Appendix B

Flooding Working Paper

Prepared by Jacobs

(Final/V03) , dated 22 June 2016

New Grafton Correctional Centre

Infrastructure New South Wales

Flooding Working Paper

Final | 3

22 June 2016

New Grafton Correctional Centre

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Jacobs Australia Pty Limited

710 Hunter Street
Newcastle West NSW 2302 Australia
PO Box 2147 Dangar NSW 2309 Australia
T +61 2 4979 2600
F +61 2 4979 2666
www.jacobs.com

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Document history and status

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Final draft	21/03/2016	Final issue	Nicole Bichel	Greg Rogencamp	Rachel Vazey
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Contents

Executive Summary

Infrastructure NSW (INSW) is seeking approval under Division 4.1, Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A) for the concept proposal and Stage 1 Development Application (DA) for the New Grafton Correctional Centre (the Project). The Project is located approximately 12.5 kilometres (km) southeast of Grafton, within the Clarence Valley Local Government Area (LGA) at 313 Avenue Road, Lavadia (the Project Site). The Project would be delivered through a public private partnership (PPP) with a private custodial service provider operating and managing the NGCC from financial close of the procurement for a 20 year period. Infrastructure NSW will coordinate the project through an authorisation order in close consultation with Corrective Services (CSNSW) a division of the Department of Justice.

The Project satisfies the criteria of Schedule 1 of *State Environmental Planning Policy (State and Regional Development) 2011* as the capital investment value of the correctional centre as proposed exceeds $30 million. As such, the Project is declared to be as State Significant Development (SSD) under Division 4.1, Part 4 of the EP&A Act and the Minister for Planning is the consent authority for the application. The Secretary's Environmental Assessment Requirements (SEARs) for the Project were issued by the Department of Planning and Environment (DPE) on 21 December 2015.

It is a requirement of SEAR No. 15, and the *NSW Floodplain Development Manual 2005*, to assess the potential impacts associated with the Project with respect to climate change, increases to rainfall intensity, compatibility with the hydraulic functions and stability of downstream water courses as well as any changes flood behaviour which may impact on the emergency management measures within the locality. This working paper addresses this requirement.

The *Clarence River Flood Study 2013* (CVC, 2016) has been reviewed and deemed satisfactory in determining the flood risk for the Project Site. Therefore, it is considered that no additional modelling is required to determine the effect and impact of the proposed project on flood behaviour.

As the Project is located outside of the probable maximum flood extent determined by the Clarence River Flood Study 2013 (CVC, 2016), it is concluded that the Project has no risk of flooding. Further, due to the size of the site in relation to the Clarence River floodplain, it is also concluded that the Project would not have any effect on the downstream Clarence River floodplain.

The Project Site is unlikely to be affected by sea level rises associated with climate change as well as increases in rainfall intensity.

This working paper has considered the Secretary's Environmental Assessment Requirement (SEAR) No 15 which was to assess any flood risk on site and to consider any relevant provisions of the *NSW Floodplain Development Manual* (2005), including the potential effects of climate change, sea level rise and an increase in rainfall intensity.

1. Introduction

1.1 Background

Infrastructure NSW (INSW) is seeking approval under Division 4.1, Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A) for the concept proposal and Stage 1 Development Application (DA) for the New Grafton Correctional Centre (the Project). The Project would be delivered through a public private partnership (PPP) with a private custodial service provider operating and managing the NGCC from financial close of the procurement for a 20 year period. The primary aim of the PPP is to achieve innovation and efficiencies in the proposed design, construction and delivery of the Project. INSW will coordinate the Project through an authorisation order in close consultation with Corrective Services (CSNSW) a division of the Department of Justice.

The Project satisfies the criteria of Schedule 1 of *State Environmental Planning Policy (State and Regional Development) 2011* as the capital investment value of the correctional centre as proposed exceeds $30 million. As such, the Project is declared to be as State Significant Development (SSD) under Division 4.1, Part 4 of the EP&A Act and the Minister for Planning is the consent authority for the application. The Secretary's Environmental Assessment Requirements (SEARs) for the Project were issued by the Department of Planning and Environment (DPE) on 21 December 2015.

1.2 Locality

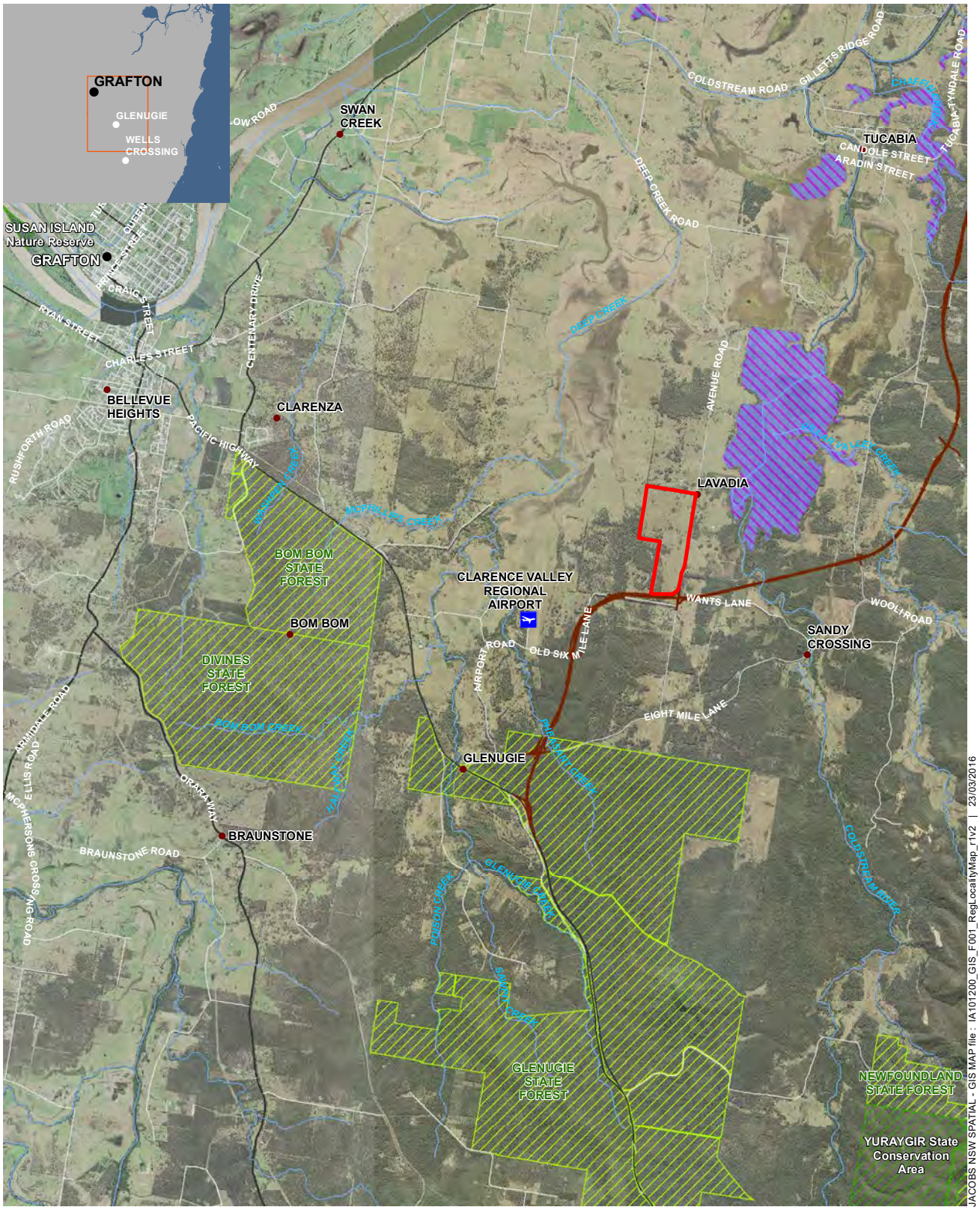
The Project is located approximately 12.5 kilometres southeast of Grafton (refer to **Figure 1-1)** within the Clarence Valley Local Government Area (LGA) at 313 Avenue Road, Lavadia (the Project Site). The Project Site is zoned RU2 - Rural Landscape under the *Clarence Valley Local Environmental Plan 2011.* Development for the purpose of a correctional centre is permissible with consent within the RU2 Rural Landscape zone.

The Project Site includes two properties comprised of Lot 26 DP 751376 and Lot 1 DP 1190399 and is 195 hectares in size (refer to **Figure 1-2**). The site has historically been used for cattle grazing. In July 2015, development consent for a dwelling house in the southeast corner of Lot 1 DP 1190399 was granted by Council and construction of the house is now complete. The site is bounded by Avenue Road (also recognised as Golden Mile Road) to the east, and Old Six Mile Lane to the south. Avenue Road connects to the Pacific Highway via Eight Mile Lane to the south and Old Six Mile Lane connects to the Pacific Highway to the west via passing the Clarence Valley Airport.

It is noted that the upgraded Pacific Highway, to be constructed by Roads and Maritime Services, will become the southern boundary of this site once completed in approximately 2019. As part of that project, Avenue Road will pass over the Pacific Highway and the intersection of Avenue Road and Old Six Mile Road will be upgraded to improve local access, without direct connection to the highway.

1.3 Project description

The New Grafton Correctional Centre (NGCC) requires a staged development application that sets out a concept proposal for a new correctional centre at Grafton that provides maximum and minimum security facilities and includes a total of 1,700 beds. The building will be up to three stories high and approximately 70,000 square metres of floor area. The staged development application also seeks concurrent Stage 1 approval for site clearance and preparatory works. **Table 1-1** provides a summary of the proposal's key components and features.



Legend

- The Project
- Grafton Bypass (proposed)
- SEPP 14 Wetlands
- National Park Reserves
- State Forests

