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SURFACE/ STORMWATER MANAGEMENT STRATEGY:

100 Walls Road, Werribee (Stage 3 Bella Rosa Estate)

Resi Ventures

September 2018

(minor update December 2018)

Document history

Revision:

Revision no.	03
Author/s	Jonathon McLean
Approved	Jonathon McLean

Distribution:

Revision no.	01
Issue date	15 February 2016
Issued to	Tim Hamilton (BPD)
Description:	Draft SWMS

Revision no.	02
Issue date	8 April 2016
Issued to	Tim Hamilton (BPD)
Description:	Final SWMS

Revision no.	03
Issue date	3 May 2016
Issued to	Tim Hamilton (BPD)
Description:	Final SWMS

Revision no.	04
Issue date	5 May 2016
Issued to	Tim Hamilton (BPD)
Description:	Final SWMS

Revision no.	05
Issue date	27 September 2018
Issued to	Tim Hamilton (BPD)
Description:	Final SWMS

Revision no.	06
Issue date	17 December 2018
Issued to	Tim Hamilton (BPD)
Description:	Final SWMS

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Ref: R:\Projects\2015\119_100 Wall Rd, Werribee- SWMS\1_Deliverables\P115119 100 walls rd swms v4.doc

Contents

1 Introduction

Alluvium Consulting Australia Pty Ltd (Alluvium) has been engaged by BPD (on behalf of Resi Ventures) to prepare a Surface/Storm Water Management Strategy (SWMS), in support of its permit application for the 100 Walls Road, Werribee site.

The objectives of this SWMS are to propose management strategies for:

- Stormwater quantity
- Stormwater quality

Through meeting these objectives, this SWMS acts as a critical component of the development servicing strategy and ensures stormwater is managed in accordance with Melbourne Water's and Council's requirements.

Resi Ventures are looking to develop Stage 3 of their 100 Walls Road property in Werribee. It is located within the Alfred Road Development Services Scheme (DSS) and the Black Forest Road DSS.

Reference material

- Melbourne Water's Alfred Road Development Services Scheme (DSS) and Black Forest Road DSS
- Site visit and inspection
- Subdivision layout plan (Breese Pitt Dixon – 8874SK01)
- Drainage plans and computations for Bella Rosa Estate Stage 1 & 2 (The Landplan Group)
- Meeting/discussion with Melbourne Water
- Australian Rainfall & Runoff (1997) – Engineers Australia
- Urban Stormwater Best Practice Environmental Management Guidelines (1999)

2 Site overview

The subject site is 3.5 ha and is bounded by McGrath Road to the west, Gordon O'Keefe Reserve and existing residential development to the north, existing residential development to the south (Gaudin Court) and Stages 1 &2 of Bella Rosa Estate (Mantello Drive) to the east (Figure 1). The subject site is considered to be Stage 3 of the Bella Rosa estate. It is located within Melbourne Water's Alfred Road Development Services Scheme (DSS) and Black Forest Road DSS.

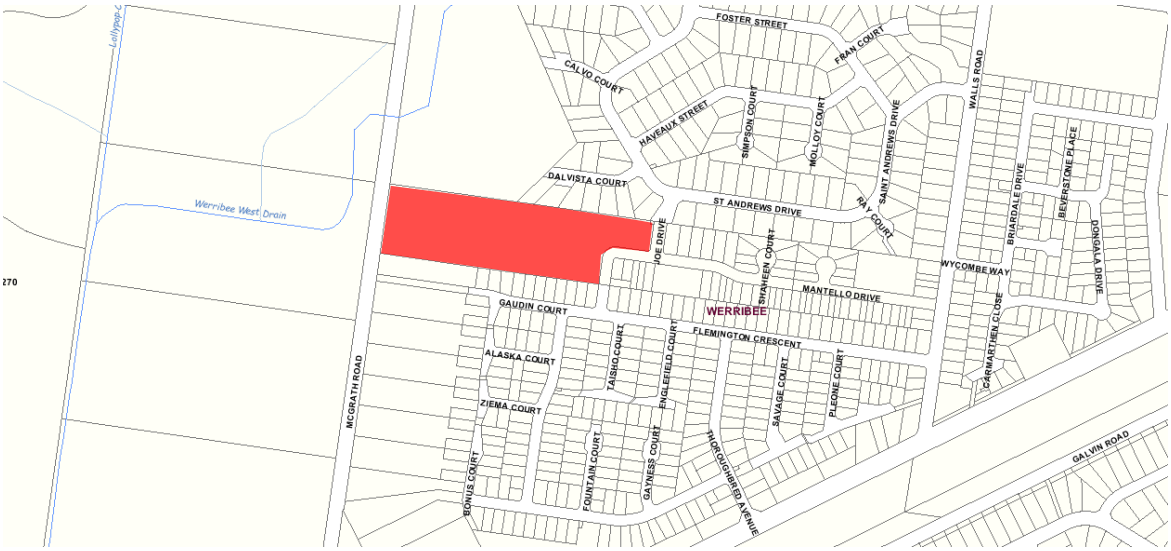

Figure 1. Site location

The subject land is split into two catchments. One that falls to the south west and one that falls to the south east. The catchment context of the study area is shown in Figure 2.The natural fall of the land has the western portion of the site within the Lollypop Creek catchment and the eastern portion of the site within the Werribee River catchment. The study area is part of Melbourne Water's Alfred Road Development Services Scheme (DSS) and Black Forest Road DSS (figure 3).

The subject site is zoned residential 1. The western portion of the site was originally inundated as part of the the Lollypop Creek floodplain system. However recent flood mitigation works have been undertaken by Melbourne Water which has removed the flood inundation overlay on the site. These works included the raising of McGrath Road along the west boundary of the site and the construction of a landscape levee along the northern site boundary which adjoins Gordon O'Keefe Reserve. Further background on the Lollypop Creek/Black Swamp flood levels is provided in Sections 2.1 and 2.2.

