Windradyne 1100
Stormwater Report

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1. Introduction

This Stormwater and OSD Report supports the proposed development of Windradyne 1100, Bathurst. Refer to Figure 1 for location of the proposed development.

AT&L have been engaged by Bathurst Regional Council (BRC) to prepare a Civil Development Application Report on the stormwater and OSD requirements for the proposed development.

The aim of the report is to assess the potential impacts of the proposed development with respect to stormwater and OSD requirements.

This report has been prepared in accordance with the:

- Bathurst Regional Council Guidelines for Engineering Works 2011,
- Bathurst Regional Development Control Plan (DCP) 2014, and
- Bathurst Regional Council Standard Drawings;

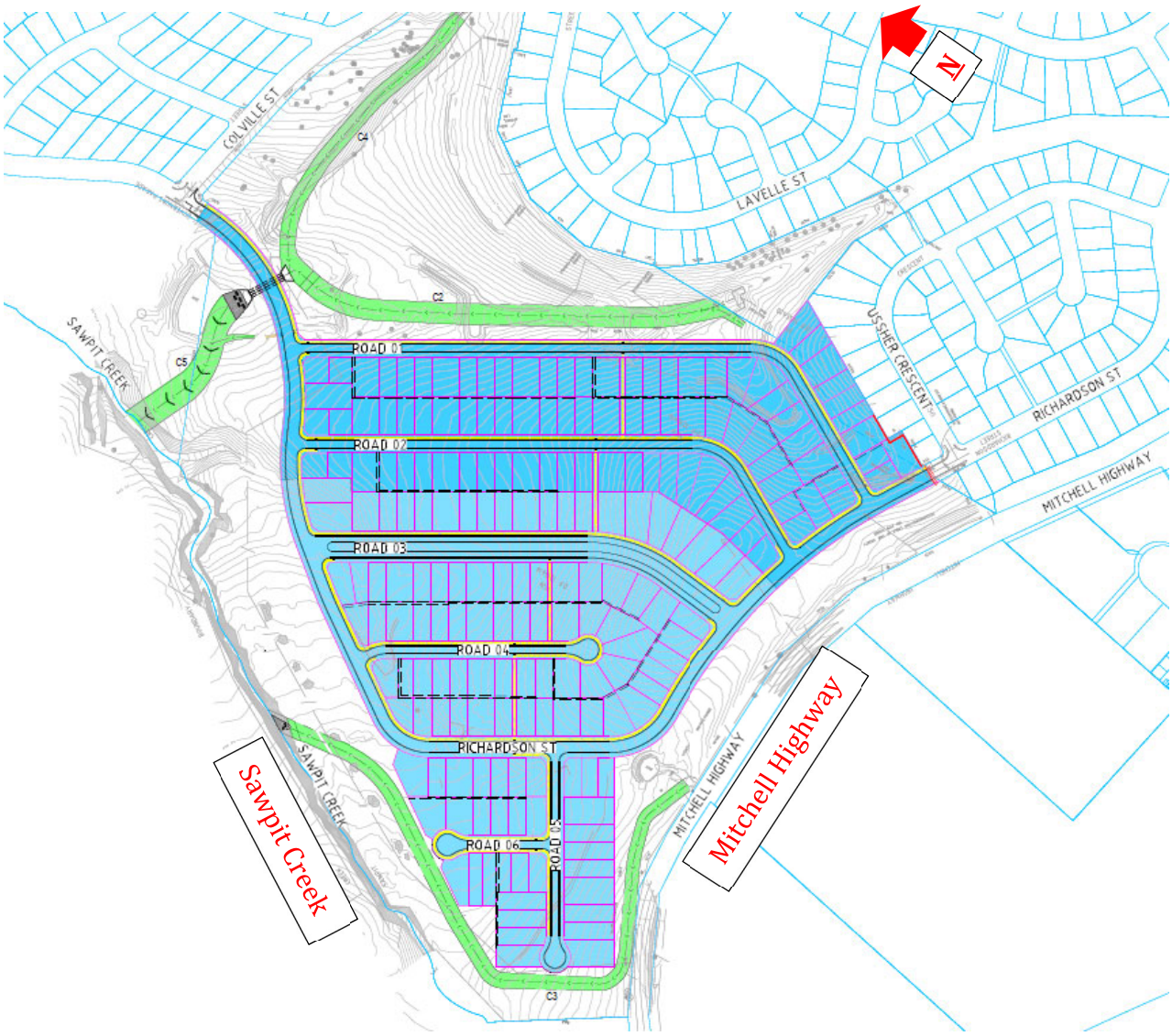

Figure 1 – Proposed Development Site

Our investigations of the site were carried out based on:

- LIDAR data available from Geosciences Australia;
- Subdivision Civil DA Drawings prepared by AT&L;
- Detailed site survey prepared by Voerman & Ratsep Land Surveyors on the 16th February 2018.

2. Existing Site

The site is located on Lots 138 DP 1123180, located within the Bathurst Regional Council LGA and the total site area is approximately 40.65 Ha (including Stage 1 and 2). Existing access to the site is via Richardson Street to the south and Governors Parade to the north.

The existing site is bound by:

- Mitchell Highway to the south;
- Sawpit Creek to the west; and
- Existing residential properties to the east and north.

The site generally slopes down from south-east (approximate RL 708.5) to the north and Sawpit Creek (approximate RL 685.5). Refer to the Survey drawings within Appendix A for all features on site along with existing contour levels.