0 2 4 Km

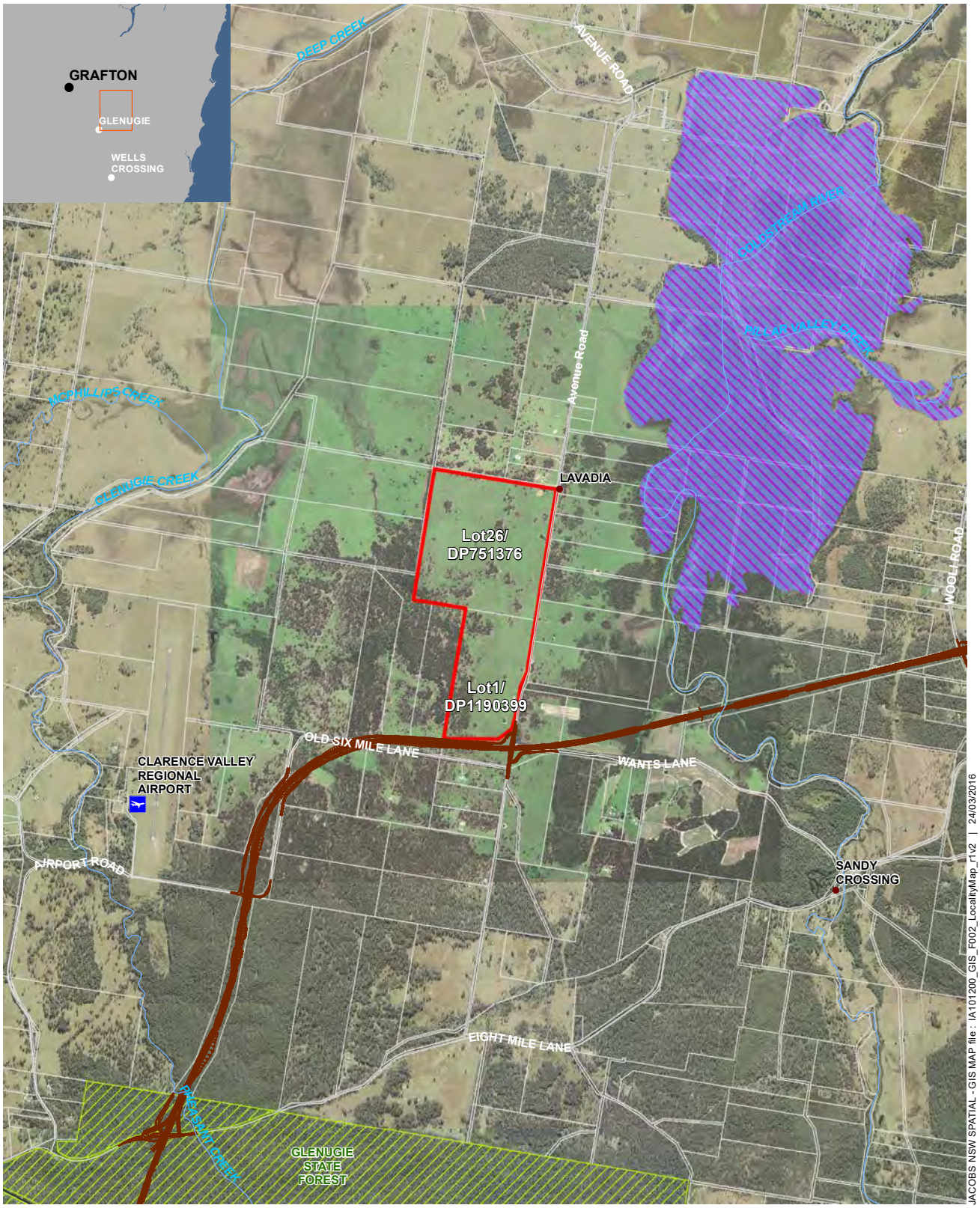
1:125,000 @ A4

N

Data sources

Jacobs 2015
LPI 2015
NSW DPE 2015
RMS 2013 (W2B Alliance)

Figure 1-1 | Regional Locality



Legend

- The Project
- Grafton Bypass (proposed)
- SEPP 14 Wetlands
- State Forests

0 1 2 Km

1:50,000 @ A4

N

Data sources
Jacobs 2015
LPI 2015
NSW DPE 2015
RMS 2013 (W2B Alliance)

Figure 1-2 | The Project

Table 1-1 Key Project Components

Stage	Description
Development summary	The staged SSD application for the site seeks approval for: • A concept approval for the New Grafton Correctional Centre. • First stage site clearance and preparatory works for the Project.
Project Concept Proposal	The NGCC includes a maximum and minimum security correctional centre of 1,700 beds comprised of: • A maximum security section of 1,300 beds that will include: • 1000 beds for male inmates. • 300 beds for female inmates. • A minimum security section that will include: • 400 bed residential accommodation for male inmates. The building envelope including the configuration, location and number of building structures required for the project would not be determined until the detailed design was completed by the PPP as part of the Stage 2 works. Consequently, the stage 2 construction works for the NGCC could occur anywhere within the development zone shown in **Figure 1-3**. The total footprint around both the maximum and minimum correctional centres, including the carpark, is around 45 ha. Some generic features of the Project would include the following: • The building will be no higher than three stories high, including two levels for inmates and staff, with a third level for plant equipment. • The approximate gross floor area will be up to 70,000 square metres. • A six metre high fence or wall will be constructed around the perimeter of the facility, with light and security camera poles up to 10 metres in height. • Store buildings, small ancillary facilities and a central energy plant will be located outside the perimeter walls / fences. • Internal access into and out of the correctional centre from Avenue Road will be provided. • Car parking for approximately 500 car spaces. • Other associated facilities include recreational oval, special accommodation units, health facilities, education and programs areas, administration, workshops, staff amenities, visitor facilities and utilities. • A 100 metre Asset Protection Zone (APZ) zone would be cleared around the correctional centre and associated facilities and car parking area in accordance with the *Rural Fires Act 1997* and requirements of the *Planning for Bush Fire Protection* (PBP; NSW Rural Fire Service [RFS], 2006). • A vegetation buffer would be provided along the northern, eastern and southern boundaries of the Project Site. The buffer would be 50 metres wide along the northern property boundary, 15 metres wide to the east along Avenue Road and 30 metres wide along the southern property boundary. • An internal and external fire access road on the inside and the outside of the perimeter fence of the facility will be constructed to ensure safe operational access for emergency services personnel responding to a bushfire event. • Water, power and communication utilities within the site. • Landscaping of ground cover and /or shrubbery in areas to be defined.

Stage	Description
Stage 1 Site Clearance and Preparatory Works	Stage 1 (early works) DA, includes preparatory work within the cadastral boundaries of Lot 26 DP 751376 and Lot 1 DP 1190399. This would involve: • Vegetation clearance and biodiversity management activities. • Construction of access roads including fire access roads. • Construction of auxiliary facilities such as construction compound, construction staff parking facilities and stockpiles sites. • Provision of water, power and communication utilities within the site. • Demolition of the existing house and sheds within the footprint of the Project. • Bulk excavation works as required. • Landscaping.
Value	The capital investment value for the Project concept proposal is in excess of $30 million
Project Site	• Located at 313 Avenue Road, Lavadia. • Lot 26 DP 751376. • Lot 1 DP 1190399. • Project Site is195 hectares (ha) in size.

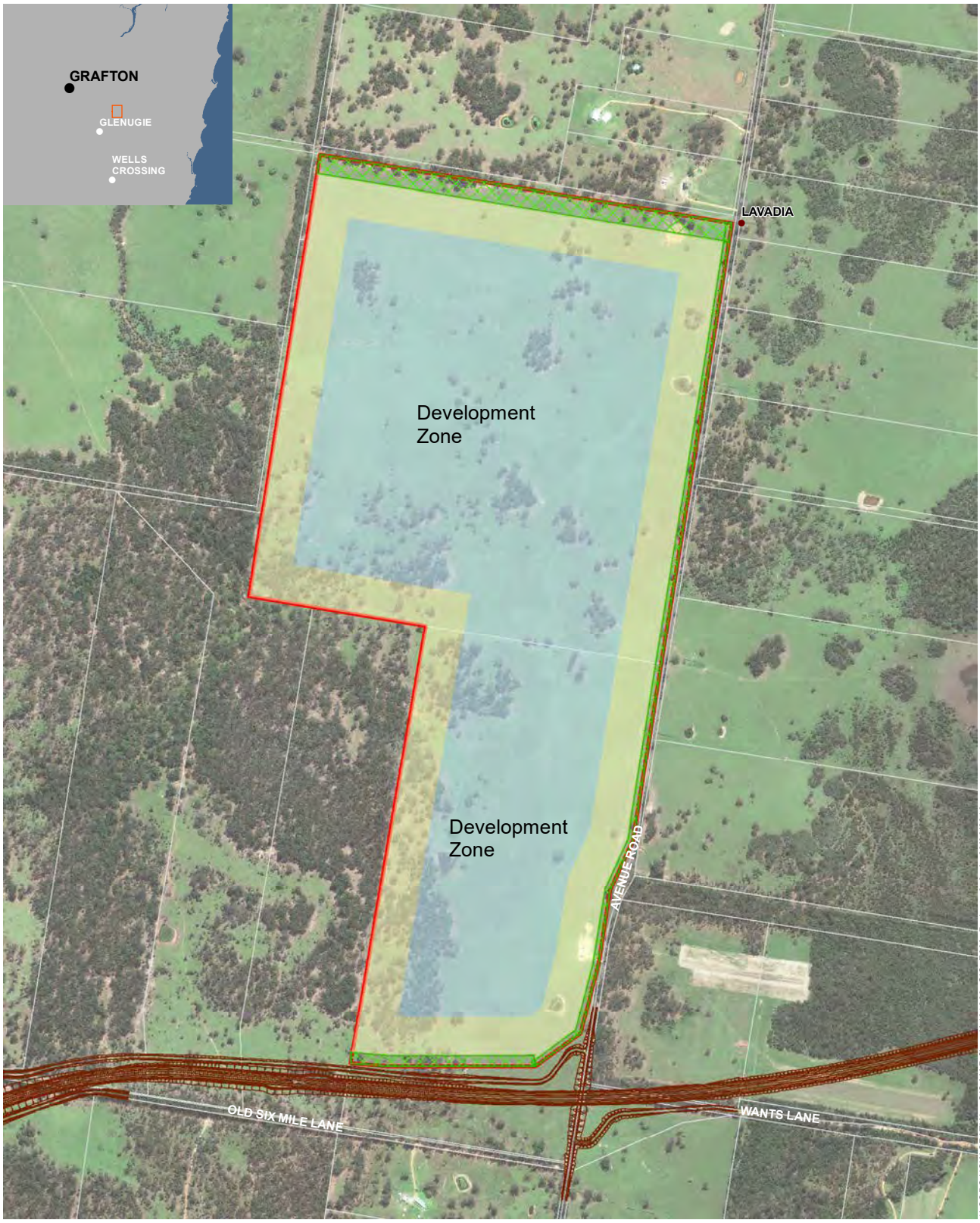
A future Stage 2 SSD application is proposed to be lodged for the construction of the NGCC and would be based on the final design and layout of the facilities as defined through the PPP which would include:

- Construction of the New Grafton Correctional Centre.
- Car parking and associated facilities include guards' tower, recreational oval, special accommodation units, administration, workshops, staff amenities, visitor facilities and utilities.
- Clearing of the 100 metre Asset Protection Zone (APZ) zone around the NGCC.
- Internal and external fire access roads.
- Any additional excavation works as required.
- Provision of water, power and communication utilities to and within the site.

No approval under the subject SSD application is sought for the Stage 2 construction works associated with the New Grafton Correctional Centre and ancillary infrastructure.

The NGCC is part of the government's program of social infrastructure expansion to meet the overall needs of the correctional system in terms of efficiency and growth agendas. Once complete, the NGCC would provide up to 1,700 new beds and up to approximately 600 to 650 full time equivalent positions, which will significantly boost correctional centre capacity and jobs, particularly in regional NSW. Better Prisons provides an opportunity to transform and improve correctional services. Under these reforms, best practices will be identified, shared and replicated across the NSW prison system.

During construction, around 275 to 300 jobs full time equivalent positions would be created for the total Project. Construction is estimated to take 33–36 months. However, as the NGCC may be staged, the construction period may vary according to final design and construction methodology. The capital investment value for the Project concept proposal is in excess of $30 million.



Legend

- The Project
- Landscaping zone
- Asset Protection Zone
- Development Zone
- Grafton Bypass (proposed)

0 250 500 Metres

1:15,000 @ A4

N

Data sources

Jacobs 2015
LPI 2015
NSW DPE 2015
RMS 2013 (W2B Alliance)

Figure 1-3 | The Project

1.4 Project objectives

The objectives of the Project are to:

1) Be a safe and secure correctional centre.
2) Be a humane and ethically managed centre.
3) Help reduce the risk of re-offending through (among other things) preparing inmates for reintegration into the community on release from the CSNSW network.
4) Manage resources effectively and efficiently, enhancing value for money.
5) Utilise effective governance arrangements.
6) Produce strong economic and social benefits to the local Grafton region, the northern NSW region and the broader NSW community.
7) Be a valuable physical asset for the duration of the Operating Phase and beyond.
8) Be operated in such a way as to keep pace with best correctional practice over the term of its operational life.
9) Be operated so that it links with the broader management strategies and operational needs of the CSNSW network.

