the above, the development is expected to result in the following catchment characteristics:

- Directly Connected Impervious Area 3.33 ha
- Indirectly Connected Impervious Area 0.71 ha
- Pervious Area 3.06 ha

Total 7.1 ha

3.2 Stormwater Management Requirements

The District Council of Alexandrina includes requirements within its Development Plan for the management of stormwater runoff from new developments. These requirements set out provisions for the management of peak flows and water quality. Council has also sought advice from the EPA in relation to the proposed development.

The guidance provided in the Development Plan and the requirements of the EPA are in general accordance and require that:

- Stormwater peak flows are to be maintained at pre-development levels.
- Stormwater is to be managed to achieve the following runoff quality outcomes:
  (a) an 80 per cent reduction in average annual total suspended solids
  (b) a 60 percent reduction in average annual total phosphorus
  (c) a 45 percent reduction in average annual total nitrogen
  (d) a 90 per cent reduction of litter / gross pollutants

(e) no visible oils/grease for flows up to the 1-in-3 month average return interval flood peak flow.

- Development is protected from flooding for events up to a 1% AEP.

A stormwater management strategy has been developed for the site which addresses the above. Figure 5 provides an overview of the various elements of this plan. The various components of the strategy are described in the following sections of this document.

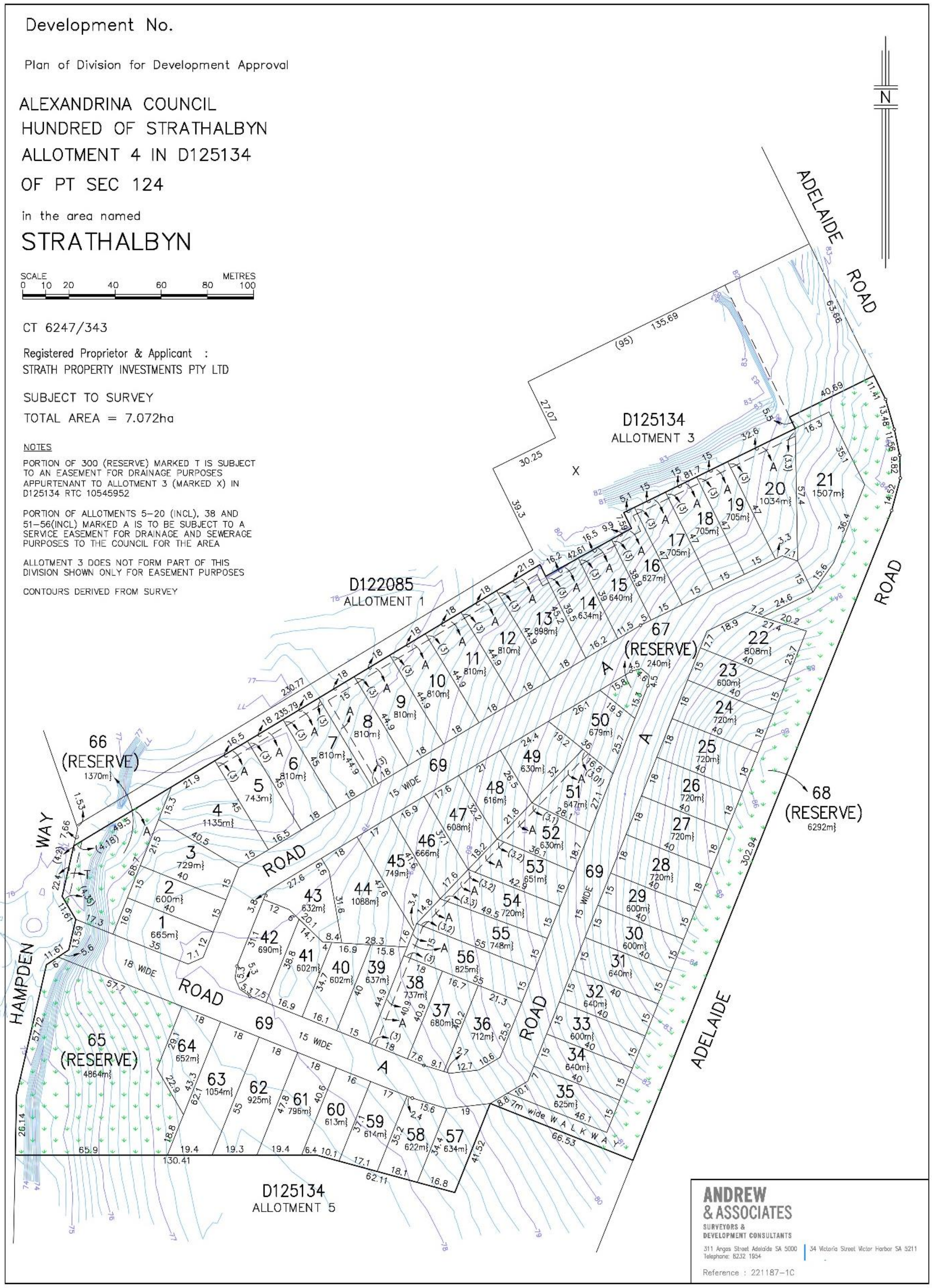
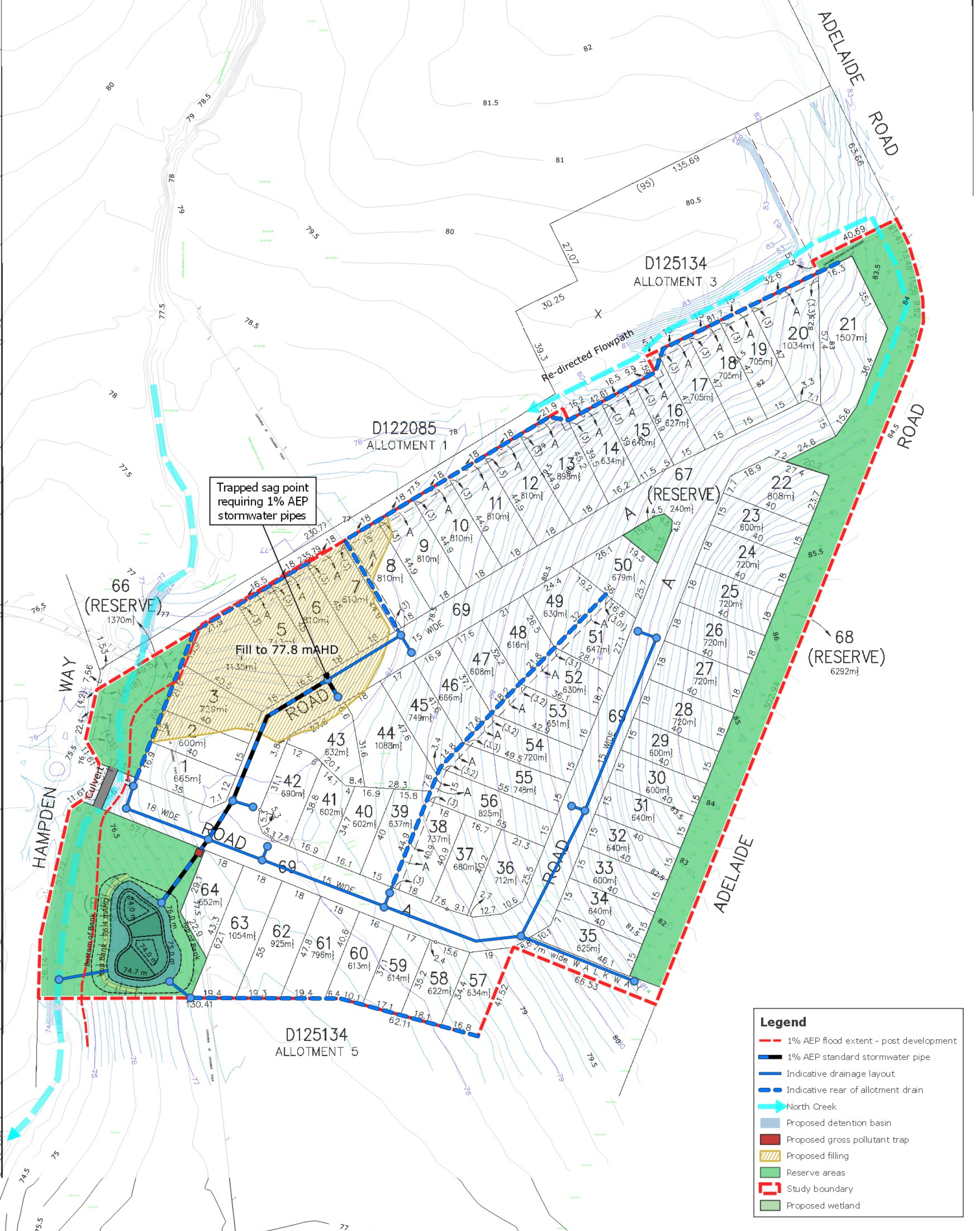