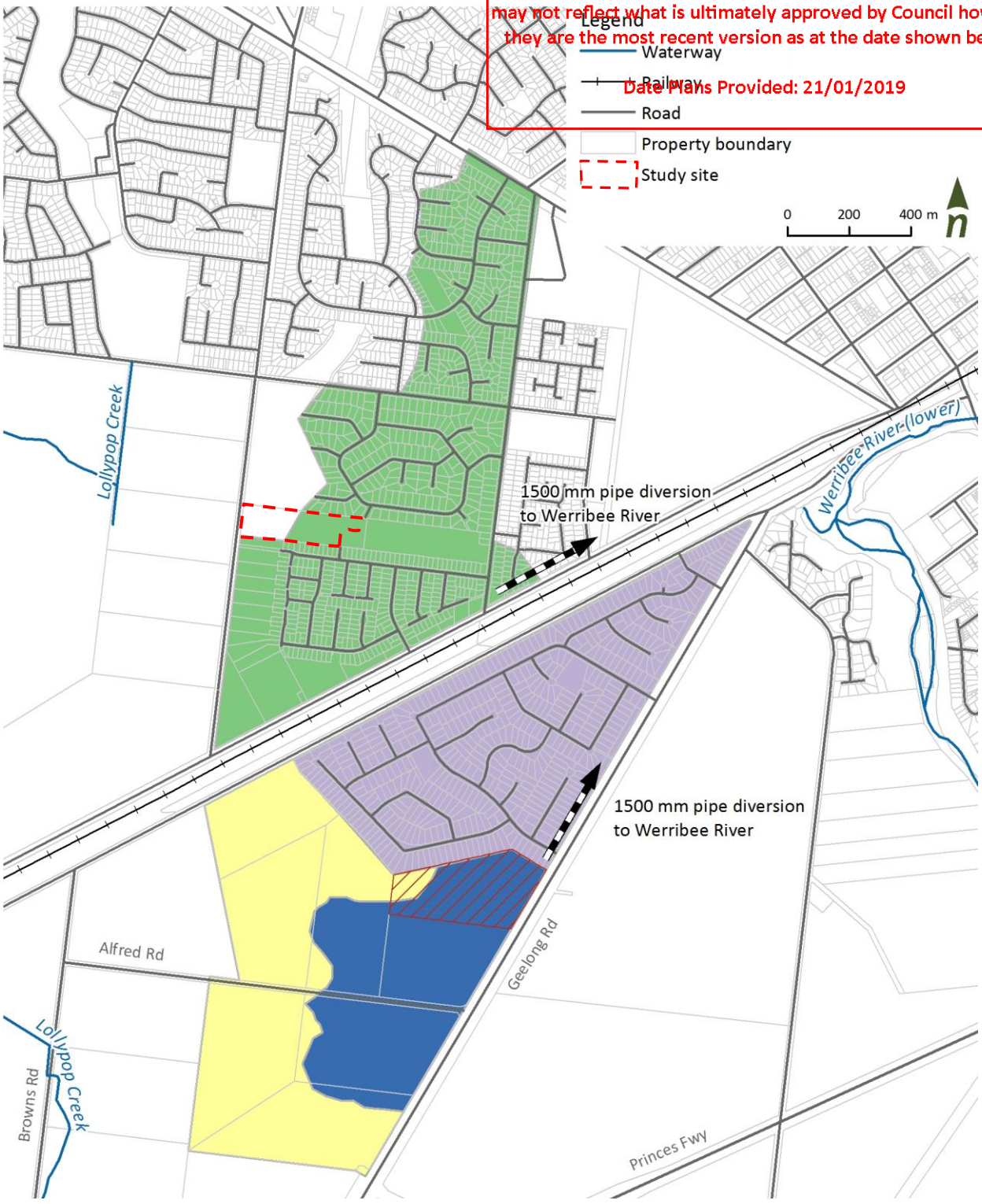

Figure 2. Catchment context

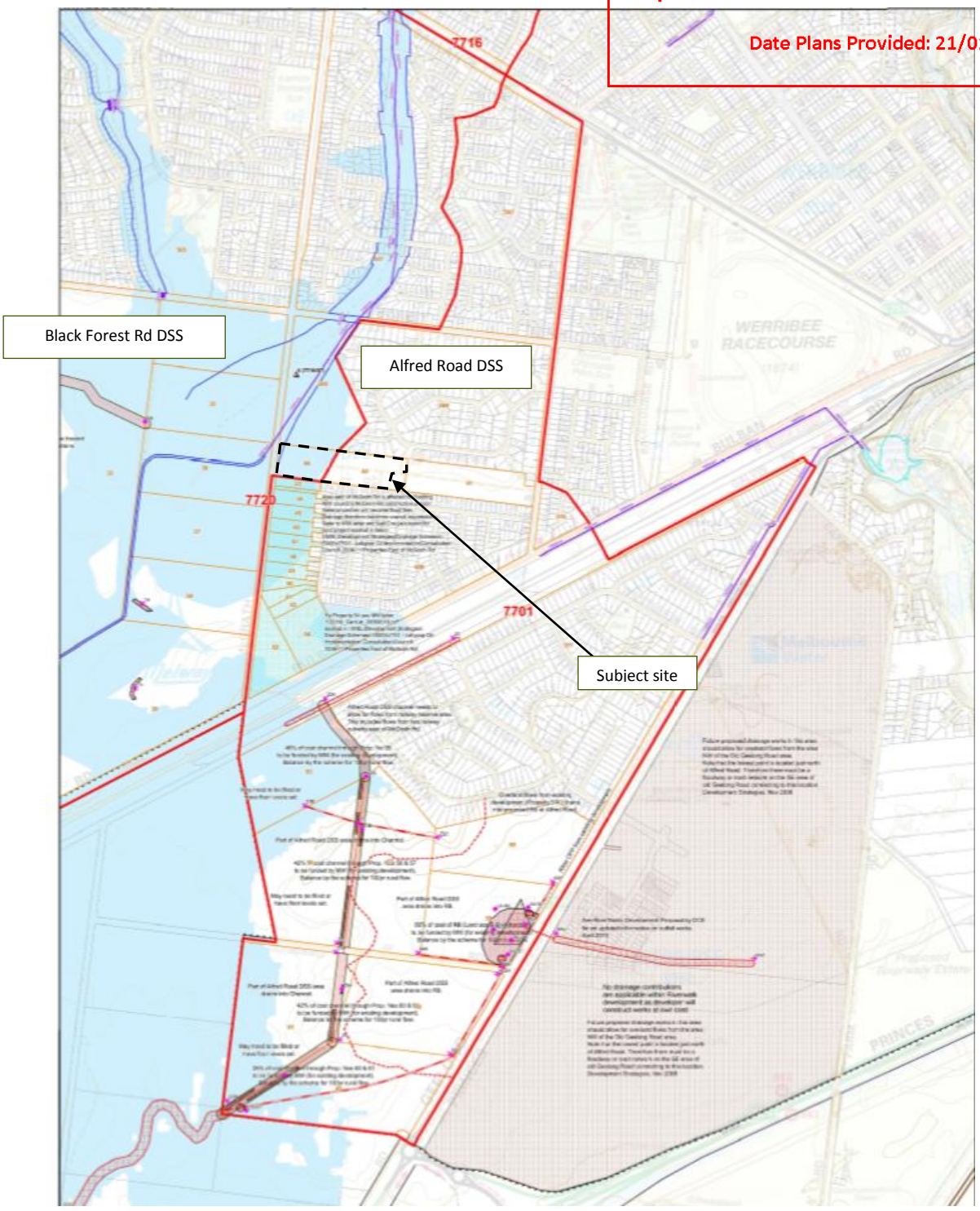

Figure 3. Alfred Road DSS and Black Forest Road DSS

2.1 Flood levels pre-2010

Black Swamp is a natural floodplain depression on Lollypop Creek between Black Forest Road and Balcan Road which has been artificially drained as shown on Figure 1. The excavated drains have radically altered the natural hydrology of the swamp by lowering drainage levels and drying the swamp out.

At McGrath Road an artificial drainage/floodway channel known as the Werribee West Floodway connects to Lollypop Creek at the Black Swamp. The Werribee West Floodway has a primary function to convey overflows from the Werribee River through to Black Swamp during major flood events in that river but also provides outfall drainage to existing and proposed urban developments in Wyndham Vale.