1.5 Report structure

This working paper addresses flood risk and supports the EIS as required under Division 4.1, Part 4 of the EP&A Act. The structure of the working paper is summarised in **Table 1-2**. SEARs relevant to this working paper and where they have been addressed in the paper are summarised in **Table 1-3**.

Table 1-2 Report structure

Section reference	Section heading	Description
Executive summary	Executive summary	Concise summary of this technical paper and the key findings
1	Introduction • Background • Locality • Proposal description • Proposal objectives • Report structure	Description of the project relevant to potential flood impacts. Provides an overview of the study objectives and structure of technical report.
2	• Assessment requirements	Identifies the key legislation that this technical study must follow.
3	Existing environment and potential impacts of the Project.	Establishes existing flood risk to the project site and identifies key flood risk impacts related to the development.
4	Management of impacts	Identifies key flood risk impacts related to the development.
5	Conclusions and recommendations • Conclusions • Recommendations	Concise statement of key findings of the construction and operational impacts of the Project relating to flood risk.

Table 1-3 Summary of SEARs relevant to this specialist working paper

SEARs	Cross reference
SEAR No 15 - Flooding Assess any flood risk on site and consideration of any relevant provisions of the *NSW Floodplain Development Manual* (2005), including the potential effects of climate change, sea level rise and an increase in rainfall intensity.	Section 3

2. Assessment requirements

2.1 Legislative requirements

The Project concept proposal satisfies the criteria of Clause 16, Schedule 1 of *State Environmental Planning Policy (State and Regional Development) 2011*, as it is for the purposes of a new correctional centre that has a capital investment value of more than $30 million. As such, the Project is declared to be State Significant Development (SDD) in accordance with Section 89C of the EP&A Act. The Minister for Planning, or his delegate, is the consent authority for the SSD under Section 89 D of the EP&A Act.

INSW has also requested that a staged development application is made for Project in accordance with Section 83B and Section 89D of the EP&A Act. The EIS, and this working paper, provides an assessment of the concept proposal and Stage 1 of the Project. Subsequent applications will be made for future stages of the Project.

Under Section 78(8A) of the EP&A Act, an EIS must accompany an application for SSD. The SEARs for the Project were issued by DPE on 21 December 2015 in accordance with Schedule 2 of the *Environmental Planning and Assessment Regulation 2000*. This working paper has been prepared in accordance with the SEARs.

2.1.1 Technical area - flooding

As required by SEAR No. 15, the Project must assess the flood risk and consideration of any relevant provisions of the NSW Floodplain Development Manual (2005), including the potential effects of climate change, sea level rise and an increase in rainfall intensity.

The objective of this assessment is to determine whether the development of the Project would:

- Cause changes to the current downstream floodplain behaviour.
- Whether the flood risk to the Project Site would impact on the operation of the Project, safe evacuation of the facility during a flood event, and the security requirements of the Project.

Ultimately, this assessment needs to determine the direct impact of the Project on the Clarence River Floodplain, which includes the upstream tributaries of Coldstream River.

3. Assessment methodology

3.1 Overview

This specialist assessment is focused on assessing the flooding impacts associated with the construction and operation of the onsite infrastructure within the Project Site boundary (i.e. within the footprint of Lot 26 DP 751376 and Lot 1 DP 1190399).

3.2 Construction

In assessing the impacts of the Project associated with construction, it has been assumed that no works or activities would extend beyond the Project boundary (i.e. all works would remain within the footprint of Lot 26 DP 751376 and Lot 1 DP 1190399).

This assessment has relied upon the hydraulic modelling results provided by Clarence Valley Council (the Council) for the Clarence River floodplain. As this study was recently undertaken (2013) in accordance with the NSW Floodplain Management Manual and adopted by Council, it is considered suitable for this assessment.

3.3 Operations

In assessing the impacts of the Project associated with operations, it has been assumed that no works or activities would extend beyond the Project Site boundary (i.e. all works would remain within the footprint of Lot 26 DP 751376 and Lot 1 DP 1190399).

This assessment has relied upon the hydraulic modelling results provided by Clarence Valley Council for the Clarence River floodplain. As this study was recently undertaken (2013) in accordance with the NSW Floodplain Management Manual and adopted by Council, it is considered suitable for this assessment.

4. Existing environment and potential impacts of the Project

4.1 Flood Assessment and Mapping

4.1.1 Base case flood risk

To meet the requirements of SEAR No. 15, the flood risk to the Project was assessed.

The extent of the probable maximum flood and the flood planning level as determined by the Clarence Valley Council Local Environmental Plan has been provided in **Figure 4-1**. **Figure 4-1** shows the Project Site is not affected by the current floodplain mapping for the Clarence River floodplain. The definition of probable maximum flood and flood planning level is provided in **Section 8**.

It was determined that the Project Site was located above and outside the mapped extent of the probable maximum flood for the Clarence River, as determined by the *Clarence River Flood Study 2013* (CVC, 2016). Therefore, the Project Site is not considered to be located on flood prone/liable land, as defined by the NSW *Floodplain Development Manual 2005*.

It was considered that no additional hydraulic modelling was warranted as part of this assessment. Moreover, it is not possible to model the impact of development on the floodplain as it is outside the floodplain.

4.1.2 Climate change, increase in rainfall intensity, and projected sea level rises

It is a requirement of the *NSW Floodplain Development Manual 2005* to assess the Project Site for the impacts associated with climate change, increases to rainfall intensity, compatibility with the hydraulic functions and stability of downstream water courses as well as any changes to flood behaviour which may impact on the emergency management measures within the locality. This assessment has been provided in the following sections.

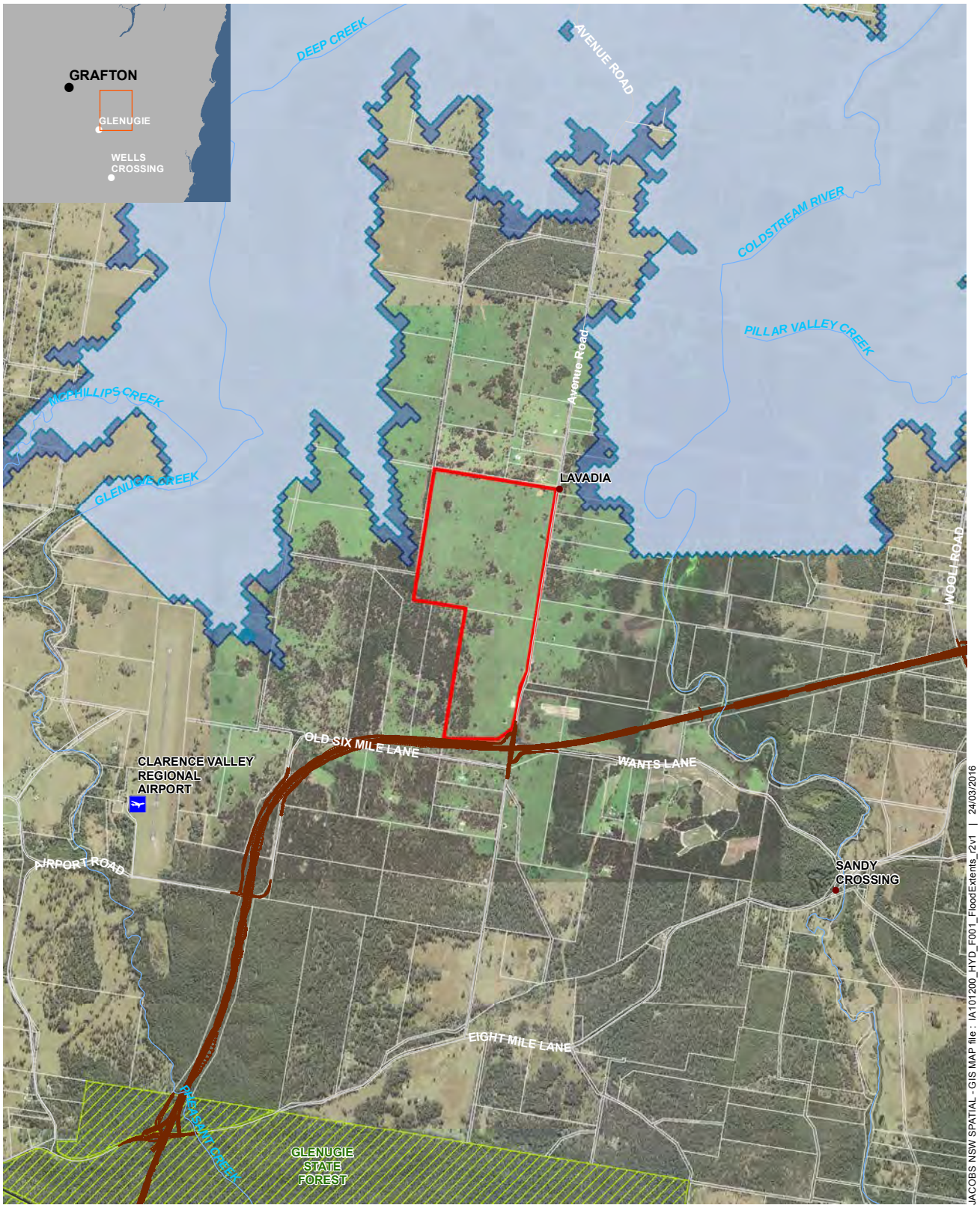
The widely accepted methodology to assess the impact of climate change and increase in rainfall intensity is to assess the impacts to the Project Site for events greater than the flood planning level. Generally the 1:200 AEP (annual exceedance probability) and 1:500 AEP flood events can be used as proxies for the effects of climate change. By assessing events greater than the adopted flood planning level, a complete flood risk profile can be developed for the Project Site.

As defined by the *NSW Floodplain Development Manual*, the probable maximum flood is the largest statistically probable precipitation coupled with the worst flood-producing catchment conditions. By definition, the probable maximum flood cannot not increase in magnitude even under climate change conditions. As the site is located outside the probable maximum flood extent, it is considered that there is no impact to the Project Site or the downstream floodplain due to the effects of climate change and any increase in rainfall intensity.

A rise in sea level has the potential to impact flood behaviour in coastal river systems as a result of higher ocean levels at the river mouth. This would result in higher maximum flood heights for any given flood event in coastal areas. The implication of this is that the Project Site could be affected by the probably maximum flood at some time in the future if sea levels did rise.

The sea level rise estimates for this project were based on the NSW Government's *Sea Level Rise Policy Statement* (DECCW, 2009), which identifies increases of 0.4 metres for 2050 and 0.9 metres for 2100.

The Woolgoolga to Ballina Highway Upgrade EIS determined that a 0.6 metre rise in sea levels would be appropriate for this locality. The sea level rise modelling carried out for the Woolgoolga to Ballina Highway Upgrade EIS showed that a 0.6 metres rise in sea levels would not impact on the smaller upper catchments rivers and creeks crossed by the Pacific Highway Upgrade (which would be adjacent to the Project Site). As the proposed highway upgrade traverses along the southern border of the Project Site, it is considered that predicted sea level rises would not impact on the Project Site.