Figure 4: Proposed Development Layout



tonkin

Job Number: 200687
Filename: 200687GQ002RevA
Revision: A
Date: 2021-09-07
Drawn: BT

Data Acknowledgement:
Site layout and site contours from Andrews & Associates, 2021

STRATH HUB PTY LTD

PROPOSED RESIDENTIAL SITE LOT 4
STORMWATER MANAGEMENT PLAN

Figure 5

4 Peak Flow Management

4.1 Proposed Drainage Layout

It is proposed that stormwater drainage within the development is provided by a combination of underground pipe work (nominally designed for a 20% AEP event) and surface flow paths (nominally designed to cater for flows up to a 1% AEP event) to direct flows to a detention basin located in the south western corner of the site. An indicative layout of the drainage is shown in Figure 5.

Based on the existing site contours, minor filling works are proposed for north eastern corner of the site to allow for the runoff from the road to be directed south towards the basin. Apart from that, filling works are also proposed towards the north western portion of the site where the detention basin for the 51-lot subdivision is located. It is proposed to fill this site to at least 77.8 mAHD and have the finished floor levels of the buildings be set at least 150 mm above to achieve a minimum of 300 mm freeboard above the 1% AEP peak water level for the adjacent detention basin.

A trapped sag point is identified to occur as a result of the filling works at the north western portion of the site. As such, it is proposed that the stormwater drainage pipes between the sag point and the detention basin be designed to cater for the 1% AEP event.

It should be noted that various portions of the site, mainly reserve 65, reserve 66, and the northern portion of reserve 68, will bypass the detention basin and will discharge directly to North Creek. This has been accounted for in the sizing of the detention basin, such that the combined total site discharge for the post-development scenario is reduced to the pre-development discharge.

4.2 Analysis of Peak Flows

4.2.1 Pre-Development Peak Flows

Peak flows from the undeveloped site were calculated using DRAINS. The site was modelled as being 100% pervious, with rainfall losses using an initial loss - continuing loss model. An initial loss of 26 mm and a continuing loss of 4.4 mm/hr has adopted in accordance with parameters contained in Australian Rainfall and Runoff (ARR) 2016.

The time of concentration for the catchment was calculated using the Kinematic Wave equation, with a 100 m flow length, 3.3% surface grade and a retardance coefficient of 0.1.

The resulting peak flows for a 20% and 1% AEP event are set out below:

- 20% AEP 0.159 m^3/s
- 1% AEP 0.609 m^3/s

These flows have been used to set the maximum permissible peak discharge rates for the developed site.

4.2.2 Post Development Peak Flows

Peak flows from the developed catchment were calculated using DRAINS with the impervious area parameters described in Section 3.1.

Various detention basin sizes were trialled to achieve peak outflows matching the pre-development peak flows described above. A basin having a low-level orifice outlet and a high-level weir outlet was required to achieve the pre-development peak flows.

The following basin parameters were adopted:

- Low water level 75.0 mAHD
- Weir Level 75.8 mAHD
- Peak 1% AEP Flood Level 76.1 mAHD
- Top of Bank 76.4 mAHD
- Orifice diameter 275 mm
- Basin volume 1070 m^3 (between low water and 1% AEP flood level)

The layout of a basin achieving the above detention requirements is shown in Figure 5.

Outputs from the DRAINS model showing the post development flows are attached in Appendix B.

The outputs demonstrate that the post development peak flows are reduced to the pre-development flows as follows:

- 20% AEP 0.097 m^3/s
- 1% AEP 0.607 m^3/s

5 Water Quality Management

Construction of a detention basin in the south western corner of the development provides the opportunity to integrate a wetland into its base for the purposes of water quality improvement. The proposed configuration of the wetland is shown in Figure 5.

The performance of the system was modelled using MUSIC.

Runoff from the development was modelled using a single 'Residential' land use node, with an impervious area of 4.1 ha.

The wetland was modelled using the following parameters:

- Wetland Surface Area 670 m^2
- Permanent Pool Volume 420 m^3
- Extended Detention Depth 0.7 m (with 275 mm orifice)

The results of the MUSIC analysis are shown below.