Large areas of land outside the confines of Black Swamp are subject to inundation. According to modelling undertaken by WaterTechnology the flood in February 2005 was close to a 100 year Average Recurrence Interval (ARI) event and caused widespread flooding including in the margins of residential land on the east side of McGrath Road. The Railway was also overtopped. An aerial image of the 2005 flood is shown in Figure 4.

Figure 4. Lollypop Creek / Black Swamp flooding in 2005 looking north-east

Hydrologic and hydraulic modelling has been used by Melbourne Water to define the 100 year inundation extent within the Lollypop Creek and Black Swamp floodplain (refer to Figure 3). As shown in Figure 5, the western portion of the 100 Walls Road site is encumbered by the 100 year ARI flood (note: this is prior to 2010).

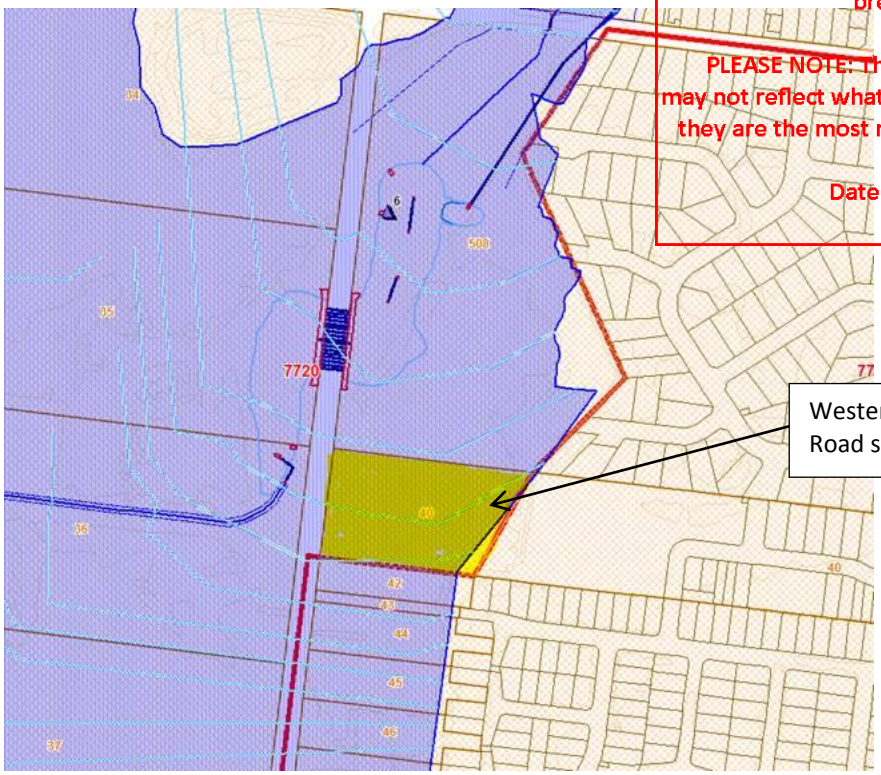

Figure 5. 100 year ARI flood mapping by Melbourne Water (prior to 2010 works)