Currently, much of the site is unoccupied and covered by grassed paddocks with high-voltage electrical aerial cables traversing the site. There is a relatively small dam close to Mitchell Highway, south of the site (within the Stage 2 area). The site can be classified as a “greenfield” site.

2.1. External Catchments

The Windradyne 1100 development site is located at the downstream end of a local drainage catchment which drains into Sawpit Creek to the west of the site. Refer to Figure 3 for catchment discharge locations points relative to the site, and Figure 4 for contributing catchments.

As part of the development’s S94 contribution, 4 stormwater diversion channels C2 – C5 with low flow pipes will be constructed to capture runoff from the upstream catchments with the Governor’s Parade crossing sized to cater for the 1% AEP stormwater flow.

This is in accordance with Bathurst Council’s Section 94 Contribution Plan, Stormwater Catchment Plan and comments.

The ultimate alignment and configuration of the channels will be subject to detailed design, however all will utilise 450 diameter low-flow stormwater pipes and be sized to ensure the requisite flows are wholly contained within the channel.

Refer to Figure 3 below for an excerpt from Bathurst Stormwater Catchment Plan showing channels C2-C5.

The locations of the stormwater channels coincide with:

- Discharge Point 1 – Channel 3;
- Discharge Point 3 – Channel 2; and
- Discharge Point 4 – Channel 4.

Noting Discharge Point 2 will be diverted within the proposed road network to Channel 2.

Figure 2: S94 Contribution Plan Excerpt (Courtesy of Bathurst Regional Council)

Stormwater generated within the proposed development will discharge via the S94 channels mentioned above or directly to Sawpit Creek.