- Reduction in Suspended Solids 96%
- Reduction in Phosphorus 80%
- Reduction in Nitrogen 46%

These reductions meet or exceed the reductions required by Council and the EPA.

To achieve the required reductions in gross pollutants and oils discharged to North Creek, a proprietary gross pollutant trap is proposed to be installed on the inlet pipe work to the wetland. Such a trap will achieve the required reductions in gross pollutants and oils and will assist in reducing the required frequency of desilting the wetland and well as protecting its amenity due to a reduction in floating debris within the system.

6 Flood Management

6.1 North Creek Floodplain

The development is largely situated outside the 1% AEP floodplain of North Creek as described in Section 2.1.4.

There is a low-lying area in the north western corner of the development that would be subject to shallow flooding under current conditions. It is proposed to fill this area to a level of 77.8 mAHD as described in Section 4.1. Filling up to this level allows for 400 mm freeboard above the 1% AEP floodplain peak water level.

The area to be filled lies within a backwater of the floodplain away from the main flow path. Filling of the area is therefore not expected to result in any upstream increase in flood levels.

6.2 Site Access

The proposed access to the site is to be from the roundabout on Hampden Way. This access will require a crossing of North Creek.

A culvert having capacity to carry the 1% AEP flow (10 m^3/s) will be required. It is expected that to facilitate the construction of such a culvert, some regrading, widening and deepening of North Creek upstream and downstream of the culvert will be required.

6.3 Eastern Upstream Catchment

As discussed in Section 2.3 above, runoff from land to the east of the proposed development is currently discharged across the site from a culvert under Adelaide Road.

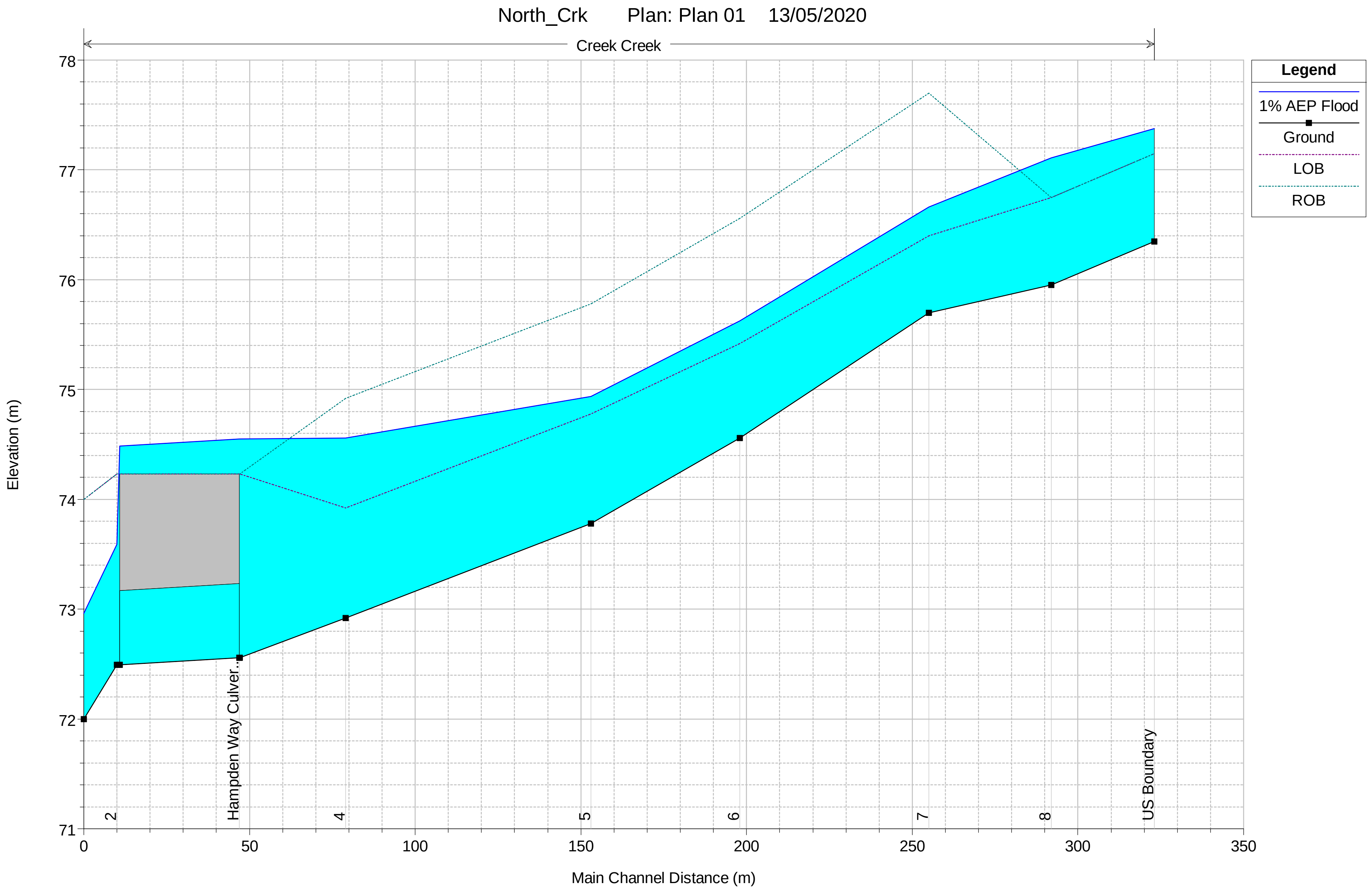
Formalisation of this drainage path will be required. The flow path can be redirected along the Adelaide Road reserve buffer and then through land immediately to the north of the proposed development into the natural flow path that exists within this land. The redirection of the flow path has been accounted for in the sizing of the detention basin for the 51-lot subdivision to the north of the proposed site area.