2.2 Flood Levels post-2010

In 2008 a study of the requirements for upgrade of McGrath Road to achieve 100 year ARI flood protection was completed for Council by Neil Craigie. The study was based upon two dimensional hydraulic modelling of the floodplain. The recommendations were as follows:

- McGrath Road be raised above 100 year ARI flood levels with the crossing formed using large box culverts partially submerged in a major new wetland pool straddling the road reserve. The wetland, located within the Gordon O'Keefe Reserve, is part of Melbourne Water's scheme and main drainage works;

- McGrath Road be used to form the eastern barrier to flooding extent south of the Werribee West Floodway crossing;

- A link embankment be created on the south boundary of the Gordon O'Keefe Reserve on the east side of McGrath Road across to existing subdivisional fill, so as to prevent inundation of land further south on the east side of McGrath Road and facilitate its eventual filling and development;

- Additional culverts would need to be provided under the Railway near the current creek/floodway culvert crossings to mitigate flooding in the Bulban Road/McGrath Road intersection area and to prevent overtopping of the Railway at this location in the 100 year ARI event.

Therefore flood mitigation was a key objective of the McGrath Road upgrade. One of the key functions was to use the road as a means to provide 100 year ARI flood protection to properties on the east side. This intention was confirmed in an email from Melbourne Water on the 7th August 2015, which stated:

"Following construction of McGrath Road, the properties to the east of McGrath Road including the subject site (100 Walls Road) are no longer subject to flooding from Melbourne Water's drainage system."

The McGrath Road upgrade and flood mitigation works commenced in 2010. This is illustrated in Figure 6, Figure 7 and Figure 8 below.

Figure 6. Aerial image in January 2010 showing works have yet to commence

Figure 7. Aerial image in October 2010 showing McGrath Road upgrade and flood mitigation works under construction

Figure 8. Aerial image in October 2017 showing McGrath Road upgrade and flood mitigation works complete

Melbourne Water advised in an email on the 9th August 2017 that following the upgrade of McGrath Road, the relevant flood levels for the subject site grade from 22.31AHD at the north boundary and 22.27AHD at the south, for the western portion of the site. A field survey by Anthony Field Surveying (2017) shows that McGrath Road and the bund along the southern boundary of Gordon O'Keefe Reserve are above the 100 year ARI flood levels.

2.3 Site photos

The following photos demonstrate some features of the subject site and their location is shown on the aerial photograph in Figure 13.

Figure 9. At Mantello Drive looking west

Figure 10. East-west catchment boundary (levee) looking north

Figure 11. Looking towards south-west corner

Figure 12. Looking north at flood levee in Gordon O'Keefe reserve

Figure 13. Aerial photo

3 Catchments

Section 2 provided an overview of the "macro" catchments that relate to Stage 3 of the Bella Rosa Estate. Within the subject site the land is split into two catchments. With the regional flood mitigation works that have recently been completed, there are no external catchments that flow through the site.

Table 1. Contributing catchments

Description	Flow direction	Type	Area (ha)	Comment
East	South-east	Internal catchment	1.6	Outfalls to existing drainage system in Mantello Drive (Stage 2 of Bella Rosa)
West	South-west	Internal catchment	1.9	Outfalls to open drain parallel to McGrath Rd

Figure 14. Contributing catchments

4 Stormwater Quantity – Existing Conditions

East Catchment

Surface drainage from the subject site flows in an easterly direction towards Mantello Drive / Iko Way, which has recently been constructed as part of the Bella Rosa Stage 2 subdivision.

The kinematic wave equation and rational method was used to estimate the peak design flows from the subject site under existing (ie pre-development) conditions. Using the established procedure in Australian Rainfall and Runoff (ARR, 87), the key parameters used in the determination of the rational method flows were:

- Area =1.6 ha
- Time of concentration of 35 minutes (L=140m, S=1/300, n=0.1)
- Werribee Intensity Frequency Duration rainfall
- Runoff coefficient of 0.176 for the 100 year event and 0.122 for the 5 year event
- Scale correction factor for the rational method of 1.43 for 100 year and 1.35 for 5 year (see below)
- Q_{100} = 76 l/s and Q_5 = 24 l/s

Recent research on the estimation of peak flood flows for rural catchments for Engineers Australia has been published in Australian Rainfall and Runoff (ARR) Project 5, Stage 2 Report, dated June 2012. This report recommends that ARR move to a regional regression analysis approach for calculating pre-development peak flood flows. The regional regression analysis approach has been developed by the Bureau of Meteorology, but is not recommended for catchments less than 50 hectares. The report also considered the accuracy of the current ARR method (the Adams Rural Rational Method) and found that this method was appropriate, but suggested adjustment of the results for very small catchments as per the relation shown on Figure 5.3.6 of the ARR 2012 report (see Figure 15).