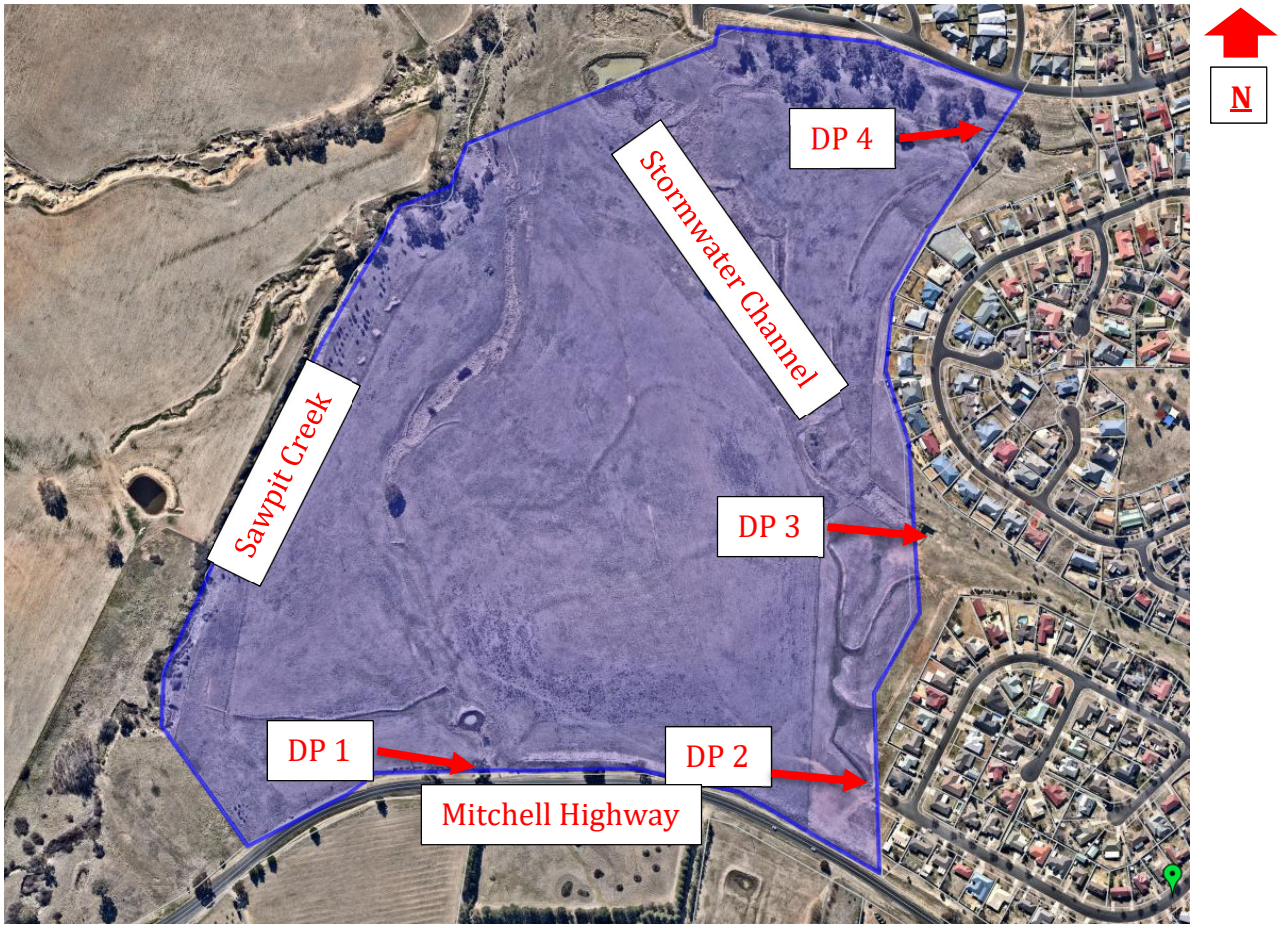

Figure 3 – Existing Overland Flow Discharge Locations

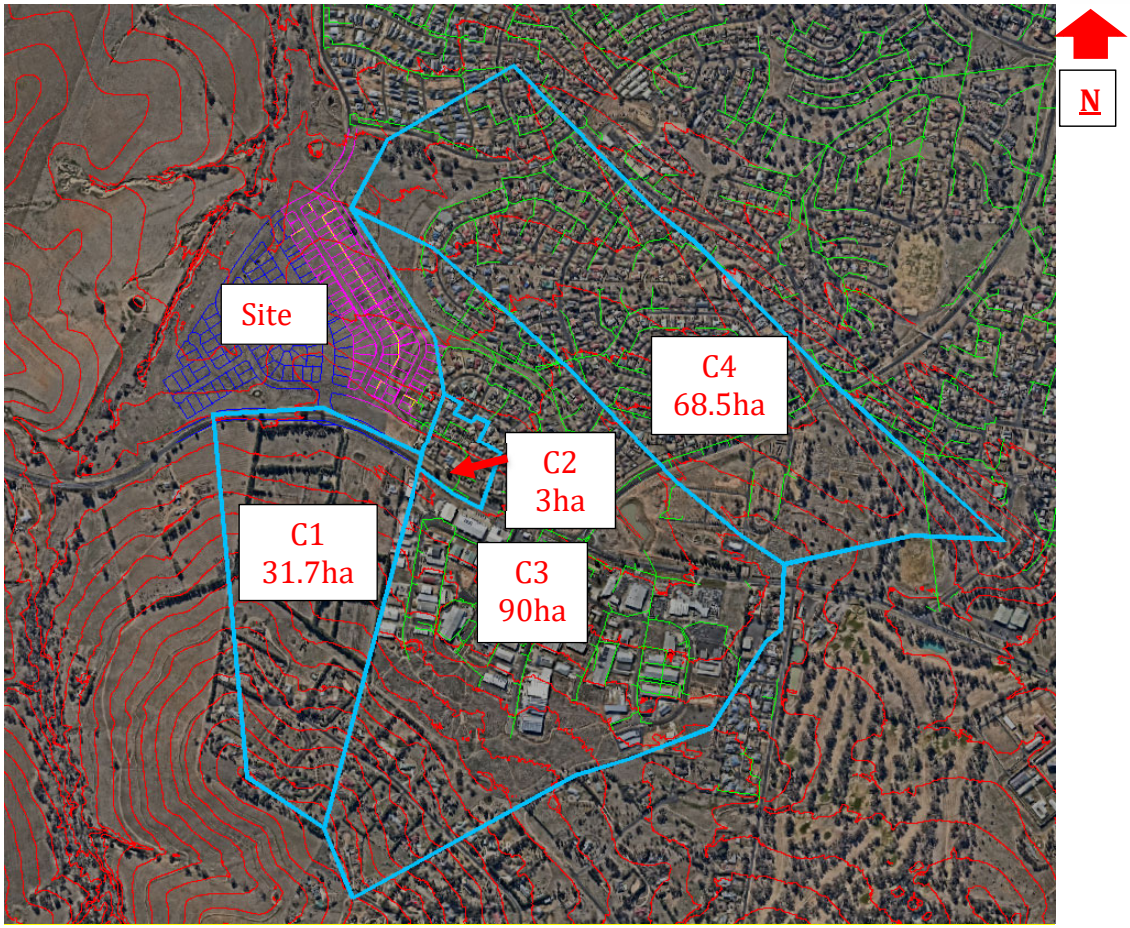

Figure 4 – Approximate Contributing Catchments

2.1.1. Catchment 1 / Channel 3

This existing catchment is approximately 31.70 ha in area consisting of large rural lots. This catchment drains into the development site via surface flow and underground stormwater network under the Mitchell Highway (Discharge Point 1).

This catchment will be diverted around the proposed development site by Channel 3 and discharges directly to Sawpit Creek, with appropriate scour protection and energy dissipation subject to detailed design.

2.1.2. Catchment 2 / Local Stormwater Network

This existing catchment is approximately 3 ha consisting of low-density residential lots and a small road catchment. This catchment drains into the development site via underground stormwater network under Richardson Street and discharges to the site via an existing headwall (Discharge Point 2).

This catchment is affected by the development extent of works, to ensure no impacts to upstream lots it is proposed that this line be diverted along Proposed Richardson Street extension and Road 01 and discharging to the existing stormwater channel, via a new headwall and appropriate scour protection.

2.1.3. Catchment 3 / Channel 2

This existing catchment is approximately 90 ha in area consisting of low-density residential lots, and large industrial lots, drains to the development site via underground stormwater network and overland flow, ultimately discharging to the site via an existing headwall (Discharge Point 3).

This catchment is affected by the proposed development extent of works, to ensure no impacts to upstream lots it is proposed that stormwater culverts sized for the 100-year ARI storm event be installed under the extension of Governors Parade to cater for the overland flow. These trunk assets have been sized within Section 2.4.1 of this report.