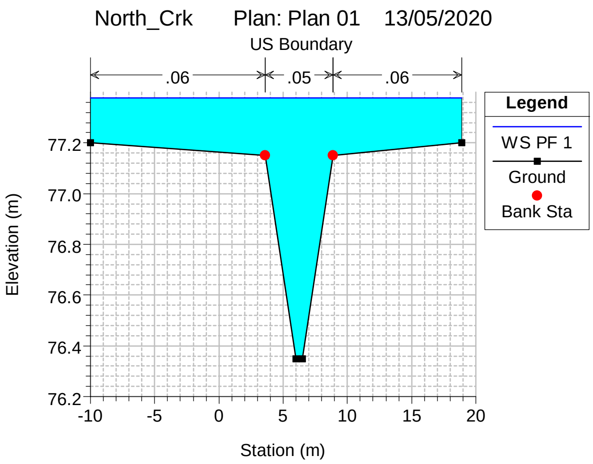
7 References

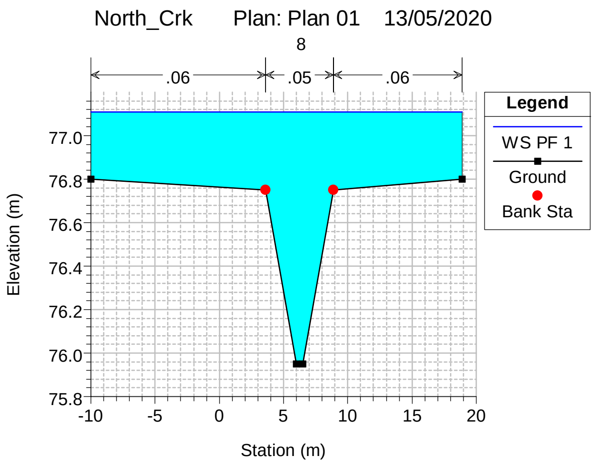
Connell Wagner (2004) ‘The Strath Hub Development – 100 Year Flood Extents’ Strath Hub Pty Ltd, Nov 2004.

Euseff, TH (1995) “A regional Flood Frquency Approach to the Mt Lofty Ranges’ University of Adelaide, June 1995.

Appendix A – HECRAS Model Outputs


North_Crk Plan: Plan 01 13/05/2020
Creek Creek
Legend
1% AEP Flood
Ground
LOB
ROB
Elevation (m)
Main Channel Distance (m)
78
77
76
75
74
73
72
71
0
50
100
150
200
250
300
350
2
Hampden Way Culver...
4
5
6
7
8
US Boundary