Legend

- The Project
- Grafton Bypass (proposed)
- State Forests
- Flood planning area (1 in 100)
- Flood prone land (extreme)

0 1 2 Km

1:50,000 @ A4

N

Data sources

Jacobs 2015
LPI 2015
NSW DPE 2015
RMS 2013 (W2B Alliance)

Figure 4-1 | Flood Extent

4.1.3 Compatibility with hydraulic functions

It is important to maintain the hydraulic functions of the floodplain. However, as the Project Site is not located on the floodplain, there are no changes to the hydraulic functions of the floodplain.

4.1.4 Watercourse stability

The Project is located at the top of a catchment which drain to the Coldstream River (to the east) and to tributaries of the Coldstream River (to the west). There are 10 primary discharge locations from the Project Site which have the potential to affect the discharge behaviour from the site. The changes to overland flow behaviour for these primary discharge points are explored in detail in the *Stormwater Management Plan* (Jacobs, 2016).

4.1.5 Emergency management measures

It is not anticipated that the Project would have any impact on the existing community emergency management arrangements for flooding, since the site is not located within the floodplain and, therefore, would not require evacuation. The site is well suited to the development of a sensitive land use, as defined by the *Clarence Valley Local Environmental Plan* (2011), as there is no risk-to-life from flood within the facility.

Although the site is not located within the floodplain, some access roads to the Project Site may be impacted by flood events which could hinder access to the site. Warning times for Clarence River flood events are relatively long (in the order of days). Coldstream River flood events have much shorter warning times (in the order of hours).

It is considered that contingency measures for site access during times of flood would need to be included within the operational plan for the Project.

5. Management and mitigation of impacts

5.1 Relevant construction activities

All construction of onsite infrastructure would occur within the Project Site boundary (i.e. within the footprint of Lot 26 DP 751376 and Lot 1 DP 1190399). As this site is not located on flood liable land, there are no impacts on flooding due to construction and hence no management or mitigation requirements are considered necessary.

5.2 Operation of the facility

All operation activities would occur within the Project Site boundary (i.e. within the footprint of Lot 26 DP 751376 and Lot 1 DP 1190399). As the Project Site is not located on flood liable land, there are no impacts on flooding due to operation of the facility and hence no management or mitigation requirements are considered necessary.

As noted in **Section 4.1.5**, some access roads to the Project Site may be impacted by flood events which could hinder access to the Project Site. It is considered that contingency measures for site access during times of flood would need to be included within the operational plan for the Project.

6. Conclusions

This working paper has assessed the potential for flooding-related impacts with respect to the Project associated with climate change, increases to rainfall intensity, compatibility with the hydraulic functions and stability of downstream water courses as well as any changes flood behaviour which may impact on the emergency management measures within the locality.

The *Clarence River Flood Study 2013* (CVC, 2016) has been reviewed and deemed satisfactory in determining the flood risk for the Project site. Therefore, it is considered that no additional modelling is required to determine the effect and impact of the proposed project on flood behaviour.

As the Project is located outside of the probable maximum flood extent determined by the Clarence River Flood Study 2013 (CVC, 2016), it is concluded that the Project has no risk of flooding and would not have any effect on the downstream Clarence River Floodplain.

The Project Site is unlikely to be affected by sea level rises associated with climate change as well as increases in rainfall intensity.

It is concluded that the Project complies with the requirements of the *NSW Floodplain Development Manual 2005*.

This working paper has considered the SEAR No 15 which was to assess any flood risk on site and to consider any relevant provisions of the *NSW Floodplain Development Manual* (2005), including the potential effects of climate change, sea level rise and an increase in rainfall intensity. In doing this, this report has met the relevant sections of SEAR No 15 as issued for the Project; refer to **Table 1-3**.

7. References

Jacobs, 2016, *New Grafton Correctional Centre Stormwater Management Plan*, Jacobs Australia

New South Wales State Government, 2005, *NSW Floodplain Development Manual* (2005), New South Wales State Government.

New South Wales State Government, 2011, *Clarence Valley Local Environmental Plan 2011 under the Environmental Planning and Assessment Act 1979.*

8. Terms and acronyms used in the document

Acronym	Definition
AEP	Annual exceedance probability – the chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage.
CSNSW	Correctional Services New South Wales
CVC	Clarence Valley Council
DECCW	Department of Environment and Climate Change
DPE	Department of Planning and Environment.
EIS	Environmental Impact Statement.
FPL	The Flood Planning Level (FPL) are the combinations of flood levels derived from significant historical flood events or floods of specific AEPs and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporate in management plans.
INSW	Infrastructure NSW.
LGA	Local government area.
NGCC	New Grafton Correctional Centre.
NSW	New South wales
PMF	The Probably Maximum Flood (PMF) is the largest Flood that could be conceivably occur at a particular location, usually estimated from the probable maximum precipitation, and where applicable, snow melt, coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain.
PPP	Public-private partnership
SEAR	Secretary's Environment Assessment Requirements.
SRD SEPP	*State Environmental Planning Policy (State and Regional Development) 2011.*
SSD	State Significant Development.

Appendix C

MUSIC Link Report

CLARENCE VALLEY COUNCIL

MUSIC-*link* Report

Project Details		Company Details	
Project:	Grafton PPP	**Company:**	Woolacotts Consulting Engineers
Report Export Date:	5/05/2017	**Contact:**	
Catchment Name:	16-26_JG-Grafton MUSIC Model	**Address:**	
Catchment Area:	174.8ha	**Phone:**	
Impervious Area*:	14.19%	**Email:**	
Rainfall Station:	58076 GRAFTON		
Modelling Time-step:	6 Minutes		
Modelling Period:	1/01/1972 - 31/12/1976 11:54:00 PM		
Mean Annual Rainfall:	1160mm		
Evapotranspiration:	1327mm		
MUSIC Version:	6.2.0		
MUSIC-link data Version:	6.20		
Study Area:	North		
Scenario:	CVC Development		

* takes into account area from all source nodes that link to the chosen reporting node, excluding Import Data Nodes

Treatment Train Effectiveness

Node: Receiving Node	Reduction
Flow	1.42%
TSS	90.2%
TP	78.4%
TN	45.3%
GP	100%

Treatment Nodes

Node Type	Number
Swale Node	13
Detention Basin Node	5

Source Nodes

Node Type	Number
Agricultural Source Node	14

Comments

Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Agricultural	C1A	Area Impervious (ha)	None	None	3.326
Agricultural	C1A	Area Pervious (ha)	None	None	4.303
Agricultural	C1A	Total Area (ha)	None	None	7.63
Agricultural	C1B	Area Impervious (ha)	None	None	4.384
Agricultural	C1B	Area Pervious (ha)	None	None	3.945
Agricultural	C1B	Total Area (ha)	None	None	8.33
Agricultural	C1C	Area Impervious (ha)	None	None	1.149
Agricultural	C1C	Area Pervious (ha)	None	None	15.18
Agricultural	C1C	Total Area (ha)	None	None	16.33
Agricultural	C2A	Area Impervious (ha)	None	None	5.937
Agricultural	C2A	Area Pervious (ha)	None	None	34.80
Agricultural	C2A	Total Area (ha)	None	None	40.74
Agricultural	C2B	Area Impervious (ha)	None	None	0.652
Agricultural	C2B	Area Pervious (ha)	None	None	25.28
Agricultural	C2B	Total Area (ha)	None	None	25.94
Agricultural	C3A	Area Impervious (ha)	None	None	2.152
Agricultural	C3A	Area Pervious (ha)	None	None	4.147
Agricultural	C3A	Total Area (ha)	None	None	6.3
Agricultural	C3B	Area Impervious (ha)	None	None	0.482
Agricultural	C3B	Area Pervious (ha)	None	None	11.51
Agricultural	C3B	Total Area (ha)	None	None	12
Agricultural	C4A	Area Impervious (ha)	None	None	1.802
Agricultural	C4A	Area Pervious (ha)	None	None	2.297
Agricultural	C4A	Total Area (ha)	None	None	4.1
Agricultural	C4B	Area Impervious (ha)	None	None	0.369
Agricultural	C4B	Area Pervious (ha)	None	None	0.260
Agricultural	C4B	Total Area (ha)	None	None	0.63
Agricultural	C4C	Area Impervious (ha)	None	None	0
Agricultural	C4C	Area Pervious (ha)	None	None	6.4
Agricultural	C4C	Total Area (ha)	None	None	6.4
Agricultural	C5A	Area Impervious (ha)	None	None	2.131
Agricultural	C5A	Area Pervious (ha)	None	None	2.478
Agricultural	C5A	Total Area (ha)	None	None	4.61
Agricultural	C5B	Area Impervious (ha)	None	None	0.58
Agricultural	C5B	Area Pervious (ha)	None	None	0
Agricultural	C5B	Total Area (ha)	None	None	0.58
Agricultural	C5C	Area Impervious (ha)	None	None	1.330
Agricultural	C5C	Area Pervious (ha)	None	None	39.36
Agricultural	C5C	Total Area (ha)	None	None	40.7
Agricultural	CARPARK 2B	Area Impervious (ha)	None	None	0.51

Only certain parameters are reported when they pass validation

Node Type	Node Name	Parameter	Min	Max	Actual
Agricultural	CARPARK 2B	Area Pervious (ha)	None	None	0
Agricultural	CARPARK 2B	Total Area (ha)	None	None	0.51
Detention	Detention Basin DPW1	% Reuse Demand Met	None	None	0
Detention	Detention Basin DPW2	% Reuse Demand Met	None	None	0
Detention	Detention Basin DPW3	% Reuse Demand Met	None	None	0
Detention	Detention Basin DPW4	% Reuse Demand Met	None	None	0
Detention	Detention Basin DPW5	% Reuse Demand Met	None	None	0
Receiving	Receiving Node	% Load Reduction	None	None	1.42
Receiving	Receiving Node	GP % Load Reduction	90	None	100
Receiving	Receiving Node	TN % Load Reduction	45	None	45.3
Receiving	Receiving Node	TP % Load Reduction	60	None	78.4
Receiving	Receiving Node	TSS % Load Reduction	85	None	90.2
Swale	NAT. SWALE C1	Bed slope	0.01	0.05	0.0157
Swale	NAT. SWALE C2	Bed slope	0.01	0.05	0.023
Swale	NAT. SWALE C3B	Bed slope	0.01	0.05	0.02
Swale	NAT. SWALE C5C	Bed slope	0.01	0.05	0.0111
Swale	SWALE 2BC	Bed slope	0.01	0.05	0.05
Swale	SWALE C1A	Bed slope	0.01	0.05	0.017
Swale	SWALE C2A	Bed slope	0.01	0.05	0.023
Swale	SWALE C3A	Bed slope	0.01	0.05	0.018
Swale	SWALE C4A	Bed slope	0.01	0.05	0.024
Swale	SWALE C4B	Bed slope	0.01	0.05	0.024
Swale	SWALE C4C	Bed slope	0.01	0.05	0.05
Swale	SWALE C5A	Bed slope	0.01	0.05	0.018
Swale	SWALE C5B	Bed slope	0.01	0.05	0.018

Only certain parameters are reported when they pass validation

Appendix D

Calculations

GRAFTON – 16-26

Onsite Detention (All Basins)

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Job GRAFTON Date 24/4/17

ON-SITE DETENTION CALCS

REF: D10 - Handbook for stormwater drainage design

OSD: Post developed back to pre-developed

ARI's: 5, 10, 20, 100 yr

DURATION: 10min → 3hrs

XP_RAFTS

CONFIGURATION:

Global databases:

a) Initial / continuing losses

Pervious = 10 mm/hr Initial
2.5 mm/hr Continuous

Impervious = 2 mm/hr Initial
0 mm/hr Continuous

b) IFD Geffluent

GRAFTON

BOM: Lat = -29.700(S)
Long = 153.075 (E)

f_2 = 4.38
f_{50} = 16.64
Skew: 0.07

2yr 1hr =	41.1 mm/hr	50yr 1hr =	80.5 mm/hr
2yr 12hr =	8.12 mm/hr	50yr 12hr =	16.5 mm/hr
2yr 72hr =	2.63 mm/hr	50yr 72hr =	5.69 mm/hr

Designed Job no. Sheet no.

