FLOOD IMPACT ASSESSMENT

Proposed Residential Development

DEVELOPMENT ADDRESS

81 Martini Parade
Lithgow, NSW 2790

LEGAL DESCRIPTION

LOTS 585 to 587 DP9370 and LOT 31 DP251410

FOR

Mitch Partridge Building

ORIGINAL REPORT DATE
February 2024

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Report Details

Client: Mitch Partridge Building

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81 Martini Parade
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CONTENTS

1. INTRODUCTION

Developer	Mitch Partridge Building
Address	81 Martini Parade, Lithgow, NSW 2790
Local Authority	Lithgow City Council
Property Description	LOTS 585 to 587 DP9370 and LOT 31 DP251410
Size of Development	Approx. 0.1125 ha
Type of Development	Residential Development
Time to Undertake Works	12 – 18 Months
Existing Land Use & Zone	Currently there is a 2-bedroom fibro / weatherboard house with a detached single car garage and carport. Zone R1 – General Residential.
Adjacent Land Use & Zone	Residential, zoned R1 – General Residential.
Engineering Consultant	Calare Civil
Report Written By	Harrison Oakley
Qualifications	B.E (Hons) Civil / B.E (Hons) Environmental
Experience	6+ years' experience across disciplines including civil design and project management, construction supervision, hydrologic and hydraulic investigation, modelling and design.
Report Checked By	Garth Dean Director
Qualifications	B.E. GDSTT FIEAust CPEng NER APEC Engineer IntPE (Aus) RBP (Vic/NT)
Experience	30+ Years Civil Engineering Experience
Purpose of Report	To assess the flood conditions for both the existing and proposed scenarios at the subject site. A Flood Impact Assessment is required as it is noted that the subject site is situated within the overland flow path for an unnamed tributary that has its headwaters within the Hassans Walls State Forest. As part of this assessment, flood levels and flow paths, have been determined to inform the floor levels for the proposed development.

2. SITE DESCRIPTION

2.1. Topography & Drainage

The proposed development is on the western side of Martini Parade Lithgow, immediately northwest of the Cooerwull Public School – Infants Campus. The site is situated within the drainage corridor for an unnamed tributary that has its headwaters within the Hassans Walls State Forest. Flows from this tributary are initially captured by a detention basin / sediment pond on the Thales Site which then discharges to both the piped stormwater drainage network and designated overland flow paths during extreme rainfall events.

It is noted that as part of the piped stormwater drainage network there is an existing underground lined channel that flows through the site in a north-westerly direction; all street drainage in the vicinity discharges into this channel. The channel is noted as being rectangular and approximately 1150mm wide and 1000mm deep, however the depth of cover is unknown. This channel generally follows the alignment of the natural watercourse and during high rainfall events, flows that exceed its capacity, subsequently surcharge the kerb inlet pits in the street and result in overland flows.

Overland flows on Martini parade are all associated with the flooding of this channel however there are three apparent sources:

- The first being, local overland flows generated in the upstream portion of the catchment that bypass the existing pit and pipe network,
- The second being the surcharging of the local stormwater network as noted above,
- The Third being “emergency” discharges from the upstream basin. When this basin spills during extreme rainfall events, it releases water onto Martini Parade at the intersection of Bayonet St

Overland flows on Martini parade initially travel north down to a sag point adjacent to the subject site, then from here, flows will overtop the kerb and cut through the existing residential areas, travelling in a north-westerly direction down to Main Street and ultimately Farmers Creek. This is the typical flood mechanism for the site although it is noted that flows may break out of the road corridor slightly upstream of the sag point, however this is dependent on the magnitude of flow. For reference, a general locality plan is provided in **Figure 2-1** below.

With regard to the subject site, it is quite flat however gently falls to the back of the lot with an average grade of 1.8% with elevations ranging from approximately 913.0m AHD at the front of the lot to 912.3m AHD at the back. While the site (and surrounding areas) is quite flat, it sits within a localised depression that would have historically formed the overbank areas for the aforementioned watercourse. Noting this and the behaviour of overland flows, consideration needs to be given to how altering the site, i.e. adjusting levels or creating obstructions, may impact upon the conveyance of any overland flows that are yielded during high rainfall events.