North_Crk Plan: Plan 01 13/05/2020
US Boundary
.06 .05 .06
Legend
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)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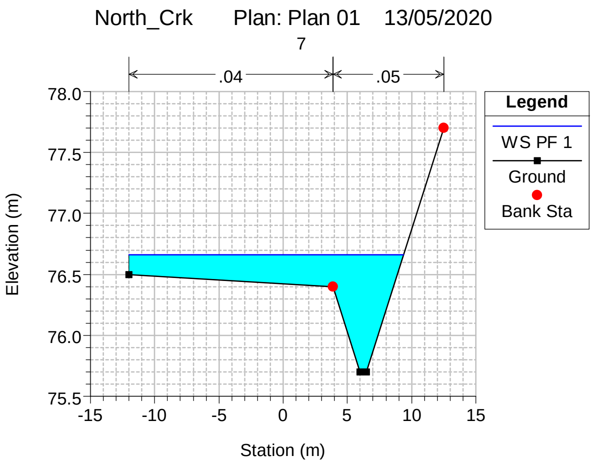
Ground
Bank Sta
Elevation (m)
Station (m)


North_Crk Plan: Plan 01 13/05/2020
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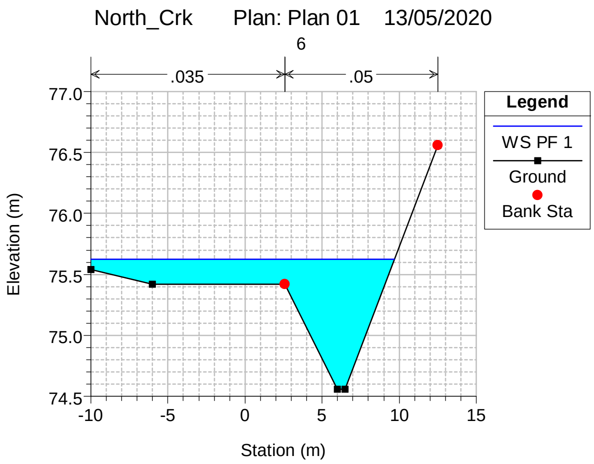
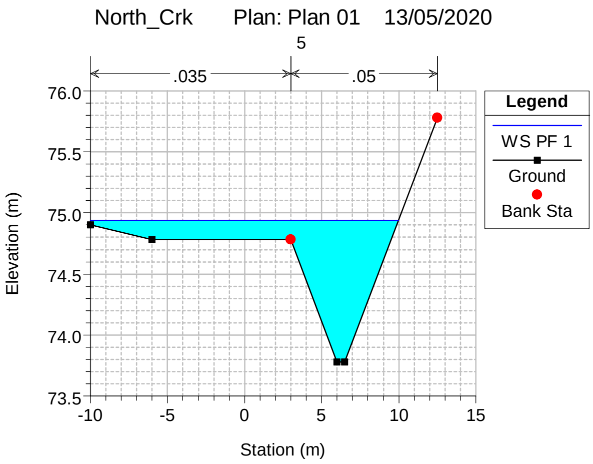
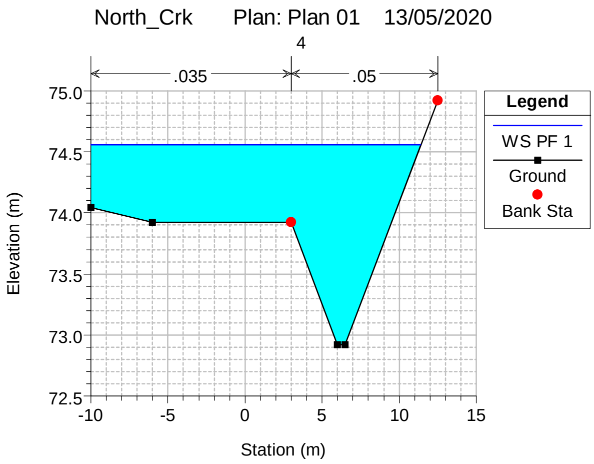
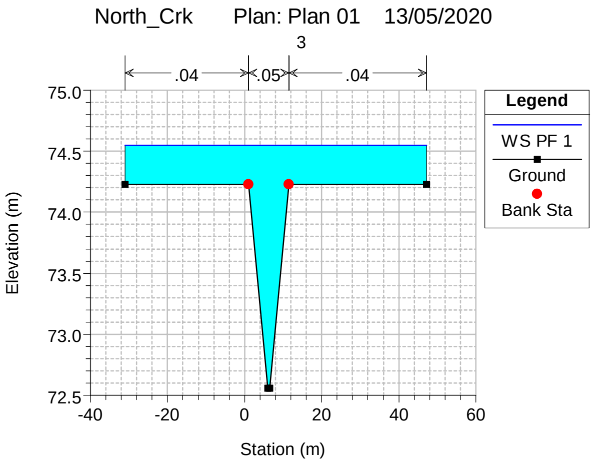
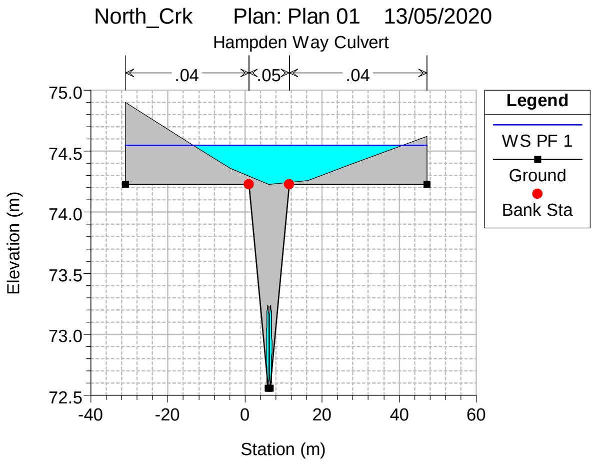
.04 .05
Legend
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)