It is proposed to installed stormwater channel 2 to cater for this catchment extending from Discharge Point 3 to the proposed Governors Parade extension, with the sizing of this channel subject to detailed design.

2.1.4. Catchment 4 / Channel 4

This existing catchment is approximately 68.5 ha consisting of low-density residential lots and council parkland, drains to the development site via underground stormwater network and discharging to the site via an existing headwall (Discharge Point 4).

This catchment is affected by the proposed development extent of works, to ensure no impacts to upstream lots it is proposed that stormwater culverts sized for the 100-year ARI storm event be installed under the extension of Governors Parade to cater for the overland flow. These trunk assets have been sized within Section 2.4.1 of this report.

It is proposed to installed stormwater channel 4 to cater for this catchment extending from Discharge Point 3 to the proposed Governors Parade extension, with the sizing of this channel subject to detailed design.

2.1.5. Channel 5

Stormwater channel 5 will convey stormwater discharge from the proposed trunk assets under Governors Parade extension and Channels 2/4 to Sawpit Creek. This channel configuration will be confirmed during detailed design and will have appropriate scour protection and energy dissipation measures in place to ensure no-worsening on Sawpit Creek.

2.2. Existing Site

The site is classed as greenfield and having no existing pit and pipe network, stormwater infiltrates the grassed paddocks.

The site generally slopes down from south-east to the north to the existing stormwater channel and to the west towards Sawpit Creek.

There are two existing water storage dams at overland flow convergence points located on site. It is proposed as part of the development works that these be removed and/or modified.

2.3. Proposed Site Stormwater Drainage

All proposed stormwater drainage from the development will be designed in accordance with the Bathurst Regional Council engineering requirements and guidelines.

All stormwater on the lots and within the road reserve is proposed to be collected via pits and pipes, and ultimately connect into Sawpit Creek to the west of the site. For Windradyne 1100, there are four Legal Point of Discharges for the site, draining via pipe headwall/channel, into:

- Stormwater Channel to the North; and
- Sawpit Creek to the west.

In accordance with the BRC Engineering Guidelines the proposed stormwater network will incorporate minor and major systems:

- Minor: Underground Pipe drainage
    - On-Lots: 20% AEP; and
    - Local/Collector Roads: 20% AEP.
- Major: The combined piped and overland flow paths shall be designed to accommodate the 1% AEP storm event.

2.4. External Catchment Analysis

With the extension of Governors Parade to service the proposed development, the proposed road will effectively 'block' Discharge Point 3 and 4. To ensure the existing flowpaths is maintained, it is proposed to install several stormwater culverts to ensure un-mitigated flow to Sawpit Creek to the west.

To ensure the culverts a sized in accordance with BRC Guidelines for Engineering Works and 'Australian Rainfall and Runoff (AR&R) 2016', a RORB hydrologic model was created.

RORB is an event even based hydrologic model which calculates flood hydrographs from storm rainfall hyetographs. It can be used for modelling natural, partly urban or fully urban catchments. The RORB model was setup utilising the follow parameters:

- Land use characteristics were based on current land uses (identified from the BRC LEP maps) and aerial imagery;
- Catchment delineation for the model was based on 1m LiDAR data obtained from New South Wales Government's Spatial Services; and
- The model has been set up in accordance with the requirements of the Australian Rainfall and Runoff (AR&R) 2016. This includes the use of revised IFD charts and revised temporal patterns.

A Regional Flood Frequency Estimate (RFFE) was determined for the site using the software provided as part of AR&R 2016.

After having developed and simulated utilising the RORB model, the 1% AEP peak flow at the site of the proposed culverts under Future Governors Parade, was to be calibrated and validated using the AR&R Regional Flood Frequency Estimate (RFFE).