The proposed development will involve the demolition of the existing dwelling and garage and the construction of two, two story townhouses, each with three dwellings and private parking. There will be vehicle access provided by three driveways, one adjacent to each adjoining boundary and another centrally located between them. The driveway adjacent to the southern boundary will service the rear townhouse and a visitor parking area will be provided between the two buildings along the northern boundary. This driveway will also be required to convey the overland flows through the site. Further discussion around the grading requirements for this driveway is provided in **Sections 4.3.2.**

In summary, this assessment is required to determine the peak water levels associated with the flood mechanisms described here for both the existing and developed scenario. It is from this, that the floor levels for the proposed development can be set.

Figure 2-1: *Locality Plan for the Proposed Development and Relevant Stormwater Network Details*

2.2. Soils

A Geotechnical investigation has not been undertaken for this site to date. Furthermore, there is no requirement in this report to address / consider the sub-surface conditions.

2.3. Existing Stormwater Infrastructure

It is assumed that gutter flows from the existing dwelling are discharged to the drainage network on Martini Parade and any other runoff contributes to the overland flows paths that discharge to the rear of the lot and flow in a north-westerly direction towards Main Street. It is our understanding that there is no direct connection between the current site and the underground stormwater channel previously described in **Section 2.3**, however it is noted that when the capacity of this channel is exceeded, surcharges do contribute to the overland flows experienced on this and neighbouring sites.

2.4. Watercourses

As noted previously, passing directly through the site is an underground stormwater channel. This channel is lined and noted at being rectangular and approximately 1150mm wide and 1000mm deep, however the depth of cover is unknown. The location of this channel is indicatively shown in **Figure 2-1** however it will need to be accurately defined prior to the design of the proposed dwellings.

The channel has its headwaters in the Hassans Walls State Forest and flows in a north-westerly direction down towards Main Street. The channel generally follows the alignment of the natural watercourse; however the floodplain and overbank areas have been partially filled through the development of the area although a localised depression remains of which forms the overland flow path during high flow events.

2.5. Flora & Fauna

From a review of the survey provided and satellite imagery it is evident that there is no natural vegetation on the site. All vegetation is typical of urbanised areas e.g. short grass, small shrubs and shade trees.

No fauna survey has been undertaken but as this is in an established urban area, it is expected that this development will not impact on any fauna habitat.

If any protected, threatened or endangered species are found to inhabit the site prior to or during the construction works the relevant authorities will be informed immediately.

3. Design Criteria

3.1. Related Studies

In 2017 Lyall & Associates presented the Lithgow Flood Study Review (LFSR) of which has since been adopted by Council. The Flood Impact Assessment presented here considers the above document and all recommendations made here have been made with the LFSR in mind.

3.2. Hydraulic Requirements

As the site is subject to overland flows that result from the flooding of the underground stormwater channel (hereon be referred to as the “local flooding event”); to ensure that the proposed development does not result in additional flood impacts, any future buildings and earthworks should be designed such that:

- All habitable areas are above the 1% AEP flood level (including 500 mm freeboard),
- The site can suitably convey the overland flows without resulting in an increase to the flood levels experienced on neighbouring lots. A detailed design of the site grading and particularly the driveways will be required, taking into consideration the flow paths and flood levels.
- Access to the property can be maintained during major flood events.
- The development does not create a risk to life or infrastructure and the flood hazard on the driveways and footpaths are within acceptable limits.
- All structural designs account for inundation and the hydraulic loadings associated with the 1% AEP flood event.

4. STORMWATER QUANTITY - LOCAL FLOODING

4.1. Introduction

The principal requirement of this development is to ensure that the proposed works do not obstruct the anticipated overland flows and/or result in increased flood levels on the upstream or neighbouring properties. Through careful consideration of flow paths and the development of a flow management strategy, impacts to peak flood levels can be avoided. This assessment documents how Calare Civil reviewed the flood conditions and mechanisms associated with the site, determined the minimum requirements to ensure that there was negligible impact on flood levels and recommendations on how to manage the associated risks.

4.2. Methodology

To assess the local flooding event the pre and post development scenarios require modelling, and it is from this modelling that a comparison of flood levels and flow paths can be made.

The modelling was completed in two stages using two software packages.

The first stage was to develop a hydrograph for the critical flood as no hydrograph for the critical event was provided in the LFSR. This was completed using the stormwater drainage design and analysis software, DRAINS. The DRAINS model was setup using the initial loss – continuous loss (IL-CL) hydrologic method, where the losses were set using the NSW Office of Environment & Heritage requirements as per the AR&R 2019 guidelines. The loss data adopted came from the Mt Walker Guage (Station Number 212042) with FFA-Reconciled Losses of IL:33.8mm & CL:0.17mm/hr respectively. The East Coast South temporal pattern, pre-burst data and the AR&R 2019 rainfall depths were also applied, all of which were sourced from the Bureau of Meteorology (BoM).