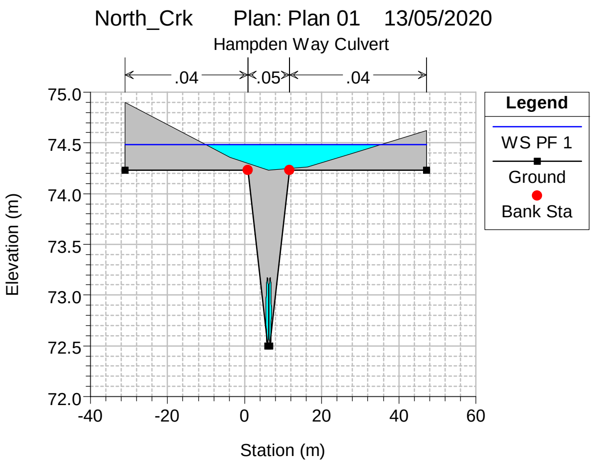

North_Crk Plan: Plan 01 13/05/2020
6
.035 .05
Legend
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)

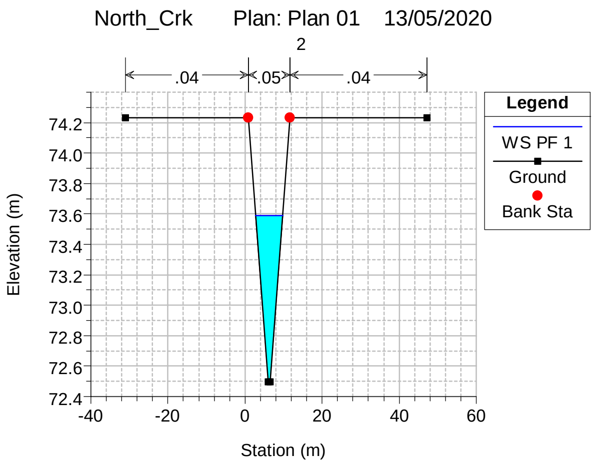

North_Crk Plan: Plan 01 13/05/2020
5
.035 .05
Legend
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)

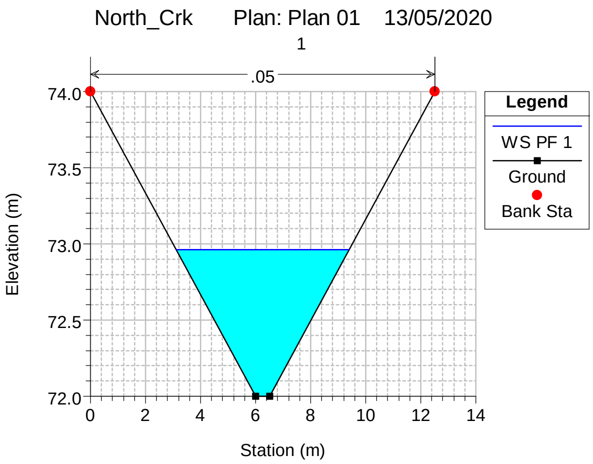

North_Crk Plan: Plan 01 13/05/2020
4
.035 .05
Legend
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)


North_Crk Plan: Plan 01 13/05/2020
3
.04 .05 .04
Legend
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)


North_Crk Plan: Plan 01 13/05/2020
Hampden Way Culvert
.04 .05 .04
Legend
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)