The RFFE uses a number of nearby gauges, all with predominately rural catchments to determines an estimate of the 1% AEP peak flow for the contributing catchment to the proposed culvert at Governors Parade. To present equivalent catchment conditions, the RORB model was initially run assuming rural catchment conditions (in terms of fraction impervious and reach types). Once the rural RORB model was

reconciled with the RFFE, the RORB model (with current land use characteristics and reach types) was run of determine the 1% AEP flows to the proposed culvert location.

2.4.1. Culvert Sizing

Following this, the size (and cross-sectional area) of the required culvert was determined, using standard design charts (Manning's equation pipe flow capacity chart).

As with any drainage system, there is potential for the proposed culvert to experience blockage, which can lead to decreased capacity. Utilising the AR&R 2016 methodology, a blockage factor of 50% has been determined, refer to Table 1 for details.

Component	Value
Rural RORB model peak 1% AEP flow (m^3/s)	19.30
RFFE peak 1% AEP flow (m^3/s)	19.30
Current land use RORB model – Catchment 3 peak 1% AEP flow (m^3/s)	31.3
Current land use RORB model – Catchment 4 peak 1% AEP flow (m^3/s)	7.0
Current land use total RORB model peak 1% AEP flow (m^3/s)	38.3
Minimum culvert cross-sectional area (assuming no blockage) (m^2)	5.73
Minimum culvert cross-sectional area (assuming blockage) (m^2)	8.60
Possible culvert configuration	3 x 2100 x 1200 (RCBC)

Table 1 – Modelled results and Proposed Parameters

2.5. Pre. Vs Post Development Flows

Utilising DRAINS software, the pre-developed flows of Windradyne 1100 was analysed versus the post-development flows (excluding external catchments), utilising conservative time of concentration values. This data is represented in Table 2.

Component	Value
1% AEP Pre-Development Flows	12.90 m^3/s
1% AEP Post-Development Flows	15.10 m^3/s
Pre Vs. Post Development Flows Windradyne 1100	+2.20 m^3/s

Table 2 – Development Flow Comparison

The above data represents the 'worst-case' solution, the development is likely to have less of an increase in peak flows due to each future lot/dwelling utilising some form of stormwater detention/stormwater re-use system i.e. a rainwater tank, which will be subject to individual lot Development Applications and slowing of stormwater discharge due to stormwater inlet times and piped flow.

Catchment analysis assumptions for Table 2:

- Impervious area 'time of concentration': 5 mins; and
- Previous area 'time of concentration': 10 mins.

2.6. Sawpit Creek

2.6.1. Sawpit Creek Pre-Developed

Sawpit Creek adjacent to the development site has been modelled within DRAINS as per Figure 4, this is based on the detailed site survey by Voerman and Ratsep dated 16th February 2018.

In the 1% AEP storm event based on the indicative catchments within Figure 3 (subject to detailed flood modelling), there is approximately:

- 13.5 m^3/s of flow within Sawpit Creek once it reaches the development site; and
- 38.3 m^3/s from external Catchments 3 and 4.

Thus, the flow within Sawpit Creek at the northern end of the site in the pre-developed case is 51.8 m^3/s external + 12.90 m^3/s Windradyne 1100 flow. Thus, the total pre-developed flow being 64.90 m^3/s.

The approximate pre-developed velocity within Sawpit Creek to the north of the site is 4.14 m /s, wholly contained within Sawpit Creek.

2.6.2. Sawpit Creek Post-Developed

In the 1% AEP storm event based on the indicative catchments within Figure 3 (subject to detailed flood modelling), there is approximately:

- 13.5 m^3/s of flow within Sawpit Creek once it reaches the development site; and
- 38.3 m^3/s from external Catchments 3 and 4.

Thus, the flow within Sawpit Creek at the northern end of the site in the post-developed case (un-detained) is 51.8 m^3/s external + 15.10 m^3/s Windradyne 1100 Flow. Thus, the total post-developed flow being 66.90 m^3/s and with a velocity of 4.18 m/s.

Based on the preliminary DRAINS modelling prepared utilising the above data, the flows within Sawpit Creek are wholly contained within the creek extents. Furthermore, adequate freeboard (more than 500mm) is maintained within Sawpit Creek even with the minor increase in flows.