In the DRAINS model a lumped catchment was developed to represent the tributary upstream of the site, LiDAR data was used to delineate the catchment area and aerial imagery informed the perviousness of the catchment. Note, the delineation of this catchment excluded the areas upstream of the basin on the Thales site because it was assumed that this portion of the catchment primarily contributes to the piped flows through controlled discharges and only contributes to the overland flows during extreme events. This “baseline” contribution is subsequently accounted for during the calibration process.

The upstream catchment was calculated as being approximately 31.95ha with the following breakdown and percentage perviousness:

- Urban = 23.65ha
    - 55% is directly connected impervious areas = 13.01ha
    - 5% is indirectly connected impervious areas = 1.18ha
    - 40% is pervious = 9.46ha
- Forested = 8.3ha → 100% pervious

Bringing the urban and forested catchments together, this yielded a catchment with the following parameters:

- Effective Impervious Area = 13.01ha (41%)
- Remaining Impervious Area = 1.18ha (3.7%)
- Pervious Areas = 17.76ha = (55.3%)

The peak flows from this catchment were then calibrated against the peak flows achieved at the nearest modelling/reporting node with the LFSR. The nearest node was Q41 “Unnamed Tributary, Downstream Martini Parade”. At this node, the peak flows for the 1% AEP event were noted as being 3.8m^3/s for in channel flows and 4.7m^3/s for overland flows during the 6hr duration event.

For reference these figures are presented in Table F1 of Appendix F within the LFSR.

Calibration achieved good results, an exact match to the reported figures in the LFSR wasn't achieved and as such a slightly conservative representation of the peak flows was adopted. The adopted peak flows were as follows, 3.75m^3/s for in channel flows and 4.74m^3/s for overland flows.

As it is the peak flows in the overland flow path that are critical for this development, it was these that were carried forward into the HEC-RAS modelling detailed below. The hydrograph adopted for these overland flows is presented in **Figure 4-1.** Note this hydrograph only accounts for the overland flows hence why there are times where there is "no flow", this just means that during these periods' catchment flows are fully contained within the channel. The hydrographs for the total catchment or channel have not been shown here for simplicity, however these can be extracted from the DRAINS model if required.

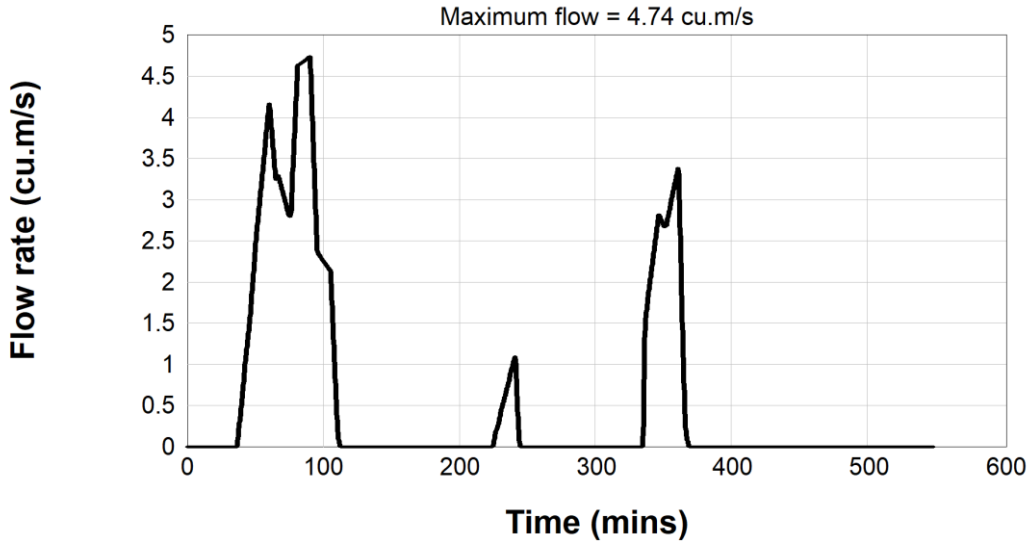

Figure 4-1: *Hydrograph adopted for the overland flows along Martini Parade during the Critical 1% AEP, 6hr duration event.*

The second stage of the modelling was to develop a surface water flow model. To do this a 2D HEC-RAS model was established using a combination of LiDAR data, detailed site survey and a modified DEM that represented the proposed development and surrounding buildings. Please note that the portion of the model represented by the LiDAR data is approximate only, however it has been deemed sufficient for the assessment of overland flows.