North_Crk Plan: Plan 01 13/05/2020
Hampden Way Culvert
.04
.05
.04
Elevation (m)
Station (m)
Legend
WS PF 1
Ground
Bank Sta


North_Crk Plan: Plan 01 13/05/2020
2
.04
.05
.04
Elevation (m)
Station (m)
Legend
WS PF 1
Ground
Bank Sta

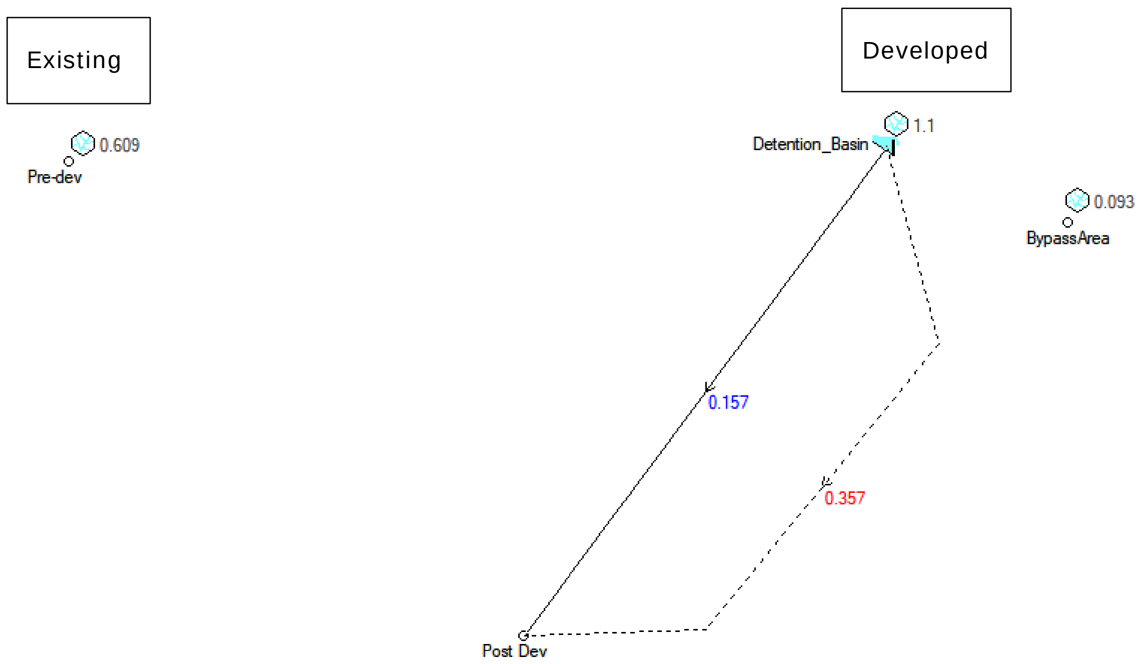

North_Crk Plan: Plan 01 13/05/2020
1
.05
Elevation (m)
Station (m)
Legend
WS PF 1
Ground
Bank Sta

HEC-RAS Plan: Exist River: Creek Reach: Creek Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Creek	323	PF 1	10.00	76.35	77.38	77.38	77.50	0.015892	1.86	8.31	28.90	0.73
Creek	292	PF 1	10.00	75.95	77.11	76.98	77.16	0.005734	1.26	12.08	28.90	0.45
Creek	255	PF 1	10.00	75.70	76.66	76.66	76.80	0.019166	1.86	6.54	21.39	0.78
Creek	198	PF 1	10.00	74.56	75.63	75.60	75.75	0.014150	1.68	6.74	19.70	0.68
Creek	153	PF 1	10.00	73.78	74.94	74.94	75.08	0.015440	1.81	6.37	19.97	0.72
Creek	79	PF 1	10.00	72.92	74.56	74.08	74.58	0.000985	0.60	16.24	21.41	0.19
Creek	47	PF 1	10.00	72.56	74.55	73.65	74.55	0.000368	0.42	34.07	78.35	0.12
Creek	15		Culvert									
Creek	10	PF 1	10.00	72.49	73.59	73.59	73.89	0.031945	2.42	4.13	7.05	1.01
Creek	0	PF 1	10.00	72.00	72.96	73.10	73.44	0.060398	3.07	3.25	6.27	1.36

Appendix B – DRAINS Model Outputs

1% AEP Peak Flows



20% AEP Peak Flows