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PRE - DEVELOPED (100% PERVIOUS)

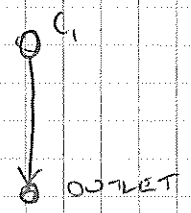
* CATCHMENT 1 (BASIN S1) → DPWS

A_T = 306518 m² = 30.65 ha

A_{IMP} = 0 m²

Slope = 2.7%

n = 0.025



RESULTS:

DUR (MINS)	Q_5 (m³/s)	Q_{10} (m³/s)	Q_{20} (m³/s)	Q_{100} (m³/s)
10	0.924	1.260	1.705	2.963
20	2.292	2.809	3.584	6.003
30	3.042	3.863	4.968	7.610
60	4.313	5.265	6.588	9.406
120	4.444	5.498	6.831	9.611
180	3.525	4.245	5.423	7.666
MAX (L/S)	4444	5498	6831	9611

= PSD

Designed JG Job no. 16-26 Sheet no.

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Job GRAFTON Date 29/4/17

* CATCHMENT 2 (PRE-DEVELOPED)

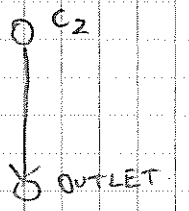
(BASIN S2) → DPW1

A_T = 408 224 m^2 = 40.82 ha

A_{imp} = 0 m^2

Slope = 2.8%

n = 0.025



RESULTS

DUR (mins)	Q_5 (m^3/s)	Q_{10} (m^3/s)	Q_{20} (m^3/s)	Q_{100} (m^3/s)
10	1.143	1.550	2.224	3.680
20	2.766	3.414	4.543	7.470
30	3.911	4.912	6.270	9.676
60	5.529	6.769	8.477	12.204
120	5.635	6.967	8.826	12.314
180	4.512	5.519	6.944	9.767
MAX (L/s)	5635	6967	8826	12314

← PSD

Designed JH Job no. 16-26 Sheet no.

* CATCHMENT 3 (PRE-DEVELOPED)

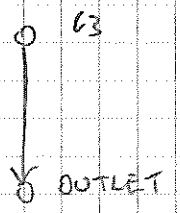
(BASIN 53) → DPW2

A_T = 192 545 m² = 19.25 ha

A_{imp} = 0 m²

Slope = 2.6%

n = 0.025



RESULTS

DUR (mins)	Q_5 (m³/s)	Q_{10} (m³/s)	Q_{20} (m³/s)	Q_{100} (m³/s)
10	0.678	0.886	1.232	2.221
20	1.598	2.065	2.611	4.124
30	2.194	2.657	3.420	5.140
60	2.932	3.526	4.403	6.223
120	3.023	3.721	4.566	6.567
180	2.417	2.926	3.633	5.118
MAX (L/s)	3023	3721	4566	6567

= PSD

Job GRAFTON Date 24/4/17

* CATCHMENT 4 (PRE-DEVELOPED)

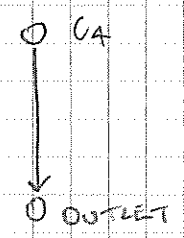
(BASIN 54) → DPW 3

AT = 111450 m^2 = 11.15 ha

AIMP = 0 m^2

Slope ≈ 2.3%

n = 0.025



RESULTS:

Dur (mins)	Q_5 (m^3/s)	Q_{10} (m^3/s)	Q_{20} (m^3/s)	Q_{100} (m^3/s)
10	0.415	0.592	0.783	1.326
20	0.973	1.285	1.647	2.600
30	1.344	1.674	2.105	3.129
60	1.842	2.205	2.656	3.734
120	1.901	2.286	2.862	3.904
180	1.466	1.831	2.256	3.075
MAX (L/S)	1901	2286	2862	3904

= PSD

* CATCHMENT 5 (PRE-DEVELOPED)

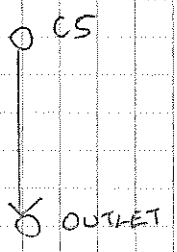
(BASIN 55) → DPW4

A_T = 463010 m² = 46.30 ha

A_{IMP} = 0 m²

Slope ≈ 2.5%

n = 0.025



RESULTS

DUR (mins)	Q_5 (m³/s)	Q_{10} (m³/s)	Q_{20} (m³/s)	Q_{100} (m³/s)
10	1.146	1.555	2.231	3.697
20	2.781	3.440	4.594	7.598
30	4.024	5.061	6.468	9.986
60	5.782	7.164	8.940	12.953
120	5.923	7.253	9.191	13.093
180	4.985	5.866	7.333	10.276
MAX (L/s)	5923	7253	9.191	13.093

= PSD

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* POST DEVELOPED (CATCHMENT SUMMARY)

* CATCHMENT 1

A_T = 306518 m^2 = 30.65 ha

A_{imp} = 93324 m^2 = 9.33 ha

Slope = 2.7 %

* CATCHMENT 2

A_T = 408224 m^2 = 40.82 ha

A_{imp} = 74316 m^2 = 7.43 ha

Slope = 2.8 %

* CATCHMENT 3

A_T = 192545 m^2 = 19.25 ha

A_{imp} = 34784 m^2 = 3.48 ha, Slope = 2.6 %

* CATCHMENT 4

A_T = 111450 m^2 = 11.15 ha

A_{imp} = 21197 m^2 = 2.12 ha, Slope = 2.3 %

* CATCHMENT 5

A_T = 463010 m^2 = 46.30 ha

A_{imp} = 32960 m^2 = 3.30 ha

Slope = 2 %

Designed JG Job no. 16-26 Sheet no.

POST - DEVELOPED

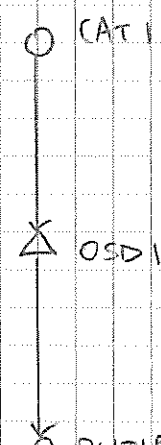
* CATCHMENT 1 (Post-Developed) → DPWS

A_T = 306518 m² = 30.65 ha

A_{imp} = 93 324 m² = 9.33 ha ; n = 0.015

$A_{perv.}$ = 21.32 ha ; n = 0.025

Slope = 2.7%



ORIGINAL PROPOSED OSD

x (RL)	x (m³)
1	0
2.2	9000

Spillway = RL 2.10
width = 70m
(x 4) 375 ϕ outlets at base

Peak depth = 2.27 RL → 1.27m
(100yr ARI)

RESULTS:

DUR (mins)	Q_5 (m³/s)	Q_{10} (m³/s)	Q_{20} (m³/s)	Q_{100} (m³/s)	
10	0.492	0.596	0.676	0.849	
20	0.751	0.830	0.922	2.916	
30	0.873	0.962	1.899	6753	
60	2.025	3.703	5.813	9.472	
120	3.108	4.326	5.773	8.777	
180	2.535	3.729	4.608	6.979	
MAX (L/s)	3108	4326	5813	9472	< PSD ∴ OK
PSD (L/s)	4444	5498	6831	9611	

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* CATCHMENT 2 (Post Developed). → DPW1

A_T = 408224 m² = 40.82 ha

A_{imp} = 74316 m² = 7.43 ha ; n = 0.015

$A_{perv.}$ = 33.39 ha ; n = 0.025

slope = 2.8%

CAT 2 (POST)

OSD 2 = DPW1

OUTLET

ORIGINAL PROPOSED OSD.

x (RL)	x (m³)
1	0
2.2	11700

Spilling = RL 2.10
width = 75m
(x4) 375 ø outlets at base

Peak depth = 2.29RL → 1.29m
(100 ARI)

RESULTS:

DUR (mins)	Q_5 (m³/s)	Q_{10} (m³/s)	Q_{20} (m³/s)	Q_{100} (m³/s)	
10	0.469	0.598	0.673	0.848	
20	0.754	0.830	0.925	3.353	
30	0.882	0.974	2.235	6.789	
60	2.994	4.365	6.976	11.396	
120	3.720	5.381	7.350	11.681	
180	3.370	4.653	6.001	8.646	
MAX (L/s)	3720	5381	7350	11681	< PSD ∴ OK
PSD (L/s)	5635	6967	8826	12314	

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Job GRAFTON Date 26/4/17

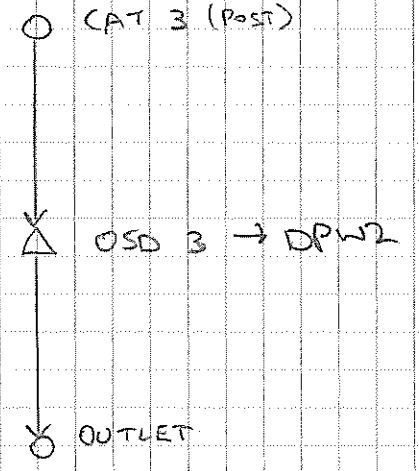
* CATCHMENT 3 (Post Developed) → DPW2

A_T = 192 545 m² = 19.25 ha

A_{Imp} = 34794 m² = 3.48 ha ; n = 0.015

A_{perv} = 15.77 ha ; n = 0.025

Slope = 2.6 %



ORIGINAL PROPOSED OSD:

z (RL)	z (m³)
1	0
2.2	5500

Spillway = RL 2.10
width = 40m
(x3) 375 ø outlets at base

Peak depth = (100 ARI)

RESULTS

DUR (mins)	Q_5 (m³/s)	Q_{10} (m³/s)	Q_{20} (m³/s)	Q_{100} (m³/s)	
10	0.316	0.411	0.484	0.613	
20	0.542	0.601	0.674	1.888	
30	0.633	0.696	0.979	3.896	
60	1.009	2.261	3.515	6.263	
120	1.596	2.732	3.586	6302	
180	1.437	2.104	2.819	4.458	
MAX (L/S)	1596	2732	3586	6302	< PSD - OK.
PSD (L/S)	3623	3721	4566	6567	

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Job GRAFTON Date 26/9/17

* CATCHMENT 4 (Post-Developed) → DPW 3

A_T = 11.150 m^2 = 11.15 ha

A_{Imp} = 21197 m^2 = 2.12 ha ; n = 0.015

$A_{Perv.}$ = 90253 m^2 = 9.03 ha ; n = 0.025

Slope = 2.3%

CAT 4 (POST)

OSD 4 → DPW 3

OUTLET

ORIGINAL PROPOSED OSD:

x (RL)	x (m^3)
1	0
2.2	4000

Spillway = RL 2.10
width = 35m
(x3) 375Ø outlets at base

Peak depth = 2.22 RL = 1.22m
(100 ARI)

RESULTS:

DUR (mins)	Q_5 (m^3/s)	Q_{10} (m^3/s)	Q_{20} (m^3/s)	Q_{100} (m^3/s)
10	0.210	0.280	0.383	0.514
20	0.451	0.505	0.571	0.706
30	0.535	0.588	0.657	1.267
60	0.654	0.723	1.202	3.378
120	0.693	0.762	1.647	3.182
180	0.664	0.738	1.232	2.111
MAX (L/s)	693	762	1647	3378
PSD (L/s)	1901	2286	2862	3904

< PSD - OK

Designed JG Job no. 16-26 Sheet no.