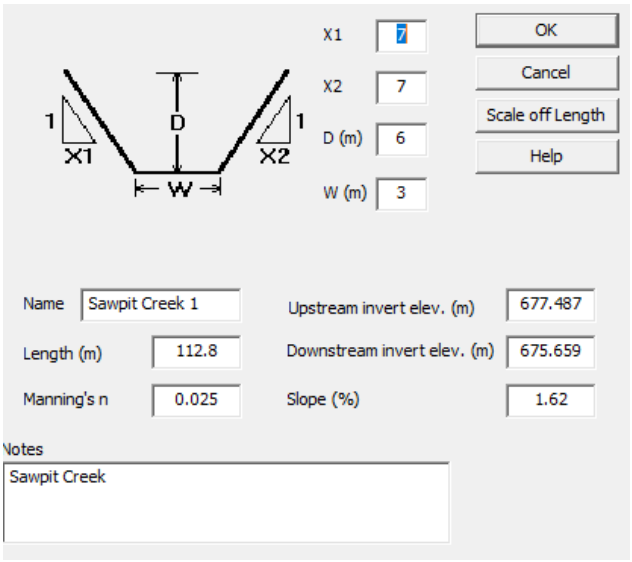

Figure 4 – Sawpit Creek Profile

With Sawpit Creek being the Legal Point of Discharge for the development, a comparison of existing site characteristics versus the development site characteristics (Table 2 and Section 2.6) was undertaken to compare the effects on Sawpit Creek.

Due to the position of the site being in the lower reaches of Sawpit Creek, the development had a negligible effect on the flow within Sawpit Creek due to the coinciding of the two major flow paths, being the creek itself and the stormwater channels proposed based on the preliminary modelling undertaken. The proposed development resulted in a <1% increase in velocity of the stormwater channel not effecting scour within Sawpit Creek.

2.7. On Site Detention System

When developments are located downstream of large catchments which are affected by overland flow it is common practise that OSD requirements for the development are waived. As the HGL of the receiving waterway will be higher than the invert of the orifice plater on the design, not allowing the stormwater to freely drain.

The reason being retaining runoff in OSD structure and hence delaying drainage of stormwater can exacerbate flooding behaviours where the location in question would normally discharge to a trunk system prior to the arrival of peak flow (Sawpit Creek and existing Stormwater Channel/Channels 2 and 4).

The substantial upstream catchments (in excess of 190ha) flowing through the Windradyne Precinct and with all previous stages not utilising OSD, OSD is not required for this development. This is to be confirmed via detailed flood modelling utilising Tuflow or RAFTS software packages.

Based on the preliminary DRAINS modelling OSD is not required for this proposed development.

2.7.1. On Site Detention System Check

Due to the topography of the development site, Sawpit Creek, trunk drainage channels and minimising earthworks undertaken, it is assumed the two likely OSD placements would be as shown in Figure 6. It is assumed that half of the development will go to each basin and that only the proposed roads and residential lots be directed to the basins.