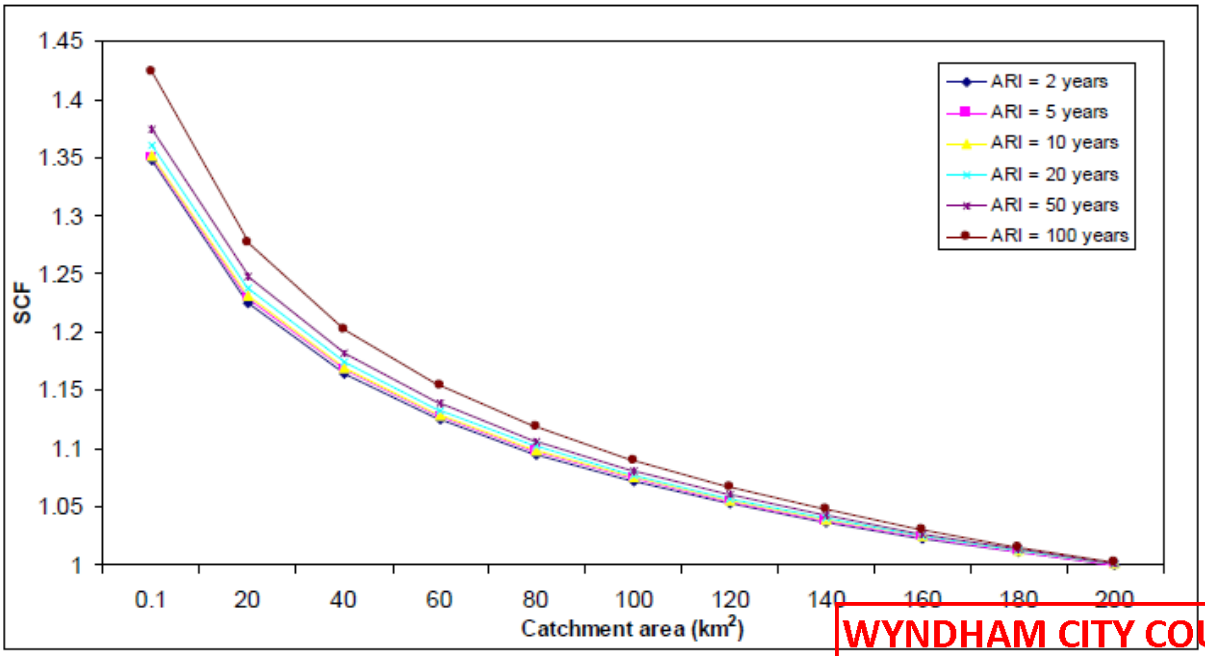

Figure 15 Relationship between scale correction factor (SCF) and catchment area.

Drainage computations undertaken by "The Landplan Group" for the Stage 2 subdivision design have been collated and reviewed. The capacity of the downstream system is constrained and the design of Stages 1 and 2 of Bella Rosa included on-site detention to reduce the discharge in a 5 year ARI event.

In summary, the Stage 2 design has made allowance for the following runoff to enter the drainage system from Stage 3:

- *Minor drainage (5 year ARI)*
    - Connection to pit 15 in Mantello Way
    - Peak 5 year design flow from Stage 3 of 95 l/s
- *Major drainage (100 year ARI)*
    - Overland flows to the south along Iko Way from Stage 3, with a peak 100 year flow of 138 l/s
    - Pipe flow to the east of 95 l/s (as per above)
    - Therefore the allowable peak 100 year design flow from stage 3 is 233 l/s (ie overland flow plus pipe flow)

West Catchment

Surface flows from the west catchment originally drained to the south west corner of the site and across McGrath Road to the Lollypop Creek floodplain system.

However recent flood mitigation works have raised McGrath Road and there is no longer a drainage outlet to the west side of McGrath Road and into the Lollypop Creek system. A site inspection reveals that runoff from the subject site flows along a shallow drainage line on the east side of McGrath Road. A downstream property owner appears to have diverted these flows into a "farm dam" storage (see figure 16). It appears the drainage line remains on the east side of McGrath Road and is somewhat of a terminal system. Figure 17 shows the "farm dam" storage in operation during April 201).

The kinematic wave equation and rational method was used to estimate the peak design flows from the subject site under existing (ie pre-development) conditions. Using the established procedure in Australian Rainfall and Runoff (ARR, 87), the key parameters used in the determination of the rational method flows were:

- Area =1.9 ha
- Time of concentration of 45 minutes (L=200m, S=1/300, n=0.1)
- Werribee Intensity Frequency Duration rainfall
- Runoff coefficient of 0.176 for the 100 year event and 0.122 for the 5 year event
- Scale correction factor for the rational method of 1.43 for 100 year and 1.35 for 5 year (see below)
- Q_{100} = 72 l/s and Q_5 = 25 l/s

Figure 16 – Existing drainage

Figure 17 – *Existing farm dams/storages for the west catchment (April 2011)*

Summary

The existing drainage capacity for both subcatchments is constrained. The key design criteria for the proposed drainage strategy is as follows:

East catchment:

- Allowable 5 year peak design flow of 95 l/s
- Allowable 100 year peak design flow of 233 l/s

West catchment:

- Allowable 5 year peak design flow of 25 l/s
- Allowable 100 year peak design flow of 72 l/s

5 Stormwater Quantity – Proposed Strategy

The proposed internal drainage system should be designed and constructed in accordance with the minor / major drainage system philosophy. For drainage assets within a catchment area of 60 hectares, Council design standards are expected to apply. For drainage assets greater than 60 hectares, Melbourne Water design standards are expected to apply.

The minor drainage system would consist essentially of an underground piped network and should be designed to accommodate a 1 in 5 year average recurrence interval event (ARI). The calculations adopted a 5 year runoff coefficient of 0.637 for the residential area, based on a fraction impervious of 0.7. Based on the catchment areas, all of the pipe network is expected to become the responsibility of Council. As outlined in Section 4, the legal point of discharge is to pit 15 in Mantello Way

The major drainage system will convey the 100 year ARI flows through the study area. This generally consists of the road reserves throughout the development. Generally the flows required to be conveyed in road reserves will be the 100 year flow minus the 5 year flow which will be contained within the minor piped drainage system (except for the localised road pavement catchment in the court bowl head which will collect and pipe the 100 year flows to the east). Based on the road width and slope, and the maximum allowable nature strip cross-fall of 10%, the capacity that can be contained within the main road reserves is shown in Table 5. This capacity has been determined using HEC-RAS based on the Melbourne Water floodway safety criteria for residential streets used as floodways and Council's requirement that 100 year flows must be contained within the road reserve and must not enter any part of private allotments:

- Manning's 'n' = 0.020
- Average velocity time average depth should be less than 0.35
- Average depth should be less than 0.30 m

Table 2. Road capacity flows

Road width	Slope	Road capacity (m^3/s)
16 m	0.5 %	4.5
14 m	0.5 %	3.5

The peak 100 year ARI developed design flows are less than 1 cumec. Therefore based upon the above information all overland flows can be safely contained within the proposed road reserves.