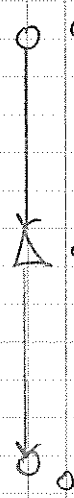
* CATCHMENT 5 (Post - Developed) → DPW4

A_T = 463010 m² = 46.30 ha

$A_{imp.}$ = 32960 m² = 3.30 ha ; n = 0.015

$A_{perv.}$ = 430050 m² = 43.0 ha ; n = 0.025

Slope = 2.0 %



ORIGINAL PROPOSED OSD:

x (RL)	x (m³)
1	0
2.2	4000 5600 m³

Spillway = RL 2.10
Width = 35m
(V3) 375 Ø outlet at base

Peak depth = 2.42 - 1 = 1.42 m (100 ARI)

RESULTS:

DUR (MINS)	Q_5 (m³/s)	Q_{10} (m³/s)	Q_{20} (m³/s)	Q_{100} (m³/s)	
10	0.511	0.596	0.687	2.349	
20	1.049	2.132	3.205	5.972	
30	2.640	3.828	5.289	8.917	
60	5.039	6.288	8.117	11.535	
120	5.483	6.603	8.068	11.512	
180	4.844	5.667	6.829	9.251	
MAX (L/s)	5483	6603	8117	11535	< PSD : OK.
PSD (L/s)	5923	7253	9191	13093	

GRAFTON – 16-26

Sediment Basin Design

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SEDIMENT BASIN DESIGN SUMMARY

BASIN	CATCHMENT (m^2)	BASIN VOLUME (Total m^3)	
S1	306518	8723	MINIMUM REQUIRED CAPACITY
S2	408224	11616	
S3	192545	5478	
S4	105321	3173	
S5	131057	3731	

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* SEDIMENT BASIN SIZING

BASIN S1

A_T = 306 518 m²
= 30.65 ha

Settling Zone Vol. = 10 × C_v × A × R (y%ile, 5day).

R_{5day}, 85 %ile = 37.2mm (GRAFTON) ← due to longer term exposure.

Ref: Table 6.3(a) Blue Book.

C_v = volumetric runoff coefficient

Class C = moderate to high runoff potential
= 0.51

Ref: Appendix F.3, Table F2 Blue Book

∴ Settling Zone volume = 10 × 0.51 × 30.65 × 37.2
= 5815 m³

∴ Storage Zone volume = $\frac{5815}{2}$ = 2908 m³

Total volume of Sediment Basin (S1) = 5815 + 2908
= 8723 m²

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BASIN S2:

A_T = 408224 m²
= 40.82 ha

Settling Zone Volume = 10 × 0.51 × 40.82 × 37.2
= 7744 m³

Storage Zone Volume = $\frac{7744}{2}$ = 3872 m³

Total volume of Sediment Basin (S2) = 7744 + 3872
= 11616 m³

BASIN S3:

A_T = 192545 m²
= 19.25 ha

Settling Zone Volume = 10 × 0.51 × 19.25 × 37.2
= 3652 m³

Storage Zone Volume = $\frac{3652}{2}$ = 1826 m³

Total volume of sediment basin (S3) = 3652 + 1826
= 5478 m³

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BASIN S4:

$A_T = 111450\ m^2$
$= 11.15\ ha$

Settling Zone volume $= 10 \times 0.51 \times 11.15 \times 37.2$
$= 2115\ m^3$

Storage Zone volume $= \frac{2115}{2} = 1058\ m^3$

Total volume of sediment basin (S4) $= 2115 + 1058$
$= 3173\ m^3$

BASIN S5:

$A_T = 131057\ m^2$
$= 13.11\ ha$

Settling Zone volume $= 10 \times 0.51 \times 13.11 \times 37.2$
$= 2487\ m^3$

Storage Zone volume $= \frac{2487}{2} = 1244\ m^3$

Total volume of sediment basin (S5) $= 2487 + 1244$
$= 3731\ m^3$

Designed JG Job no. 16-26 Sheet no.

J Worksheets

J.1 The Standard Worksheet

Note: These "Standard Calculation" spreadsheets relate only to low erosion hazard lands as identified in figure 4.6 where the designer chooses to not use the RUSLE to size sediment basins. The more "Detailed Calculation" spreodsheets should be used on high erosion hazard lands as identified by figure 4.6 or where the designer chooses to run the RUSLE in calculations.

1. Site Data Sheet

Site name: GRAFTON PPP.

Site location: Lavadia NSW 2462

Precinct:

Description of site:

Site Area	Site						Remarks
	S1	S2	S3	S4	S5		
Total catchment area (ha)	30.65	40.82	19.25	10.53	13.11		
Disturbed catchment area (ha)							

Soil analysis

Soil landscape	Clays						DNR mapping (if relevant)
Soil Texture Group							Sections 6.3.3(c), (d) and (e)

Rainfall data

Design rainfall depth (days)	5	5	5	5	5		See Sections 6.3.4 (d) and (e)
Design rainfall depth (percentile)	85th	85th	85th	85th	85th		See Sections 6.3.4 (f) and (g)
x-day, y-percentile rainfall event	37.2	37.2	37.2	37.2	37.2		See Section 6.3.4 (h)
Rainfall intensity: 2-year, 6-hour storm = S	12.7	12.7	12.7	12.7	12.7		See IFD chart for the site
Rainfall erosivity (R-factor)	3482	3482	3482	3482	3482		Automatic calculation from above data

Comments

$R = 164.74 \times (1.1177)^{S} \times S^{0.6444}$

2. Storm Flow Calculations

Peak flow is given by the Rational Formula:

$$Q_y = 0.00278 \times C_{10} \times F_Y \times I_{y,\,tc} \times A$$

where:

- Q_y is peak flow rate (m3/sec) of average recurrence interval (ARI) of "Y" years
- C_{10} is the runoff coefficient (dimensionless) for ARI of 10 years. Rural runoff coefficients are given in Volume 2, figure 5 of Pilgrim (1998), while urban runoff coefficients are given in Volume 1, Book VIII, figure 1.13 of Pilgrim (1998) and construction runoff coefficients are given in Appendix F.
- F_y is a frequency factor for "Y" years. Rural values are given in Volume 1, Book IV, Table 1.1 of Pilgrim (1998) while urban coefficients are given in Volume 1, Book VIII, Table 1.6 of Pilgrim (1998)
- A is the catchment area in hectares (ha)
- $I_{y,\,tc}$ is the average rainfall intensity (mm/hr) for an ARI of "Y" years and a design duration of "tc" (minutes or hours)

Time of concentration (tc) = $0.76 \times (A/100)^{0.38}$ hrs (Volume 1, Book IV of Pilgrim, 1998)

Note: For urban catchments the time of concentration should be determined by more precise calculations or reduced by a factor of 50 percent.

Peak flow calculations, 1

Site	A (ha)	tc (mins)	Rainfall intensity, 1, mm/hr						C_{10}
			$1_{yr,\,tc}$	$5_{yr,\,tc}$	$10_{yr,\,tc}$	$20_{yr,\,tc}$	$50_{yr,\,tc}$	$100_{yr,\,tc}$	

Peak flow calculations, 2

ARI yrs	Frequency factor (Fy)	Peak flows						Comment
		(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	

3. Volume of Sediment Basins: *Type C* Soils

Basin volume = settling zone volume + sediment storage volume

Settling Zone Volume

The settling zone volume for *Type C* soils is calculated to provide capacity to allow the design particle (e.g. 0.02 mm in diameter) to settle in the peak flow expected from the design storm (e.g. 0.25-year ARI). The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle. Peak flow/discharge for the 0.25-year, ARI storm is given by the Rational Formula:

$$Q_{Ic,\,0.25} = 0.5 \times [0.00278 \times C_{10} \times F_y \times I_{1yr,\,tc} \times A\,]\ (m^3/sec)$$

where:

$Q_{Ic,0.25}$	=	flow rate (m^3/sec) for the 0.25 ARI storm event
C_{10}	=	runoff coefficient (dimensionless for ARI of 10 years)
F_y	=	frequency factor for 1 year ARI storm
A	=	area of catchment in hectares (ha)

Basin surface area (A) = area factor x $Q_{Ic,\,0.25}$ m^2

Particle settling velocities under ideal conditions (Section 6.3.5(e))

Particle Size	Area Factor
0.100	170
0.050	635
0.020	4100

Volume of settling zone = basin surface area x depth (Section 6.3.5(e)(ii))

Sediment Storage Zone Volume

In the standard calculation, the sediment storage zone is 100 percent of the setting zone. However, designers can work to capture the 2-month soil loss as calculated by the RUSLE (Section 6.3.5(e)(iv)), in which case the "Detailed Calculation" spreadsheets should be used.

Total Basin Volume SITE IS A CLAY SITE

Site	$Q_{Ic,\,0.25}$ (m^3/s)	Area factor	Basin surface area (m^2)	Depth of settling zone (m)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)	Basin shape		
								L:W Ratio	Length (m)	Width (m)
		4100								
		4100								
		4100								
		4100								
		4100								
		4100								

4. Volume of Sediment Basins, *Type D* and *Type F* Soils

Basin volume = settling zone volume + sediment storage zone volume

Settling Zone Volume

The settling zone volume for *Type F* and *Type D* soils is calculated to provide capacity to contain all runoff expected from up to the y percentile rainfall event. The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle and can be determined by the following equation:

$$V = 10 \times C_v \times A \times R_{y\text{-}\%ile,\ x\text{-}day}\ (m^3)$$

where:

- 10 = a unit conversion factor
- C_v = the volumetric runoff coefficient defined as that portion of rainfall that runs off as stormwater over the x-day period
- R = is the x-day total rainfall depth (mm) that is not exceeded in y percent of rainfall events. (See Sections 6.3.4(d), (e), (f), (g) and (h)).
- A = total catchment area (ha)

Sediment Storage Zone Volume

In the standard calculation, the sediment storage zone is 50 percent of the setting zone. However, designers can work to capture the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(ii)), in which case the "Detailed Calculation" spreadsheets should be used.

5 day, 85th %ile

50% of Settling zone

Total Basin Volume

Site	C_v	R x-doy y-%ile	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)
S1	0·51	37·2	30·65	5815	2908	8723
S2	0·51	37·2	40·82	7744	3872	11616
S3	0·51	37·2	19·25	3652	1826	5478
S4	0·51	37·2	10·53	1998	999	2997
S5	0·51	37·2	12·11	2487	1244	3731

For determining C_v, take soil hydraulic group as 'C' = moderate to high runoff.

$\therefore C_v = 0{\cdot}51$

REF: App F·3, Table F2 Blue Book.

GRAFTON – 16-26

MUSIC Model and Water Quality

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* MUSIC MODEL

→ Model Setup = MUSIC-link (Clarence Valley North)

Rainfall & Evapotranspiration data pre-determined in MUSIC-link setup model.