The inflows modelled were those calculated using the DRAINS modelling discussed previously. These inflows were applied immediately upstream of the site and allowed to flow down Martini Parade, the modelled topography then dictated the subsequent flow paths, the results of which are discussed in **Section 4.3** below.

4.3. Results

4.3.1. Existing

From the HEC-RAS modelling, Calare Civil's preliminary understanding of the flood mechanisms at the subject site were confirmed, i.e. initially overland flows travel down Martini Parade to the sag point adjacent to the subject site. At this sag point (and slightly upstream of it) overland flows overtop the kerb and gutter and begin to travel in a north westerly direction through the residential areas down to Main Street and ultimately Farmers Creek. For reference this flood behaviour is depicted in **Figures 4-2** to **4-5,** noting the timesteps adopted are theoretical, based on an assumed date with time commencing at 00:00:00 (midnight).

Figure 4-2: *Timestep 01:41:18 – Overland flows on Martini Parade travel towards the sag point with some breakout flows beginning to travel through properties to the south.*

Figure 4-3: *Timestep 02:16:36 – Inundation of the subject site commences, the sag point on Martini Parade approaches its spill level of 913.00m AHD*

Figure 4-4*: Timestep 02:41:06 – Sag point spilling and the primary flow path through the subject site develops i.e. flows travel along the southern boundary towards the rear.*

Figure 4-5: *Peak water levels noted as impacting the property to the north as well.*

As can be seen, the existing structures influence flow behaviour and also provide constraints as the proposed development cannot negatively impact on the flood levels currently experienced in habitable areas. As the proposed development involves the total removal of the current house and shed, flood levels currently experience at the subject site are not critical; it is the flood levels experienced on the street and neighbouring properties that require consideration. The approximate peak flood depths (and levels) at several reference locations that require consideration during the "existing scenario" are as follows:

- Martini Parade Sag Point = 150 – 250mm (913.2m AHD)
- Front yard of 67 Martini Parade = 100 –170mm (913.2m AHD)
- Backyard of 67 Martini Parade = 20 – 110mm (912.8m AHD)
- Side path of 83 Martini Parade = 20 – 170mm (912.6 to 912.4m AHD)
- Backyard of 83 Martini Parade = 50 – 150mm (912.3m AHD)