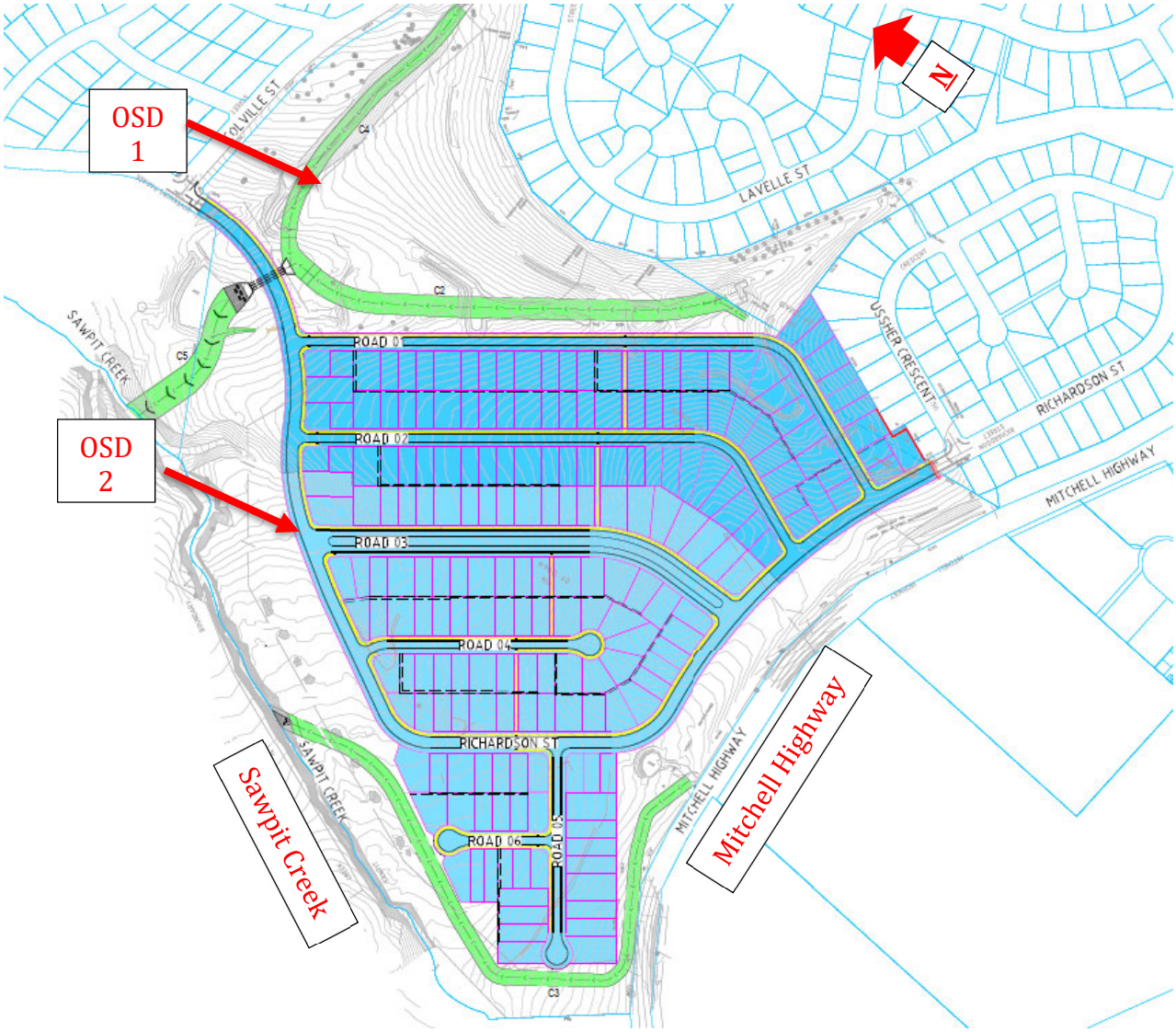

Figure 6 – OSD Locations

Due to the HGL at the proposed trunk drainage assets crossing the Governors Parade extension and the confluence of trunk drainage channels C2 and C4 at this location, OSD is not a practical approach to stormwater mitigation as the orifice plate for the proposed OSD would be lower than the HGL of the receiving waterway.

Due to the HGL within Sawpit Creek and Windradyne 1100's location within the overall catchment, OSD is not a practical approach to stormwater mitigation, as the orifice plate for the proposed OSD would be lower than the HGL of the receiving waterway.

3. Conclusion

Based on our preliminary investigations and review of previous Windradyne Subdivision stages (no previous stages have OSD present on site) it is our recommendation that Windradyne 1100 does not require OSD.

Due to the proposed development sites position in the catchment and based upon the pre-development (64.90 m^3/s) versus post-development (66.90 m^3/s), worst case stormwater flow comparison resulting in a

less than 1% increase in stormwater flow velocity within Sawpit Creek. OSD would not be beneficial within the proposed development of Windradyne 1100.

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