* BASIN DPW4

SOURCE NODE

CSA = (NODE) Internal — A1 = 10300 + 7651 + 7601 + 8990 + 5695 + 4425 + ... 1478 = 46140 m²

Amp = 4757 + 3950 + 3695 + 3795 + 3065 + 1645 + ... 210 = 21117 m²

CSB (Perm. RD) — A1 = 5790 m²
Amp = 5790 m²

CSC (Perm Remainder) — A1 = 407031 m²

Amp = 11439 m²

TREATMENT NODE

CSA → SWALE 1 : Length = MIN 66.0 m
Slope = 1.8%
Base width = 0m
Top width = 4.8
Depth = 0.6m
Veg Height = 0.10
Exfil rate = 36 mm/hr (Sandy clay).

CSB → SWALE 2 = SWALE 1

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CSA + CSB + CSC → BASIN DPW4

SURFACE AREA ≈ 4600m²

permanent pool vol. = 3731 m³

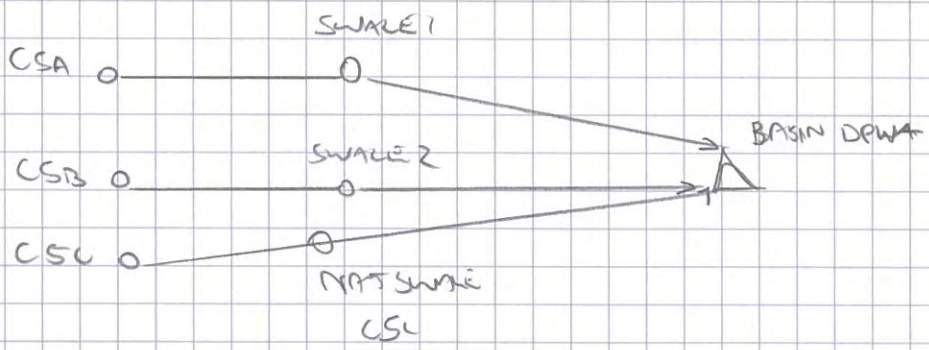
Extended det depth: (5600 − 3731) = 1869 m³ (esp vol.)

∴ d = 1869 / 4600 = 0.4m

weir width = 35m

Outlet equiv pipe Dia = √3 − 375 ≈ 600 Ø

SUMMARY:



NAT SWALE: CSC: L = 990m
slope = 1:11
bed width = 20m
Top width = 35m

BASIN OPW3

Source Node:

C4A (Intrnl): A_T = 1950 + 5185 + 2462 + 4104 + 21591 + 5629
= 40921 m²

A_{imp} = 1950 + 2876 + 1115 + 2845 + 7500 + 1848
= 18134 m²

C4B (Resm Rd + perm): A_T = 6343 m²
A_{imp} = 3726 m²

C4C (External remainder): A_T = 64186 m²
A_{imp} = 0 m²

TREATMENT NODE

SWALE C4A: Length = 400
Slope ≈ 2.4 %
Size = 4m top

C4A = C4B

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BASIN DPW3

C4A + C4B + C4C → BASIN DPW3

SURFACE AREA = 3931 m²

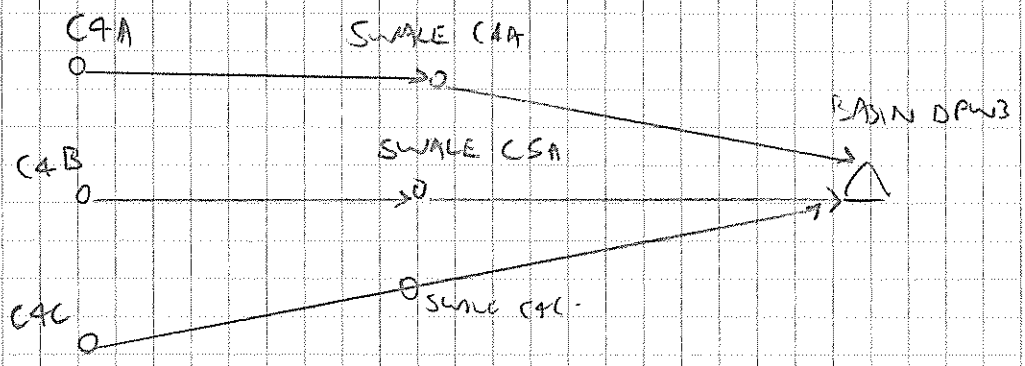
VOL = 426.6 m³

Depth = 1.2m

Low flow DIA = x375 ø ≈ 600 DIA.

O/F weir = 35m

SUMMARY:



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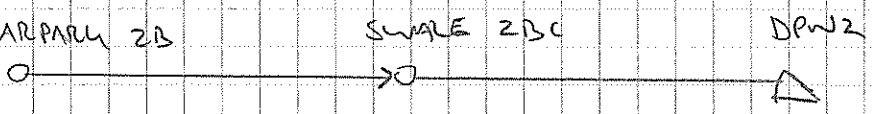
CARPARK 2B



CARPARK 2B:

$A_T = 5109 m^2$

$A_{IMP} = 5,109 m^2$

SWALE 2BC.

Length = 220

Slope = 5%

DPW2:

$SA = 5431 m^2$

$Vol = 5917 m^3$

depth = 1.2m

outlet = x 3 - 375 dia ≈ 600 dia

width = 40m

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* CATCHMENTS C3

C1A (INT): A_T = 9774 + 4000 + 6591 + 4267 + 2915 + 6316 + 6023 + 6541 + 5818 + 4332 + 3365 + 3677
= 63 019 m²

A_{IMP} = 3597 + 1630 + 1520 + 1787 + 1510 + 1025 + 1400 + 2789 + 672 + 2938 + 1615 + 1235
= 21 720

C3B (REMAIN) = 125 120 − 5109

A_T = 120 011 m²

A_{IMP} = 9308 − 5109 = 4199 m²

SMALL C1A

Length = 480 m

Grade = 1.8 %

SMALL C3B : Length = 100 m

Grade = 2 %

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* DPW5.

SA = 8498 m²

Vol = 953.4 m³

outlet = (x) 375 ø ≈ x1 600 ø

weir = 7m

* DPW1

SA = 10468 m²

Vol = 1174.2 m³

outlet = (x1) 600

weir = 7.5m

* NAT SWALE (C1) DPW5.

Length = 350

grade = 1.57 %

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CATCHMENT C1 → DPW5:

C1A (INTERNAL) MAX

A_T = 10793 + 7510 + 14548 + 7063 + 3802 + 5617 + 5845 + 5976 + 10224 + 5121
= 76299 m²

A_{imp} = 2780 + 3481 + 5431 + 2813 + 800 + 2561 + 3495 + 4314 + 4896 + 2651
= 33222 m²

SWALE C1A

L = 650
Slope = 1.7%

C1B : (CARPARK + OTHER)

A_T = 18812 + 4929 + 6625 + 4834 + 3548 + 8827 + 5728 + 2830 + 2903 + 3091 + 5599 + 4011 + 3447 + 8308 = 83292 m²

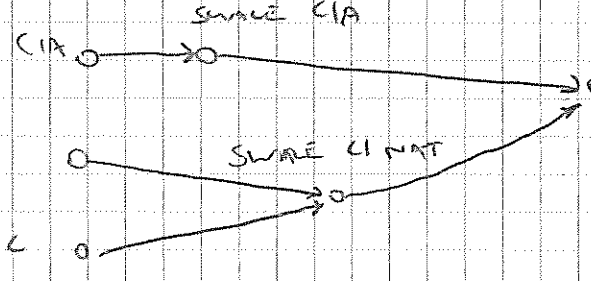
A_{imp} = 4255 + 4929 + 6625 + 1717 + 1838 + 4315 + 3575 + 2830 + 2903 + 710 + 1127 + 1885 + 3447 + 4450
= 44606 m²

C1C : (EXTERNAL REMAINDER)

A_T = 16334 m²

A_{imp} = 11334 m²

SUMMARY:



Designed SL Job no. 16-26. Sheet no.

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* CATCHMENT C2

C2A: (INTERNAL) $A_T = 407430\ m^2$

A_{imp}: 2798 + 3893 + 2443 + 3667 + 3515 + 545 +
+ 2610 + 3154 + 5766 + 3836 + 1952 +
+ 3874 + 1449 + 1869 + 2809 + 2925 +
+ 2887 + 2251 + 1930 + 3530 + 2175
$= 59878\ m^2$

C2B: (EXTERNAL REMAINDER) $A_T = 259399\ m^2$
$A_{imp} = 6860\ m^2$

SWALE C2A: $L = 550 + 20$
Slope = 2.3 %

NAT SWALE C2B: $L = 560m$
Slope = 2.3%

* RESULTS (% Reduction)

GP =	100 %	>	90 %
TN =	45.3%	>	45%
TP =	78.4%	>	60 %
TSS =	90.2%	>	85%

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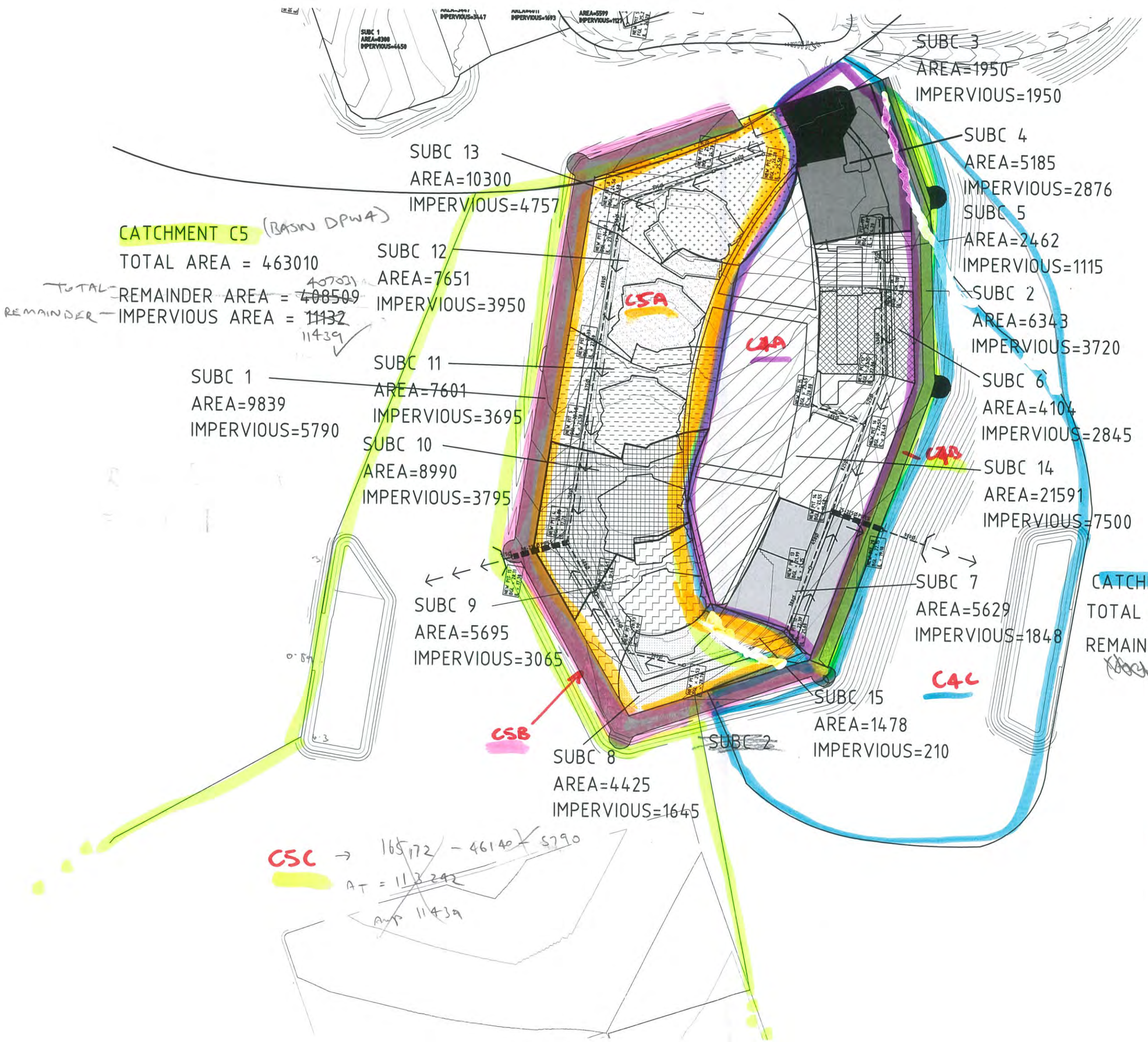
Catchment areas summary