The reference location and depths are also shown in **Figure 4-6**

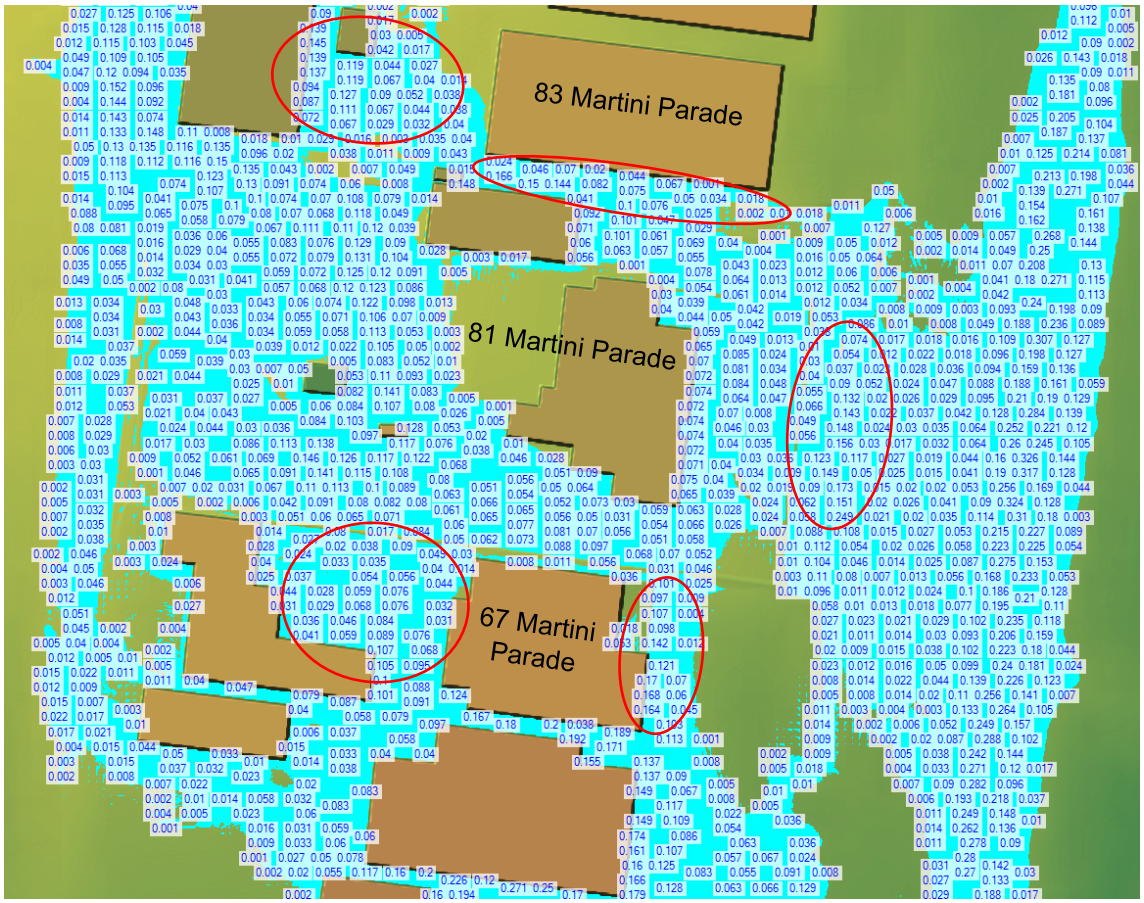

Figure 4-6: *Peak water depths for the existing scenario, depth values shown by the blue text, reference points circled in red.*

Finally, as the site is fairly flat and the volume of discharge within the overland flow path is relatively low (for a floodplain) when compared to the cross-sectional area, the velocities experienced during peak flows subsequently do not exceed 0.5m/s. Given this and the peak water depths, this equates to a velocity depth product of less than 0.4 thus these flows are considered safe for pedestrian traffic.

4.3.2. Developed

Noting that the proposed development is situated within the primary overland flow path for flood waters from Martini Parade it is critical to ensure that any changes to the topography do not result in any adverse flood impacts. Given that there are two townhouses proposed, these present a major obstruction of the flow paths and as such, could potentially result in increased flood levels on the neighbouring properties.

Noting the proposed obstructions, the modelling has indicated that water can be successfully conveyed though the developed site via a V-shaped driveway that acts as a shallow channel. This driveway is intended to help direct water through the site to a suitable discharge point in the northwestern corner. However, as the flow through the subject site arrives at both the southern and the eastern boundaries and it is restricted by the proposed townhouses, this driveway must therefore have sufficient capacity to convey flows, avoid any additional ponding upstream and also avoid directing water onto neighbouring properties.

To satisfy these requirements the site grading must account for the following considerations:

- The driveway cannot be built up in a way that inhibits flows passing through the site, particularly from the south as any step up in levels will result in additional ponding around 67 Martini Parade. As such the grading of the subject site, and particularly the driveway along the southern boundary, must tie into the existing levels to enable flows to travel though 67 Martini Parade unhindered.
- A small nib wall (<600mm high, top RL = 913.00m AHD) is required along the northern boundary to ensure the redirected flows travelling along the driveway do not subsequently flow into 83 Martini Parade. This wall is intended to deflect the majority of flows away from 83 Martini Parade and push them in a north westerly direction towards the lane way.
- The site grading is to ensure that the spill level and overflow capacity of the sag point in Martini Parade remains unaffected. Any increase in spill level (through raising the lot frontage) or reduction of overflow capacity will result in additional water being impounded within the sag point and will therefore push additional water north into 83 Martini Parade.

With these key considerations in mind, Calare Civil prepared a preliminary grading plan for the developed scenario, and it was this that was used to determine the potential flood impact of the proposed development and the corresponding design levels. From this grading plan it has been demonstrated that through careful consideration of the flood mechanisms and flow paths, negligible flood impact can be achieved. The approximate peak flood depth (and level) results for the “developed scenario” using the same reference locations adopted during the “existing scenario” are provided below with the resulting flood behaviour also depicted in **Figures 4-8** to **4-11.**

- Martini Parade Sag Point = 150 – 190mm (913.1m AHD)
- Front yard of 67 Martini Parade = 100 –170mm (913.2m AHD)
- Backyard of 67 Martini Parade = 10 – 110mm (912.8m AHD)
- Side path of 83 Martini Parade = 20 – 150mm (912.6 to 912.4m AHD)
- Backyard of 83 Martini Parade = 50 – 160mm (912.3m AHD)

The reference location and depths are also shown in **Figure 4-7**

Similarly to the flood depths experienced, there has been negligible impact of flow velocities, with all flows remaining within safe velocity / depth limits.