As described in Section 4 of this report, there is a requirement for the subject site to provide detention of flows due to the capacity of downstream infrastructure. The required storage volumes for Stage 3 need to be informed by hydrologic modelling.

5.1 Hydrologic modelling

As described in Section 4, the key design criteria for the proposed drainage strategy is as follows:

East catchment:

- Allowable 5 year peak design flow of 95 l/s
- Allowable 100 year peak design flow of 233 l/s

West catchment:

- Allowable 5 year peak design flow of 25 l/s
- Allowable 100 year peak design flow of 72 l/s

In order to achieve the above criteria, the following option has been adopted:

- Fill and drain all of Stage 3 to the eastern outfall. No discharge of residential allotments or roads to the south western corner of the site (Figure 18). Detention (5yr and 100 year) provided in the eastern catchment only.

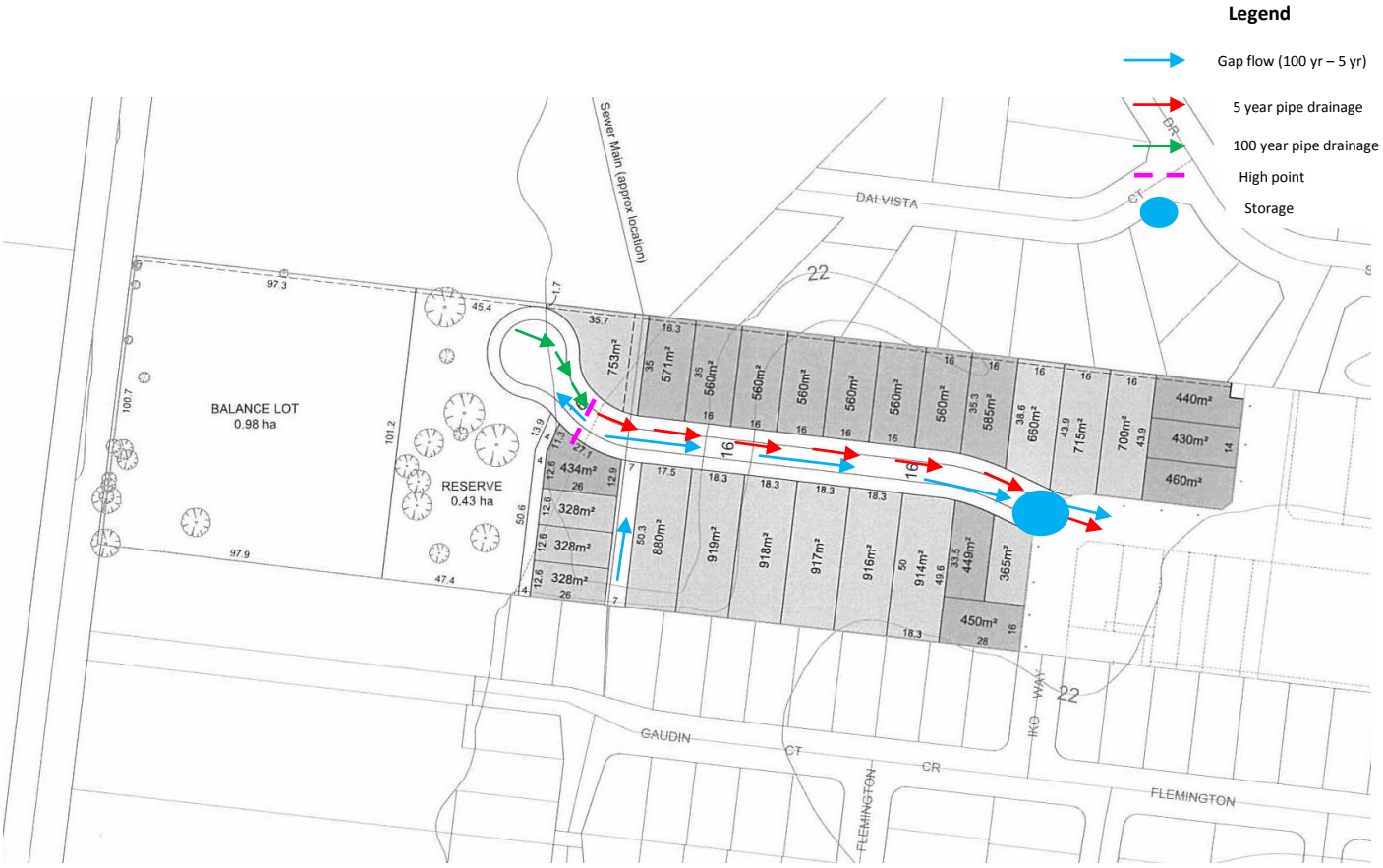

Figure 18 – *Proposed option – eastern outfall only*

In order to determine the required storage for the proposed option requires the use of a hydrologic model. The hydrologic modelling software used in this study is RORBWin version 6.15 (Nathan 2010), a Windows version of the industry accepted RORB program (Laurenson & Mein 1997). RORB is a runoff and stream flow routing program that is used to calculate flood hydrographs from rainfall and catchment data. Specifically the RORB model was used to determine peak flows and the detention storage requirements for the site.