SUBC 1
AREA=8300
IMPERVIOUS=4450
SUBC 3
AREA=1950
IMPERVIOUS=1950
SUBC 4
AREA=5185
IMPERVIOUS=2876
SUBC 5
AREA=2462
IMPERVIOUS=1115
SUBC 2
AREA=6343
IMPERVIOUS=3720
SUBC 6
AREA=4104
IMPERVIOUS=2845
SUBC 14
AREA=21591
IMPERVIOUS=7500
SUBC 7
AREA=5629
IMPERVIOUS=1848
SUBC 15
AREA=1478
IMPERVIOUS=210
SUBC 13
AREA=10300
IMPERVIOUS=4757
SUBC 12
AREA=7651
IMPERVIOUS=3950
SUBC 11
AREA=7601
IMPERVIOUS=3695
SUBC 10
AREA=8990
IMPERVIOUS=3795
SUBC 1
AREA=9839
IMPERVIOUS=5790
SUBC 9
AREA=5695
IMPERVIOUS=3065
SUBC 8
AREA=4425
IMPERVIOUS=1645
SUBC 2
CSA
CSB
C4A
C4B
C4C
CATCHMENT C5 (BASIN DPW4)
TOTAL AREA = 463010
REMAINDER AREA = 408509
REMAINDER IMPERVIOUS AREA = 11132
CATCHMENT C4 (BASIN DPW3)
TOTAL AREA = 105321 111450 m²
REMAINDER AREA = 408509
64186 m²
AT = 111450 - 40921 - 6343
= 64186
Amp = 0m².
CSC → 165172 - 46140 - 5790
AT = 113242
Amp 11439
2.4W 600D 1:4.


SUBC 17
AREA=5121
IMPERVIOUS=2651
CARPARK 2B:
AT = 5109 m²
AIMP = 5109 m²
SUBC 12
AREA=18812
IMPERVIOUS=4255
SUBC 15
AREA=3892
IMPERVIOUS=3892
SUBC 9
AREA=3548
IMPERVIOUS=1838
SUBC 14
AREA=4929
IMPERVIOUS=4929
SUBC 16
AREA=1217
IMPERVIOUS=1217
SUBC 11
AREA=2868
IMPERVIOUS=722
SUBC 13
AREA=6625
IMPERVIOUS=6625
SUBC 10
AREA=5370
IMPERVIOUS=3267
SUBC 3

SUBC 26
AREA=10793
IMPERVIOUS=2780

SUBC 25
AREA=7510
IMPERVIOUS=3481

SUBC 24
AREA=14548
IMPERVIOUS=5431

SUBC 23
AREA=3602
IMPERVIOUS=809

SUBC 22
AREA=7063
IMPERVIOUS=2813

SUBC 21
AREA=5617
IMPERVIOUS=2[illegible]

SUBC 20
AREA=5845
IMPERVIOUS=3495

SUBC 19
AREA=5976
IMPERVIOUS=4314

SUBC 18
AREA=10224
IMPERVIOUS=4896

SUBC 48
AREA=3087
IMPERVIOUS=

SUBC 46
AREA=4705
IMPERVIOUS=2809

SUBC 45
AREA=3952
IMPERVIOUS=2925

SUBC 44
AREA=3523
IMPERVIOUS=2887

SUBC 30
AREA=6023
IMPERVIOUS=1408

SUBC 31
AREA=6541
IMPERVIOUS=2789

SUBC 28
AREA=3365
IMPERVIOUS=1415

SUBC 27
AREA=4332
IMPERVIOUS=2939

SUBC 39
AREA=7345
IMPERVIOUS=2251

SUBC 47
AREA=2605
IMPERVIOUS=1930

SUBC 17
AREA=5121
IMPERVIOUS=2491

SUBC 12
AREA=18812
IMPERVIOUS=4255

SUBC 14
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SUBC 9
AREA=3548
IMPERVIOUS=1838

SUBC 8
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SUBC 7
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IMPERVIOUS=2838

SUBC 6
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SUBC 11
AREA=4036
IMPERVIOUS=1717

SUBC 13
AREA=6625
IMPERVIOUS=6625

SUBC 10
AREA=8627
IMPERVIOUS=4315

SUBC 4
AREA=5599
IMPERVIOUS=1127

SUBC 3
AREA=4011
IMPERVIOUS=1885

SUBC 2
AREA=3447
IMPERVIOUS=3447

SUBC 1
AREA=8508
IMPERVIOUS=4450

SUBC 3
AREA=1950
IMPERVIOUS=1950

TOTAL AREA = 325808

REMAINDER TOTAL AREA = 163345

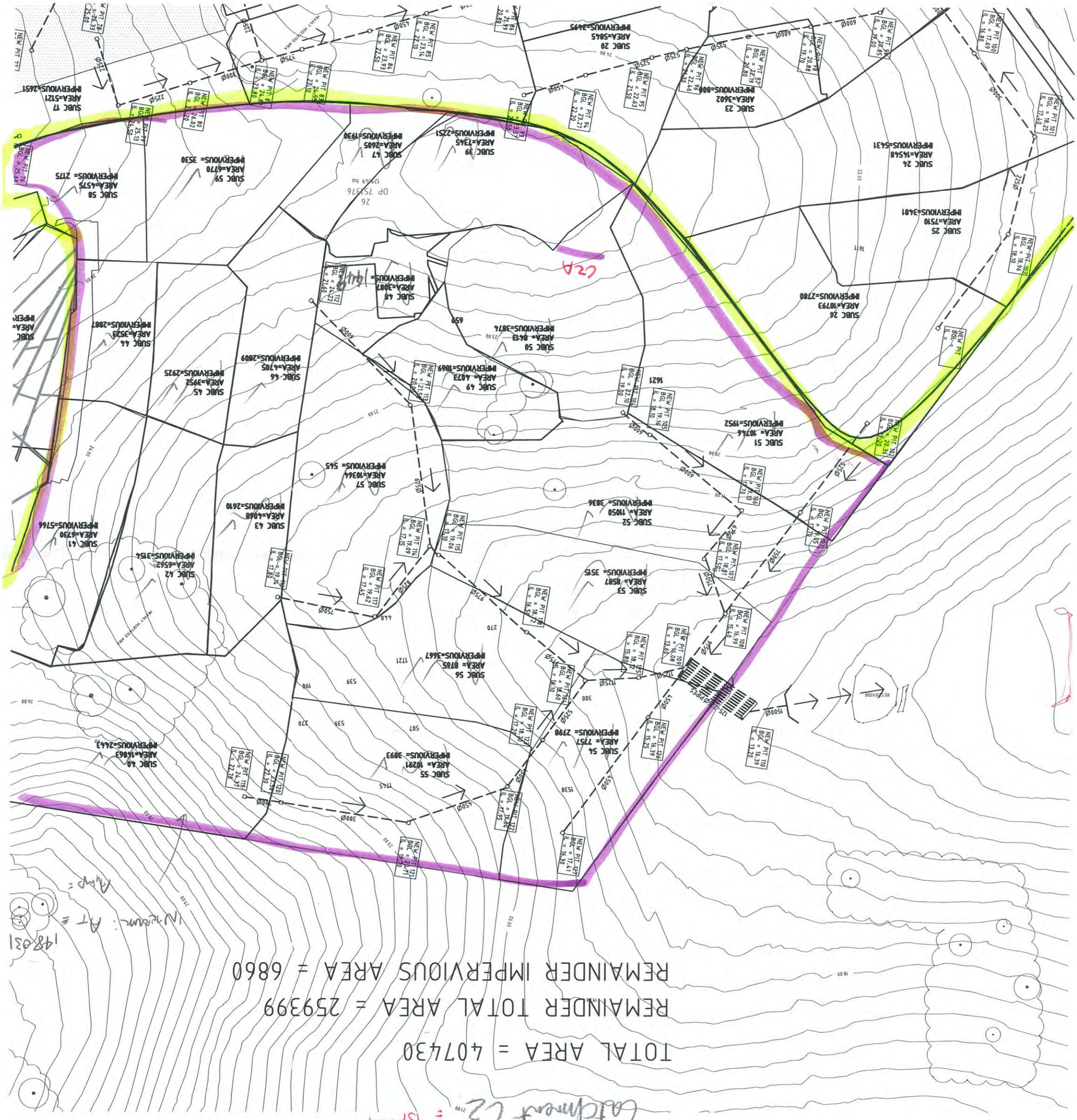
REMAINDER IMPERVIOUS AREA = 11334

C1A

C1B

C1C

SUBC 13



TOTAL AREA = 407430

REMAINDER TOTAL AREA = 259399

REMAINDER IMPERVIOUS AREA = 6860

C3A

SUBC 35
AREA=9774
IMPERVIOUS=3597

SUBC 36
AREA=4000
IMPERVIOUS=1630

SUBC 37
AREA=6591
IMPERVIOUS=1520

SUBC 38
AREA=4267
IMPERVIOUS=1789

SUBC 32
AREA=2915
IMPERVIOUS=1510

SUBC 34
AREA=6316
IMPERVIOUS=1025

SUBC 33
AREA=5818
IMPERVIOUS=672

SUBC 30
AREA=6023
IMPERVIOUS=1400

SUBC 31
AREA=6541
IMPERVIOUS=2789

SUBC 28
AREA=3365
IMPERVIOUS=1615

SUBC 29
AREA=3077
IMPERVIOUS=1235

SUBC 27
AREA=4332
IMPERVIOUS=2938

NEW PIT 64
BGL = 21.19
IL = 20.40

NEW PIT 65
BGL = 21.04
IL = 20.00

NEW PIT 66
BGL = 21.88
IL = 19.60

NEW PIT 67
BGL = 22.82
IL = 21.40

NEW PIT 68
BGL = 18.76
IL = 16.50

NEW PIT 69
BGL = 19.45
IL = 16.10

NEW PIT 70
BGL = 19.51
IL = 19.10

NEW PIT 71
BGL = 20.52
IL = 19.80

NEW PIT 72
BGL = 23.46
IL = 22.40

NEW PIT 73
BGL = 24.39
IL = 23.40

NEW PIT 74
BGL = 25.31
IL = 24.10

NEW PIT 75
BGL = 26.00
IL = 24.40

NEW PIT 76
BGL = 25.68
IL = 24.80

375Ø
525Ø
900Ø
50-225Ø PIPES
1050Ø
750Ø
875Ø
450Ø
300Ø
32
320
396
300
216

Total Area
= 193340

Remainder Total Area
= 125120

Remainder Impervious
Area = 9308