Finally, the peak water levels experienced on the subject site vary as the site gently grades to the back, as such different flood levels are experienced at the front and rear townhouses. The resulting planning levels are therefore as follows:

- Peak Water Level for the FRONT Townhouse = 913.1m AHD
- Design Habitable Floor Level for the FRONT Townhouse = 913.6m AHD (provides 500mm freeboard)
- Peak Water Level for the REAR Townhouse = 912.6m AHD
- Design Habitable Floor Level for the REAR Townhouse = 913.1m AHD (provides 500mm freeboard)
- Note, garage levels are required to sit 500-700mm below the habitable floor levels due to the required driveway configuration.

Based on these flood levels, the flood behaviour and the requirement to carefully control flows through the site, the recommendations / requirements for the proposed development are as follows:

- The driveway that provides access to the rear townhouses on the southern boundary must be designed as with a centre V profile as it is required to act as a shallow channel conveying water through the site. Water must be able to enter this “channel” in an unhindered way from both the southern and eastern boundaries. A detailed driveway and site grading design is required that takes into consideration the flood behaviour and design flow paths.
- A small nib wall (<600mm high, top RL = 913.00m AHD) is required along the northern boundary to ensure the redirected flows travelling along the driveway do not subsequently flow into 83 Martini Parade. This wall is intended to deflect the majority of flows away from 83 Martini Parade and push them in a north westerly direction towards the lane way.
- Filling at the front of the lot shall not impact on the spill level and overflow capacity of the sag point in Martini Parade
- The garages are to be set approximately 500-700mm below the habitable floor levels for each townhouse. This is permissible as they are not considered “habitable” spaces and it is also required to ensure they suitably tie into the required driveway levels.
- The garages should be graded such that water naturally drains away as flood waters subside. There should be no opportunity for water to be impounded.
- All habitable areas are to have a minimum floor level 500mm above the respective flood planning levels.
- The structural design of the townhouses needs to account for the inundation of the foundations and garages. Consideration of the subsequent hydraulic loads is therefore required.