A local scale RORB model was created for subject site (see Figure 19).

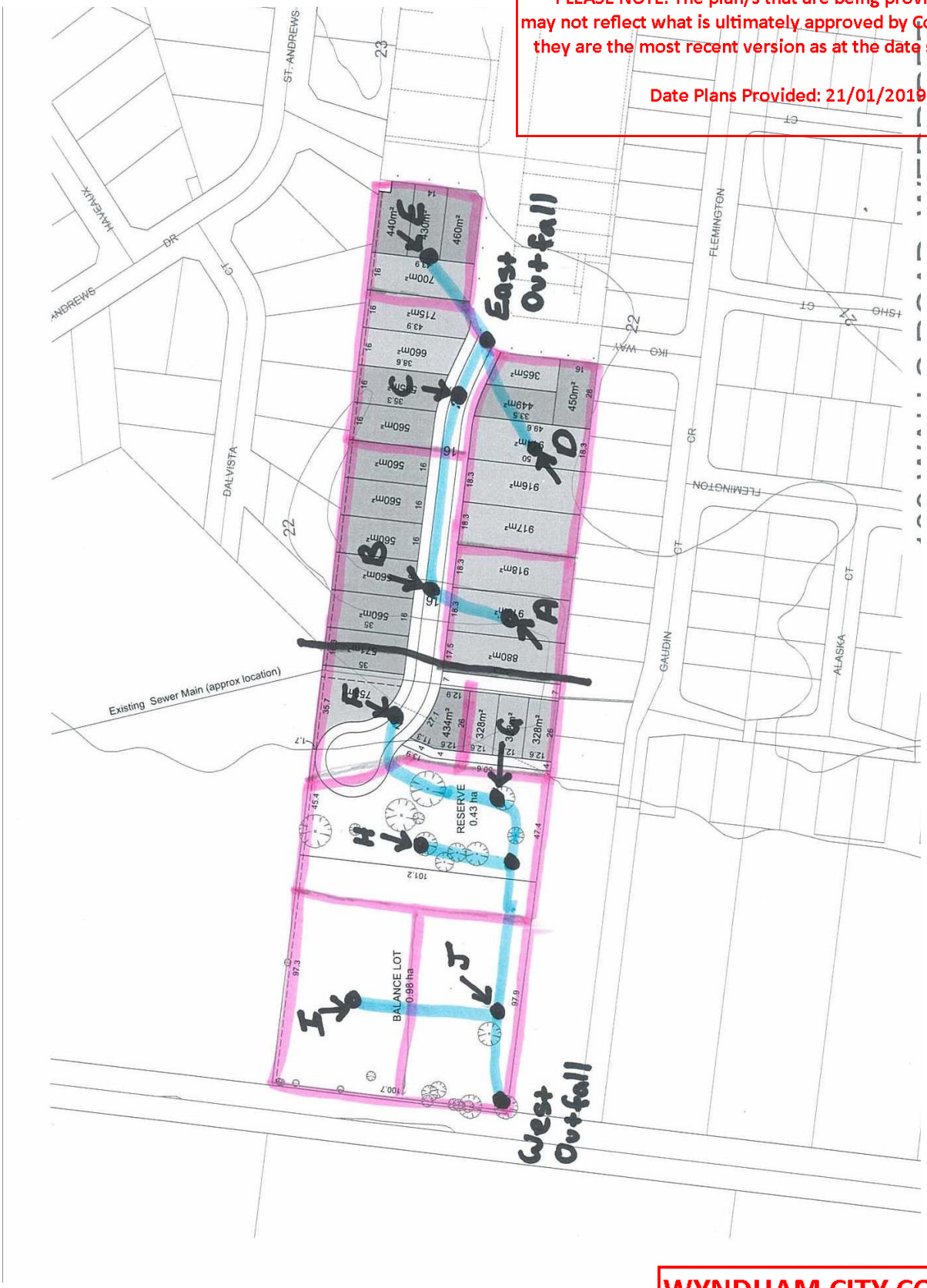

Figure 19 – *RORB catchment plan(note that for the developed catchment scenario, catchments F and G are diverted to the eastern outfall via the internal road reserve)*

The pre-developed RORB model was "calibrated" to the peak flow estimate from the rational method as shown in Table 3.

Table 3. Results of model "calibration"

Location	Pre-developed Q100 Rational Method	Pre-developed Q100 RORB	Pre-developed Q5 Rational Method	Pre-developed Q5 RORB
East outlet	540 l/s	540 l/s	196 l/s	210 l/s
West outlet	520 l/s	520 l/s	190 l/s	180 l/s

The above calibration results were based upon the following RORB parameters.

Table 4: AR&R Design Rainfall Parameters (Werribee)

Parameter	Value
1hr 2yr	17.99
12hr 2yr	3.51
72hr 2yr	0.90
1hr 50yr	37.75
12hr 50yr	7.07
72hr 50yr	1.97
Skew	0.38
F2	4.29
F50	14.90
Zone	1

Table 5. RORB parameters for existing conditions model

	East Catchment	West Catchment
Initial loss	10 mm	10 mm
Continuing Loss:	2.5 mm/hr	2.5 mm/hr
kc	0.14	0.19
m	0.8	0.8

The "pre-developed" RORB model was modified to reflect post development conditions (ie fraction impervious values and reach types were changes in the model). A fraction impervious value of 0.7 was adopted for the residential subdivision.

The RORB model was used to estimate key design flows throughout the catchment and size detention storages. At least 5 subareas exist upstream from the point of interest.

Proposed Option – Eastern outfall only

The hydrologic modelling considered a range of design storms, from 10 minutes duration through to 72 hours, in order to determine the critical duration event with respect to storage.