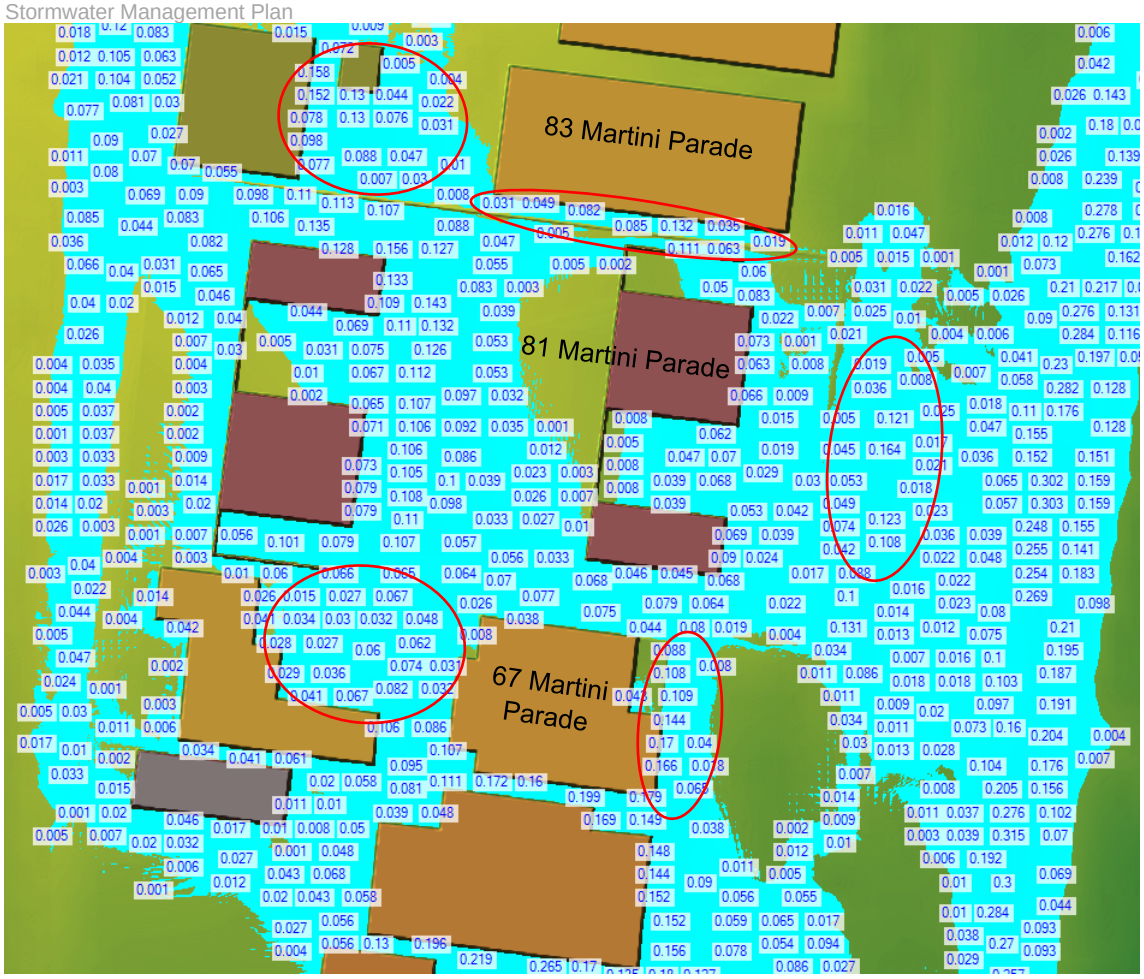

Figure 4-7: *Peak water depths for the "developed scenario", depth values shown by the blue text, reference points circled in red.*

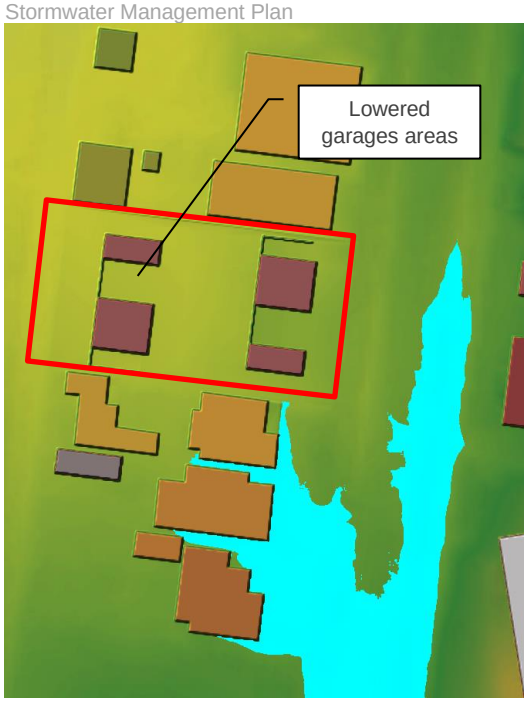

Figure 4-8: *Timestep 01:41:18 – Overland flows on Martini Parade travel towards the sag point with some breakout flows beginning to travel through properties to the south.*

Figure 4-9: *Timestep 02:16:36 – Inundation of the subject site commences and the garages of the rear townhouse inundated. The sag point on Martini Parade approaches its spill level of 913.00m AHD*

Figure 4-10*: Timestep 02:41:06 – Sag point begins to spill. Flow within the driveway along the southern boundary and through the site is fully developed. Inundation of the garages in the front townhouses commences.*

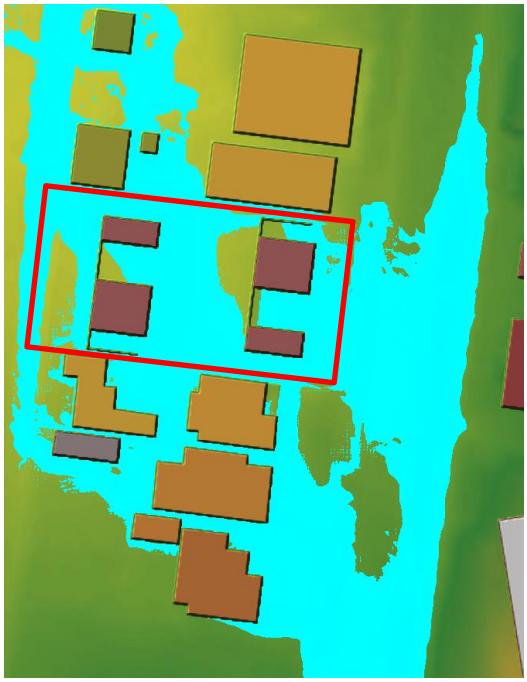

Figure 4-5: *Peak water levels noted as impacting the property to the north as well*

5. STORMWATER QUANTITY - REGIONAL FLOODING

The site is situated approximately 750 m from the centre of Farmers Creek. With the elevation of the site being approximately 8 – 10 m higher than the adjacent section of the creek bank, it is subsequently not impacted by flooding during the 1% AEP event. In addition, it is also not considered to be within the Farmers Creek floodplain or flood storage areas.