Whilst the critical duration storm event is 15 minutes to produce the peak flow, the 2 hour storm is the critical duration with respect to requiring the peak storage volume.

- Five year ARI design event
  - Peak outflow from detention system of 89 l/s
  - Peak storage volume required is 155 m3

- 100 year ARI design event
  - Peak outflow from detention system of 206 l/s
  - Peak storage volume required is 402 m3

This requires a detention storage volume of about 402 m3. In previous stages of the estate the required storage has been provided within conventional pit and pipe infrastructure within the road reserves. Detail design by the civil engineers will confirm the configuration of the baffle pit and required pipe sizes to meet the storage requirement. The peak discharge rate from the detention system is 206 l/s, which is less than the allowable peak 100 year flow of 223 l/s.

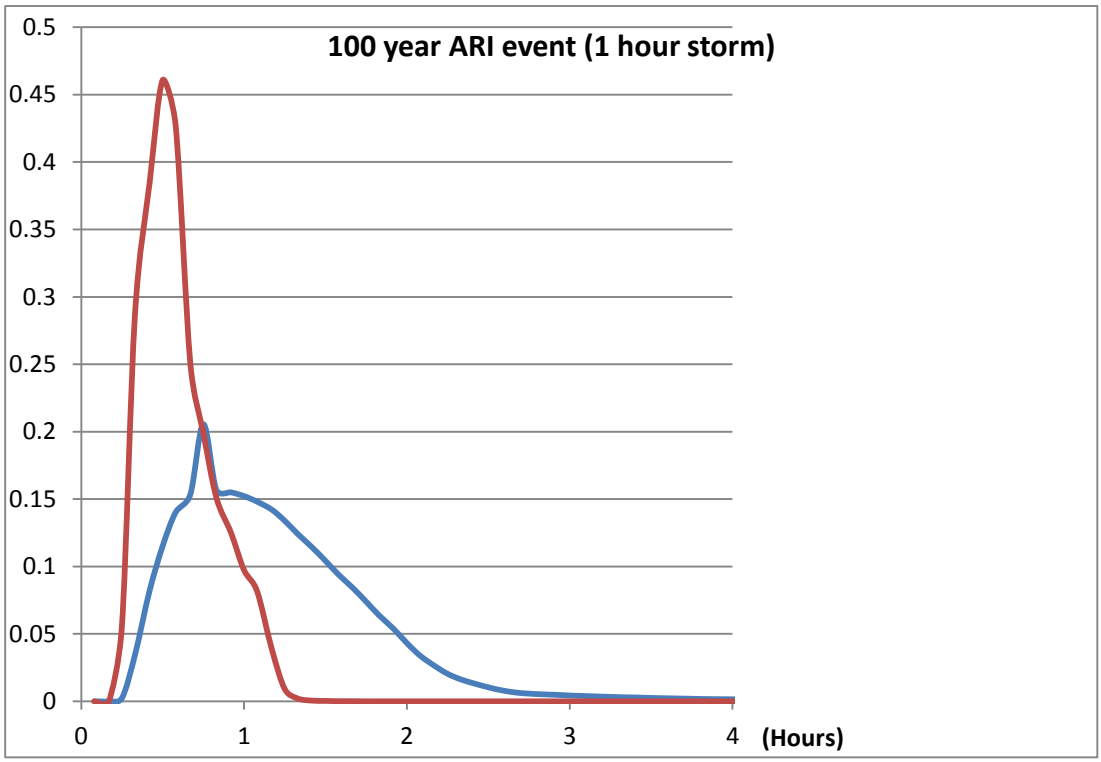

Figure 15 – Hydrograph for the critical storm event for detention

The outlet from the detention system will connect to the existing drain in Mantello Way. The detail design should allow for a maximum of 95 l/s to enter the pipe to the east and a maximum of 138 l/s overland to the south along Iko Way.

6 Proposed stormwater quality treatment system

The stormwater treatment strategy for Melbourne Water's DSS has been prepared based on meeting the best practice pollutant reduction targets:

- 70% removal of the total Gross Pollutant load
- 80% removal of the total Suspended Solids
- 45% removal of the total Nitrogen
- 45% removal of the total Phosphorus

Alluvium are of the understanding that the stormwater quality component of the existing scheme had made provision for the subject site downstream.

As a result there is no requirement to provide stormwater treatment assets within the subject site provided that the developer pays Melbourne Water the stormwater quality component of the DSS contribution rate. Payment of the DSS contribution rate funds the equivalent level of treatment downstream that is needed to reduce pollution load targets from the subject site.

7 Flood level protection

Whilst Melbourne Water has advised that the subject site is no longer subject to flooding from the 100 year ARI event (refer to Section 2), they have proposed a permit condition that requires 600mm freeboard to be achieved. Whilst McGrath Road is above the 100 year ARI flood level it does not provide 600mm of freeboard within the road reserve. As a result the proposed strategy to achieve the 600mm freeboard requirement, whilst minimising the natural ground level of the reserve and residential lots, is as follows:

- Finished surface level on a residential allotment to provide a minimum of 300mm of freeboard above the 100 year ARI flood level
- Finished floor level on a residential allotment to be 600mm above the flood level.
- The minimum floor level on a dwelling to be implemented through a section 173 agreement or equivalent mechanism .

8 Conclusion

This SWMS has proposed management strategies for stormwater quantity and stormwater quality. Through meeting these objectives, this SWMS acts as a critical component of the development servicing strategy and ensures storm water is managed in accordance with Melbourne Water's requirements.

The key issue for the site relates to the limited capacity of the surrounding drainage system. This report has identified a potential option to manage this constraint, which involves detention storage and filling. The 100 year ARI peak storage volume required is 402m^3 with a peak flow discharge of 206 l/s.