As noted in **Section 4**, the site is only impacted by local flooding associated with the unnamed tributary, as such regional flooding does not require further consideration.

For a depiction of the Farmers Creek and unnamed tributary floodplain, flood storage and flood fringe areas, please refer to Figure 6.4 of the LFSR Volume 2 – Figures.

6. CONCLUSION

6.1. Flood Impacts & Risk

The purpose of this report is to assess the local flooding within Martini Parade and to ascertain the peak flood level within the subject site so to inform the flood planning and habitable floor levels. The assessment also was required to confirm that no impact to the neighbouring sites is likely.

From the HEC-RAS modelling completed it is evident that if care is taken in the grading design of the site, negative impacts on flood conveyance and flood levels can be avoided. This is primarily achieved through the utilisation of the southern driveway to convey and control overland flows; this subsequently compensates for any obstruction of existing overland flow paths posed by the proposed development.

From the modelling it was found that with the control measures in place there was negligible impact on the flood levels experienced, with a peak water depths and levels being as follows:

- Martini Parade Sag Point = 150 – 190mm (913.1m AHD)
- Front yard of 67 Martini Parade = 100 –170mm (913.2m AHD)
- Backyard of 67 Martini Parade = 10 – 110mm (912.8m AHD)
- Side path of 83 Martini Parade = 20 – 150mm (912.6 to 912.4m AHD)
- Backyard of 83 Martini Parade = 50 – 160mm (912.3m AHD)

Similarly to the flood depths, there has been negligible impact of flow velocities, with no concentrated flow paths being developed and all flows remaining within safe limits velocity / depth limits.

With these anticipated water levels, the resulting design planning levels are required to be:

- Design Habitable Floor Level for the FRONT Townhouse = 913.6m AHD (provides 500mm freeboard)
- Design Habitable Floor Level for the REAR Townhouse = 913.1m AHD (provides 500mm freeboard)
- Note, garage levels are required to sit 500-700mm below the habitable floor levels due to the required driveway configuration.

6.2. Recommendations

During the detailed design of this development, Calare Civil recommend that the following be implemented to ensure no adverse flood impact is experienced:

- The driveway that provides access to the rear townhouses on the southern boundary must be designed by a civil engineering consultancy to avoid filling the floodway and to control flow through the site. As such it shall be “cut in” to avoid any steps up in the floodway and have a centre V profile to control flow direction. The final design is to be confirmed by flood modelling to ensure no negative impact on neighbouring properties and that the floor levels proposed in this report are still valid.
- A small nib wall (<600mm high, top RL = 913.00m AHD) is required along the northern boundary to ensure the redirected flows travelling along the driveway do not subsequently flow into 83 Martini Parade. This wall is intended to deflect the majority of flows away from 83 Martini Parade and push them in a north westerly direction towards the lane way.
- Filling at the front of the lot shall not impact on the spill level and overflow capacity of the sag point in Martini Parade.
- The garages are to be set approximately 500-700mm below the habitable floor levels for each townhouse this will ensure they can suitably tie into the required driveway levels.
- The garages should be graded such that water naturally drains away as flood waters subside. There should be no opportunity for water to be impounded.
- All habitable areas are to have a minimum floor level 500mm above the respective flood planning levels.
- The structural design of the townhouses needs to account for the inundation of the foundations and garages. Consideration of the subsequent hydraulic loads is therefore required.

7. LIFECYCLE COST ASSESSMENT

As this is a private development no assets are to be handed over to Council and so a cost assessment has not been undertaken.

8. ASSET HANDOVER

There are no assets to hand over to Council.

9. REFERENCES

1. Australian Rainfall & Runoff (AR&R) 2019:
    - Regional Flood Frequency Estimation Modelling
    - AR&R Data Hub
    - FFA-Reconciled Losses Map
    - WMA Water Review of AR&R Design Inputs for NSW - Appendix C
2. Bureau of Meteorology:
    - Design Rainfall Data System
3. NSW Water Management (General) Regulation 2018 Hydroline Spatial Data 1.0
4. Lyall & Associates
    - Lithgow Flood Study Review May 2017 Rev. 1.4 Volume 1 - Report
    - Lithgow Flood Study Review May 2017 Rev. 1.4 Volume 2 – Figures
5. NSW Department of Planning and Environment:
    - Flood Hazard: Flood Risk Management Guideline FB03, (June 2023).

APPENDIX A

Plans